MINUTES

Minutes of the **Seventy-fourth (74th) meeting** of the Senate held on **July 19, 2022 (Tuesday)** at **03.00 P.M.** in the Seminar Hall of the Institute.

Following members of the Senate attended the meeting:

1.	Prof. Rama Shanker Verma, Director	–	Chairman
2.	Prof. M.M. Gore	–	Member
3.	Prof. Anuj Jain	–	Member
4.	Prof. Geetika	–	Member
5.	Prof. R. K. Singh	–	Member
6.	Prof. P. K. Dutta	–	Member
7.	Prof. Haranath Kar	–	Member
8.	Prof. P. P. Sahay	–	Member
9.	Prof. A. D. Bhatt	–	Member
10.	Prof. Anil Kumar Sachan	–	Member
11.	Prof. Ajai Kumar Singh, CED	–	Member
12.	Prof. R. D. Gupta	–	Member
13.	Prof. R. K. Tripathi	–	Member
14.	Prof. R. S. Yadav	–	Member
15.	Prof. V. K. Srivastava	–	Member
16.	Prof. R. C. Vaishya	–	Member
17.	Prof. Ram Pal Singh	–	Member
18.	Prof. H. S. Goyal	–	Member
19.	Prof. Vijaya Bhadauria	–	Member
20.	Prof. Shubhi Purwar	–	Member

21.	Prof. Shiv Datt Kumar	–	Member
22.	Prof. S. S. Narvi	–	Member
23.	Prof. K. N. Pandey	–	Member
24.	Prof. R.K. Nagaria	–	Member
25.	Prof. P. K. Mehta	–	Member
26.	Prof. Ravi Prakash Tewari	–	Member
27.	Prof. S. J. Pawar	–	Member
28.	Prof. Shivesh Sharma	–	Member
29.	Prof. Anjana Pandey	–	Member
30.	Prof. Sadhana Sachan	–	Member
31.	Prof. L. K. Mishra	–	Member
32.	Prof. Rakesh Kumar	–	Member
33.	Prof. Raj Mohan Singh	–	Member
34.	Prof. A. K. Singh	–	Member
35.	Prof. D. S. Kushawaha	–	Member
36.	Prof. D. K. Yadav	–	Member
37.	Prof. Paulson Samuel	–	Member
38.	Prof. Asheesh Kumar Singh	–	Member
39.	Prof. Rajesh Gupta	–	Member
40.	Prof. Richa Negi	–	Member
41.	Prof. Ram Awadh Mishra	–	Member
42.	Prof. Pankaj Srivastava	–	Member
43.	Prof. Mukul Shukla	–	Member
44.	Prof. Avanish Kumar Dubey	–	Member
45.	Prof. Rajeev Srivastava	–	Member
46.	Prof. M.K. Khurana	–	Member
47.	Prof. S. N. Pandey	–	Member
48.	Prof. Tanuj Nandan	–	Member
49.	Prof. Ganesh Pd. Sahu	–	Member
50.	Dr. Sarvesh K. Tiwari, Registrar	–	Secretary

Special Invitees:

1. Dr. Abhishek Kumar, Head, Department of Applied Mechanics.
2. Dr. Vishnu Agarwal, Head, Department of Biotechnology.
3. Dr. Ravindra Tripathi, Head, Humanities and Social Sciences
4. Dr. Gorakh Nath, Department of Mathematics.
5. Dr. Naresh Kumar, Head, Department of Physics.
6. Dr. Vibhuti Tripathi, Head, School of Management Studies.

The following members could not attend the meeting:

1.	Prof. Rajeev Tripathi	–	Member
2.	Prof. Vinod Yadava	–	Member
3.	Prof. R. P. Tiwari	–	Member
4.	Prof. Neeraj Tyagi	–	Member
5.	Prof. Ravi Prakash	–	Member
6.	Prof. Amit Dhawan	–	Member
7.	Prof. G. K. Mehrotra	–	Member
8.	Prof. Vijay Shankar Tripathi	–	Member
9.	Prof. Madhu Dikshit	–	External Member
10.	Prof. Jai Prakash Saini	–	External Member
11.	Prof. Braj Bhushan	–	External Member

The Chairman, Senate extended a warm welcome to all the members and thanked them for taking their time out to join the meeting of the Senate.

The Senate deliberated on the agenda items and the agenda item-wise proceedings are as under:

Item No. 74.01 : **To confirm the minutes of the Seventy-third (73rd) meeting of the Senate held on March 24, 2022**

Resolution : The Senate considered the confirmation of the minutes of its Seventy-third (73rd) meeting held on March 24, 2022 along with observations on the above minutes received from Prof. Avanish Kumar Dubey in respect of resolution

No. 73.07 and 73.08. The Senate, after detailed deliberations on the observations resolved to confirm the minutes of the Seventy-third (73rd) meeting of the Senate with the following modifications in the resolution on the agenda item No 73.07 & 73.08:

Resolution on Agenda item No. 73.07.

For:

"The Senate considered the nomination of one Professor as a nominee of the Senate to the Board of Governors of the Institute as its member in terms of the Section 11 (f) of the NITSER Act-2007 as well as the guidelines accepted by the Senate for nomination of two members.

The Senate, in consideration of the above, resolved to nominate Prof. Ajai Kumar Singh, Department of Civil Engineering as a Professor nominee of the Senate to Board of Governors for period of two year w.e.f. April 01, 2022"

To be read as:

"The Senate considered the nomination of one Professor as a nominee of the Senate to the Board of Governors of the Institute as its member in terms of the Section 11 (f) of the NITSER Act-2007 as well as the guidelines accepted by the Senate for nomination of two members.

The Senate, in consideration of the above, resolved to nominate Prof. Ajai Kumar Singh, Department of Civil Engineering by consensus as a Professor nominee of the Senate to Board of Governors for period of two year w.e.f. April 01, 2022"

The Senate further suggested that the seniority list of faculty members may be finalised at the earlier.

Resolution on Agenda item No. 73.08.

For:

'The Senate considered the proposal and after deliberations resolved to accept for amendment as *"at least two accepted/published Journal papers in SSCI/SCI/Scopus indexed publications/ patent (approved / granted) as one of the criteria" for submission of thesis. The student shall be either the first author or second author (in case supervisor is the first author) and supervisor will certify that the papers are from the research work of the student.*

The Senate resolved that the amended norms shall be applied on the students who were admitted on or after session 2017-18."

To be read as:

"The Senate considered the proposal and after deliberations resolved to accept for amendment as at least two accepted/published Journal papers in SSCI/SCIE/Scopus indexed publications/ patent (approved / granted) as one of the criteria" for submission of thesis. The student shall be either the first author or second author (in case supervisor is the first author) and supervisor will certify that the papers are from the research work of the student.

The Senate resolved that the amended norms shall be applied on the students who were admitted on or after session 2017-18."

Item No. 74.02 : **To consider the action taken report on the decisions taken in the Seventy-third (73rd) meeting of the Senate held on March 24, 2022.**

Resolution : The Senate noted the action taken by the Institute on the decisions taken in its the Seventy-third (73rd) meeting held on March 24, 2022, as circulated.

Item No. 74.03 : **[A] To confirm and ratify the approval accorded by the Chairman, Senate on the following matters:**

(a) Recommendations of the Ph.D. Oral Boards of different departments.

(b) Recommendations of the meetings of the Standing Committee and Unfair Means Committee.

(c) Recommendations of the Chairman, SMPC.

(d) Recommendations of the Chairman, SDPC.

[B] To consider the recommendations of the Chairman, SUGC.

Resolution : [A] (a) The Senate confirmed and ratified the approval accorded by the Chairman, Senate on the recommendations of Ph.D. Oral Boards of following students of the Institute:

Sl. No.	Registration No.	Name	Department
1.	2017REL05	Mr. Devesh Shukla	ECED
2.	2015RBT06	Mr. Vivek Kumar	BOTD
3.	2016RME05	Mr. Srikant Tiwari	MED
4.	2014RAM52	Mr. Rahul Kumar Singh	AMD
5.	2017RMA02	Ms. Akansha Verma	MATHD
6.	2016RGI06	Md. Omar Sarif	GIS
7.	2018REL13	Mr. Shivam	ECED
8.	2016RCS03	Mr. Prince Rajpoot	CSED
9.	2016RCS51	Mr. Ankur Maurya	CSED
10.	2016RCE06	Mr. Arjun Prasad	CED
11.	2016RMA04	Mr. Saurabh Srivastav	MATHD
12.	2018RMS03	Ms. Chhaya Mani Tripathi	SMS
13.	2016RMS05	Ms. Ankita Khare	SMS
14.	2015RBT57	Mr. Abhishek Sharan	BOTD

(b) The Senate confirmed and ratified the approval accorded by the Chairman, Senate on the recommendations made by the Standing Committee in its meetings held on April 08, 2022; May 04, 2022; June 03 2022; June 06, 2022; & June 24, 2022.

A copy of the approved minutes of the above meetings of the Standing Committee is placed at **ANNEXURE–I**.

(c) The Senate confirmed and ratified the approval accorded by the Chairman, Senate on the recommendations made by the SMPC in its meeting held on April 05 & April 07, 2022; May 30, 2022; July 05, 2022 and July 14, 2022, subject to the following observations:

(i) The Senate considered the recommendations of the Chairman, SMPC on the request of the Department of Physics to run two year (four semester) Master of Science (M.Sc.) in Physics programme and approved the proposal in-principle. The detailed proposal with the financial and infrastructural requirements for starting the programme may be prepared & put up before the Senate.

(ii) The Senate considered the recommendations of the Chairman, SMPC on the request of the Department of Electrical Engineering for revision/ modifications in the existing Course Structure and Curriculum of M.Tech. programme (Regular) and Part time.

The Senate approved the proposed Course Structure and curriculum of M.Tech. Programme (Regular) and Part time with specialization in Control and Instrumentation, Power Electronics and Drives, and

Power System.

The revised/modified syllabus of the programme is placed at **ANNEXURE-II.**

A copy of the approved minutes of SMPC is placed at **ANNEXURE-III.**

(d) The Senate confirmed and ratified the approval accorded by the Chairman, Senate on the recommendations made by the SDPC on subject to following observation in respect of point No. 04 of the SPDC meeting held on 30.06.2022 in its meeting held on April 08, 2022; and May 18, 2022 and June 30, 2022

The Senate deliberated on the request of Mr. Mohit Kumar (Registration No. 2021RCS14) for grant of post facto approval to attend online classes in the even semester 2021-22 from 02.03.2022 onwards till end of the semester and resolved turned down his request.

The Senate also resolved that the student may be advised to take semester leave by the Department.

A copy of the approved minutes of SDPC is placed at **ANNEXURE-IV.**

[B] The Senate considered the following recommendations of the SUGC which were put up before the Senate by the Chairman, SUGC for consideration.

(i) The Senate considered the recommendations of the SUGC to rename the proposed new 1st year course of 'English Language and Technical Communication' to 'Professional Communication' and approved the same.

(ii) The Senate considered the recommendations of the SUGC to propose the new 1st year course of 'Environment and Climate Change' to be a 2-credit course instead of the present proposed zero (0) credit course and approved the same.

(iii) The Senate deliberated on the modalities through which the students going on internship in VIII semester would require to complete the theory courses of VIII semester and the evaluation their work during internship. The Senate resolved to constitute an Institute level Committee to give its recommendations, which will be placed before the Senate/Chairman, Senate for consideration.

(iv) The Senate considered the request of Mr. Shashank Tiwari (20183038), a B.Tech. student of the Department of Mechanical Engineering to appear in the forthcoming supplementary examination to improve his SPI from 4.93 to 5 or more in 3rd Semester and after deliberations resolved to allow the student to appear in the Supplementary Examination for 3rd Semester subjects, as a special case.

Item No. 74.04 : **To consider the progress of implementation of National Education Policy (NEP) – 2020 in the Institute.**

(a) Discussion and finalization on B.Tech. 1st Semester for Course Structure & Curriculum.

(b) Discussion on 03 New UG programmes.

Resolution : (a) The Senate deliberated on the report of the Committee constituted for preparation of B.Tech. 1st Semester course structure and Curriculum (Common Syllabus) in-line with NEP-2020 and accepted the recommendations of the report.

The Senate resolved to complete the BoAC meetings of all the departments till Aug 31, 2022 to finalize the complete B.Tech. Course Structure & Curriculum (if not already completed) in light of the recommendations of the Committee.

(b) The Senate considered the proposal of the Department of Applied Mechanics for starting two new B.Tech. Programmes in Aerospace Engineering and Metallurgy Engineering and observed that the Departments has already proposed two new B.Tech. courses namely B.Tech. (Engineering and Computational Mechanics) & B. Tech. (Material Engineering), which are in the approval stage by the Finance Committee & the Board of Governors.

The Senate in light of the same resolved to consider these two proposed programme, after start of the other two programmes, approval of which is in process.

Item No. 74.05 : **To consider the two proposal received for Institution of Gold Medal as recommended by Senate Scholarship Medal Award and Prizes Committee.**

Resolution : The Senate considered the recommendations of the Senate Scholarship, Medal Award and Prizes Committee & accepted the proposal for institution of following two new Sponsored Gold Medals.

(i) The Senate considered the request made by Mrs. Shashi Gupta, W/o Late Brig. Arvind Agrawal, an alumnus of BE (Mechanical) first division with Honours in 1974 of the Institute for institution of a new gold medal sponsored by her in the name of Late Brig. Arvind Agrawal to be named as "Late Brig. Arvind Agrawal Gold Medal", The medal will be awarded to the overall first position holder of Mechanical Engineering (second year) students of B.Tech. Programme as per recommendations of the Senate Scholarship Medal Award and Prizes Committee.

(ii) The Senate considered the request made by Prof. Manoj Madhava Gore, S/o Late (Shrimati) Malati Madhava Gore, an alumnus of the Institute of M.Tech. [Computer Science and Engineering] first batch [1989-91], for the institution of a new gold medal, sponsored by him in the name of Late (Shrimati) Malati Madhava Gore to be known as "Late (Shrimati) Malati Madhava Gore Memorial Gold Medal, for Institute faculty member", which will be awarded to best faculty member among the Assistant Professors and Associate Professors of the institute working on permanent positions.

The Senate considering the details presented as above resolved to accept the proposal for Institution of two Gold medals as above. The Senate also observed that for change of purpose of Gold Medal at No. 2 as recommended by the Committee, consent of the concerned sponsored may be obtained.

The Senate further resolved that as per approved guidelines for institution of Gold Medals, the recommendations of the Senate on the matter be placed before the Board of Governors for approval.

Item No. 74.05 : **Any other matter with the permission of the Chair**

Resolution : The Senate considered the following matters with the permission of the Chairman, Senate:

(i) The Senate deliberated on the report of the Equivalence Committee for examining the course curriculum of the M.Sc. (Mathematics and Scientific Computing) programme offered by the Department of Mathematics, MNNIT Allahabad and evaluating its equivalence with two year M.Sc. (Mathematics) P.G. course offered by other Indian Universities/Institutes and resolved to accept the recommendations of the Committee.

A copy of the report of the Committee is placed at **ANNEXURE-V**.

(ii) The Senate considered the proposal for allowing admission to Ph.D. programme with fellowship to the students with Master's degree but without valid GATE/NET Score. The Senate after detailed deliberations resolved in principle to allow for 15 (fifteen) seats for such candidates.

The Senate also agreed that the fellowship to such admitted candidates may be provided through funds available with Dean (R&C). The Senate further resolved that the Dean (R& C) may work out detailed modalities for the grant of fellowship and put up the same before the Senate for further consideration.

The meeting concluded with the vote of thanks to the Chair.

12/08/22

(Sarvesh K. Tiwari)
Registrar / Secretary

Approved

18/8/22

(Rama Shanker Verma)
Director / Chairman

Director
M.N.N.I.T. Allahabad
Prayagraj

कार्यालय अधिष्ठाता [शैक्षिक]
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
प्रयागराज - २११००४ [उ०प्र०] भारत
Office of the Dean [Academic]
Motilal Nehru National Institute of Technology Allahabad
Prayagraj – 211004 [UP] India

ANNEXURE–I

19.4.22 2022 4.30 19.00 158

Dated:-08-04-2022

Minutes of the Meeting of Standing Committee (Grade Discrepancy) held on 08-04-2022 [Friday] at 04:00 PM in the office of Dean (Academic). Following members were present:

Prof. R.K Singh, Dean (Academic)	- Chairman
Prof V.K. Srivastava, ECED	- Senate Nominee
Prof. Paulson Samuel, Dean [Student Welfare]	- Member
Prof. Vijaya Bhadauria Chairperson SDPC	- Member
Prof. R.A. Mishra, Chairman SMPC	- Member
Prof. Mukul Shukla Chairman SUGC	- Member
Dr. Anubhav Rawat, MED	- Special Invitee
Dr. Basant Kumar F.I. [Examination]	- Convener

1. The committee reviewed the case of following students for grade discrepancy during End (Odd) Semester Examination 2021-22 (B.Tech. 3rd Semester & MCA 1st Semester). The Committee recommended the following:

SL. NO	REGISTRATION NO.	NAME OF STUDENT/ DEPARTMENT	DEPARTMENT	COURSE CODE	SUBJECT NAME	GRADE		COMMENTS	NAME OF COURSE COORDINATOR / INSTRUCTOR
						OLD	NEW		
1.	20200014	AYUSH GUPTA	Chemical	AM13207	Fluid Flow Operation Laboratory	B	A+	Due to error the marks of end sem viva could not be added in the practical exam.	Dr. Anubhav Rawat
2.	20200027	LOVEKUSH KUSHWAH	Biotechnology	AM13205	Biomaterial Science and Engineering Laboratory	B+	B+	No Change in Grade	Dr. R. Sujithra
3.	20200027	LOVEKUSH KUSHWAH	Biotechnology	BT13101	Biochemistry	B+	B+	No Change in Grade	Dr. Sangeeta Negi
4.	20201039	DEBADWAR GAURI ATUL	Civil	CE13201	Building Planning & Construction (Lab.)	C	C	No Change in Grade	Dr. P. R. Pal
5.	20201039	DEBADWAR GAURI ATUL	Civil	CE13202	Computer Based Numerical Techniques (Lab.)	B+	B+	No Change in Grade	Dr. Pramod Soni
6.	20201057	KANDUKURI YASWANTH	Civil	CE13202	Computer Based Numerical Techniques (Lab.)	A	A	No Change in Grade	Dr. Pramod Soni
7.	20201057	KANDUKURI YASWANTH	Civil	AM13101	FLUID MECHANICS-I	A	A	No Change in Grade	Dr. A. R. Paul
8.	20201075	PIYUSH KASHYAP	Civil	AM13101	FLUID MECHANICS-I	A	A	No Change in Grade	Dr. A. R. Paul

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9.	20201105	SHIVAM VERMA	Civil	AM13101	FLUID MECHANICS-I	B+	B+	No Change in Grade	Dr. A. R. Paul
10.	20201057	KANDUKURI YASWANTH	Civil	AM13201	FLUID MECHANICS-I LABORATORY	A	A	No Change in Grade	Dr. Tanmoy Mondal
11.	20201075	PIYUSH KASHYAP	Civil	AM13201	FLUID MECHANICS-I LABORATORY	B+	B+	No Change in Grade	Dr. Tanmoy Mondal
12.	20203043	AYUSH KUMAR	Mechanical	AM13203	MATERIALS SCIENCE AND ENGINEERING LABORATORY	B	B	No Change in Grade	Dr. Ajaya Bharti
13.	20203156	VED PRAKASH SINGH	Mechanical	AM13203	MATERIALS SCIENCE AND ENGINEERING LABORATORY	B+	B+	No Change in Grade	Dr. Ajaya Bharti
14.	20206034	RAHUL MODI	Mechanical	AM13203	MATERIALS SCIENCE AND ENGINEERING LABORATORY	A	A	No Change in Grade	Dr. Ajaya Bharti
15.	20209018	ASHOK JANGID	Chemical	AM13203	MATERIALS SCIENCE AND ENGINEERING LABORATORY	B	B	No Change in Grade	Dr. Ajaya Bharti
16.	20203138	SHIVAM OJHA	Mechanical	AM13104	Strength of Materials	B+	B+	No Change in Grade	Dr. V. Murari
17.	20203138	SHIVAM OJHA	Mechanical	ME13101	Engineering Thermodynamics	A	A	No Change in Grade	Dr. Ashwini Kumar Yadav
18.	20203144	SHUBHAM KUMAR	Mechanical	ME13101	Engineering Thermodynamics	B+	B+	No Change in Grade	Dr. Ashwini Kumar Yadav
19.	20203156	VED PRAKASH SINGH	Mechanical	ME13101	Engineering Thermodynamics	B+	B+	No Change in Grade	Dr. Ashwini Kumar Yadav
20.	20203138	SHIVAM OJHA	Mechanical	ME13201	Computational Lab	A	A	No Change in Grade	Dr. Ravindra Kumar Patel
21.	20203143	SHIVANSH BAJPAI	Mechanical	ME13201	Computational Lab	B+	B+	No Change in Grade	Dr. Ravindra Kumar Patel
22.	20203144	SHUBHAM KUMAR	Mechanical	ME13201	Computational Lab	B+	B+	No Change in Grade	Dr. Ravindra Kumar Patel
23.	20203156	VED PRAKASH SINGH	Mechanical	AM13102	Kinematics of Machines	B+	B+	No Change in Grade	Dr. Ashutosh Kumar Upadhyay
24.	20203156	VED PRAKASH SINGH	Mechanical	AM13103	Materials Science and Engineering	B+	B+	No Change in Grade	Dr. S. J. Pawar
25.	20206034	RAHUL MODI	Mechanical	AM13103	Materials Science and Engineering	A	A	No Change in Grade	Dr. S. J. Pawar
26.	20206034	RAHUL MODI	Mechanical	AM13204	Strength of Materials Laboratory	A	A	No Change in Grade	Dr. Satish Kumar

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27	20206034	RAHUL MODI	Mechanical	ME13201	Computational Lab	A	A	No Change in Grade	Dr. Swastik Acharya
28.	20209018	ASHOK JANGID	Chemical	ME13201	Computational Lab	B+	B+	No Change in Grade	Dr. Swastik Acharya
29.	20209018	ASHOK JANGID	Chemical	AM13107	Fluid Flow Operation and Hydraulic Machines	B	B	No Change in Grade	Dr. Vivek Kumar Patel
30.	2021ca086	Ravindra Kumar	MCA 1st sem	CS31101	Programming & Problem solving	B	B	No Change in Grade	Dr. Anoj Kumar

2. The Committee discussed the case of Ph.D. student Mr. Omar Sarif (2016RGI06) who has requested for correction in his 10th Semester Mark Sheet; 'Open Seminar' Course is to be included, which the student delivered on 12 July 2021. The Committee recommends for the desired update in the grade sheet.

3. The Committee discussed the case of Ph.D. student Ms. Yogita Dwivedi (2017RMS02) and found that she had delivered 'Open Seminar' on December 10, 2021 and dropped the 'Thesis Performance Course', but her result did not reflect the same due to some technical error. Therefore, Committee recommends to update the result of the student.

4. The Committee discussed the case of Ph.D. student Mr. Dinesh Kumar Singh (2015REE54) and found that his 11th Semester result displayed "W" grade. A duly approved DP-04 form related to "Dropping of "Thesis Performance" course was received in this regard. The Committee observed a similar case of Mr. Maneesh Upadhya (2015REE07) who had a 'W' grade in 12th Semester. Therefore Committee recommends to update the results of these students.

Meeting ended with thanks to Chair.

08/04/2022
Dr. Basant Kumar
Faculty In-Charge Examination

8/4/22
Prof. Mukul Shukla
Chairman, SUGC

8/4/2022
Prof. R.A. Mishra
Chairman, SMPC

8/4/22
Prof. Vijaya Bhadauria
Chairperson, SDPC

8/4/22
Prof. Paulson Samuel
Dean (Student Welfare)

8-4-22
Prof. V.K. Srivastava
(Senate Nominee)

Prof. R. K. Singh
Dean (Academic)

Director

The recommendations of the Standing Committee above may kindly be approved.

18/04/2022
अधिष्ठाता (शैक्षणिक)/Dean (Academic)
मोतीलाल नेहरू रा.प्रौ.सं. इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

20/4/22

Exam Cell
21/4/22

F.I. (Exam)
21/4/

मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
Motilal Nehru National Institute of Technology Allahabad
टिप्पणी एवं आदेश
Notes & Orders

Dated: May 4, 2022

MINUTES

Minutes of the Senate Standing Committee meeting held on May 04, 2022 (Monday) at 12:00 p.m. in the chamber of Dean (Academic).

Following persons were present in the meeting:

1.	Prof. R. K. Singh, Dean (Academic)	–	Chairman
2.	Prof. V. K. Srivastava, ECED (Senate Nominee)	–	Member
3.	Prof. Paulson Samuel, Dean (Students Welfare)	–	Member
4.	Prof. Vijaya Bhadauria, Chairperson, SDPC	–	Member
5.	Prof. R. A. Mishra, Chairman, SMPC	–	Member
6.	Prof. Mukul Shukla, Chairman, SUGC	–	Member

The Chairman extended welcome to the members and thanked them for taking their time out to attend the meeting.

Agenda item-wise proceedings are as under:

Item No. 01 : **To consider the dates of various academic activities for revised academic calendar**

Resolution : The Committee discussed the dates of various academic activities for in the new academic calendar and agreed upon the scheduled activities as per the new academic calendar. [Annexure- 1]

The meeting concluded with the vote of thanks to the Chair.

The Hindi translation of the above minutes is as under:-

सीनेट की स्थायी समिति की बैठक 04 मई, 2022 (सोमवार) को अपराह्न 12:00 बजे अधिष्ठाता (शैक्षिक) के कक्ष में संपन्न हुई ।

उक्त बैठक में निम्नलिखित सदस्य उपस्थित हुए:-

1.	प्रो0 रवीन्द्र कुमार सिंह, अधिष्ठाता (शैक्षिक)	–	अध्यक्ष
2.	प्रो0 वी0 के0 श्रीवास्तव, सीनेट नामांकित सदस्य	–	सदस्य
3.	प्रो0 पॉल्सन सैमुवल, अधिष्ठाता (छात्र कल्याण)	–	सदस्य
4.	प्रो0 विजया भदौरिया, अध्यक्ष,एस0डी0पी0सी0	–	सदस्य
5.	प्रो0 आर0 ए0 मिश्रा, अध्यक्ष,एस0एम0पी0सी0	–	सदस्य
6.	प्रो0 मुकुल शुक्ला, अध्यक्ष,एस0यू0जी0सी0	–	सदस्य

अध्यक्ष महोदय ने सदस्यों का स्वागत किया और बैठक में भाग लेने के लिए समय निकालने के लिए उन्हें धन्यवाद दिया।

बैठक में निम्नलिखित महत्वपूर्ण मदों पर बिचार विमर्श किया गया।

मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
Motilal Nehru National Institute of Technology Allahabad

टिप्पणी एवं आदेश
Notes & Orders

मद संख्या 1: संशोधित शैक्षणिक कलैण्डर हेतु विभिन्न शैक्षणिक गतिविधियों की तिथियों पर विचार विमर्श करना

संकल्प समिति ने नए शैक्षणिक कैलेंडर में विभिन्न शैक्षणिक गतिविधियों की तारीखों पर चर्चा की और नए शैक्षणिक कैलेंडर के अनुसार निर्धारित गतिविधियों पर सहमति व्यक्त की। (संलग्नक-अ)

अध्यक्ष महोदय द्वारा सभी गणमान्य सदस्यों के प्रति धन्यवाद के साथ बैठक सम्पन्न हुई।

4/5/22	4-5-2022	4/5/22
(Mukul Shukla)	**(R. A. Mishra)**	**(Vijaya Bhadauria)**
Chairman, SUGC	Chairman, SMPC	Chairperson, SDPC
4/5/2022	04-05-2022	4/5/2022
(Paulson Samuel)	**(V. K. Srivastava)**	**(R. K. Singh)**
Dean (Students Welfare)	Professor, ECED	Dean (Academic)

04.5.22 05.5.22
545 12.30
341

Director

Recommendation made in the above said meeting is put up before you for your kind Consideration and approval pl

4/5/2022

अधिष्ठाता (शैक्षणिक)/Dean (Academic)
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

5/5

निदेशक
मो. ने. रा. प्रौ. सं. इलाहाबाद
इलाहाबाद

मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
Motilal Nehru National Institute of Technology Allahabad

टिप्पणी एवं आदेश
Notes & Orders

07.4.2022
10 AM
SS

Dated : 06.04.2022

Director

The Minutes of the meeting of Heads and Deans held today at 4:00 PM to address the concerns raised by the students is placed at flag 'A'.

Submitted for your kind approval, if deemed fit.

06/04/2022

Dean (Academic)
अधिष्ठाता (शैक्षिक)/**Dean (Academic)**
मो०ने०रा०प्रौ०सं० इलाहाबाद/**MNNIT Allahabad**
प्रयागराज-211004 (भारत)/**Prayagraj-211004 (INDIA)**

approved
Rsaini
6/4

निदेशक
मो. ने. रा. प्रौ. सं. इलाहाबाद
इलाहाबाद

संलग्नक - अ
ANNEX - A

Revised Academic Calendar

Events	Academic Session 2021-22, w.e.f. April 20, 2022.			
	B. Tech (6th, 8th sem), Ph.D./ M.Tech. (2nd sem), MSc (2nd and 4th sem), MBA (2nd and 4th sem)**	**B. Tech. 4th sem and MCA 4th sem**	**B.Tech. 2nd Sem***	**MCA 2nd sem**
Start of Classes	03 January 2022	21 March 2022	01 June 2022	15 February 2022
1st Short attendance notice	--	13 May 2022	08 July 2022	06 May 2022
Mid Sem Exam	--	17-24 May 2022	11 – 13 July 2022	09-14 May 2022
2nd Short Attendance notice	--	~~05 August 2022~~ 15 July 2022	11 August 2022	22 July 2022
End of Classes	27 April 2022	~~12 August 2022~~ 22 July 2022	24 August 2022	29 July 2022
End Sem Practical	25 April– 05 May 2022	~~04-12 August 2022~~ 15 July – 22 July 2022	16-24 August 2022	01-04 August 2022
End Sem Examination	09-14 May 2022	~~16- 24 August 2022~~ 25 July – 30 July 2022	25-31 August 2022	05-13 August 2022
Summer Break	15 May – 11 July 2022	~~25 May – 26 June 2022~~ 25 May – 05 June 2022	20 April -29 May 2022	21 May – 30 June 2022
Grade Submission	18 May 2022	~~29 August 2022~~ 08 August 2022	05 September 2022	19 August 2022
Declaration of Result	21 May 2022	~~31 August 2022~~ 12 August 2022	07 September 2022	31 August 2022
Grade Discrepancy Registration	22-24 May 2022	~~02-04 September 2022~~ 14 -17 August 2022	08-10 September 2022	02-04 September 2022
Grade Discrepancy Result	26 May 2022	~~06 September 2022~~ 22 August 2022	13 September 2022	06 September 2022
Supplementary Registration	22-27 May 2022	~~02-07 September 2022~~ 14 – 23 August 2022	08- 14 September 2022	02-07 September 2022
Supplementary Examination	31 May-4 June 2022	~~12-16 September 2022~~ 26 – 31 August 2022	19-24 September 2022	12-16 September 2022
Supplementary Grade Submission	07 June 2022	~~20 September 2022~~ 5 September 2022	27 September 2022	20 September 2022
Supplementary Result	10 June 2022	~~22 September 2022~~ 7 September 2022	29 September 2022	22 September 2022
	Academic Session 2022-23#			
	B. Tech (7th sem), Ph.D./ M.Tech (3rd sem), MSc (3rd sem), MBA (3rd sem)	**B. Tech. 5th sem and MCA 5th sem**	**B.Tech. 3rd Sem**	**MCA 3rd sem**
Registration	25 May- 18 July 2022	~~31 August – 25 September 2022~~ 13 August – 12 September 2022	7 September – 06 October 2022	31 August – 25 September 2022
Start of Classes	18 July 2022	~~19 September 2022~~ 16 August 2022	19 September 2022	

***The classes for B.Tech. second semester will be conducted six days per week. The first Saturday will be observed as Monday and the second Saturday will be considered as Tuesday and so on, for conducting the classes.**

****The dates for semester progress presentation for Ph.D. and thesis presentation of M.Tech. students are May 02 - July 18, 2022. Submission of grades will be done by July 22, 2022 and result will be declared on July 26, 2022. Next semester registration for Ph.D. students shall take place during July 27 - Aug 18, 2022. Note:**

#The academic calendar for first year students of session 2022-23 shall be notified according to the counselling schedule

Academic Calendar B.Tech and MCA 2nd year

May-22				
S	1			
M	2			28
T	3		Id Ul Fitr	
W	4			29
T	5			30
F	6			31
S	7			
S	8			
M	9			32
T	10			33
W	11			34
T	12			35
F	13			36
S	14			
S	15			
M	16		Buddh Poornima	
T	17	1	Mid Semester Examination	
W	18	2		
T	19	3		
F	20	4		
S	21			
S	22			
M	23	5	Mid Semester Examination	
T	24	6		
W	25	1	mid-sem break	
T	26	2		
F	27	3		
S	28	4		
S	29	5		
M	30	6		
T	31	7		

June-22				
W	1	8	mid sem break	
T	2	9		
F	3	10		
S	4	11		
S	5	12		
M	6		Classes resume after break	37
T	7			38
W	8			39
T	9			40
F	10			41
S	11			
S	12			
M	13			42
T	14			43
W	15			44
T	16			45
F	17			46
S	18			
S	19			
M	20			47
T	21			48
W	22			49
T	23			50
F	24			51
S	25			
S	26			
M	27			52
T	28			53
W	29			54
T	30			55

July-22				
F	1			56
S	2			
S	3			
M	4			57
T	5			58
W	6			59
T	7			60
F	8			61
S	9			
S	10			
M	11			62
T	12			63
W	13			64
T	14			65
F	15	1	2nd short notification	66
S	16	2	Practical Examinations	
S	17			
M	18	3		67
T	19	4		68
W	20	5		69
T	21	6		70
F	22	7	End of Classes	71
S	23			
S	24			
M	25	1	End Semester Examination	
T	26	2		
W	27	3		
T	28	4		
F	29	5		
S	30	6		
S	31			

August-22				
M	1			
T	2			
W	3			
T	4			
F	5			
S	6			
S	7			
M	8		Submission of Grades	
T	9		Muharram	
W	10			
T	11			
F	12		Declaration of Results	
S	13		6th Sem Registration Starts	
S	14		Supplementary/Grade Discrepancy Registration (Starts)	
6 M	15		Independence Day	
T	16		Start of classes of 6th Semester	
W	17		Grade Discrepancy Registration (Ends)	
T	18			
F	19			
S	20			
S	21			
M	22		Grade Discrepancy Result	
T	23		Supplementary Registration Ends	
W	24			
T	25			
F	26	1	Supplementay Exams	
S	27	2		
S	28			
M	29	3		
T	30	4		
W	31	5		

September-22			
T	1		
F	2		
S	3		
S	4		
M	5		Supplementary Grade Submission
T	6		
W	7		Supplementary Result
T	8		
F	9		
S	10		
S	11		
M	12		5th Sem Registration Ends
T	13		
W	14		
T	15		
F	16		
S	17		
S	18		
M	19		
T	20		
W	21		
T	22		
F	23		
S	24		
S	25		
M	26		
T	27		
W	28		
T	29		
F	30		

MINUTES

Minutes of the All Heads and Deans meeting with the Director held on April 06, 2022 (Wednesday) at 04:00 p.m. in the Conference Room of Director's Office.

Following persons were present in the meeting:

1.	Prof. Rama Shanker Verma, Director	–	Chairman
2.	Prof. R. K. Singh, Dean (Academic)	–	Member
3.	Prof. M. M. Gore, Dean (Faculty Welfare)	–	Member
4.	Prof. Geetika, Dean (RG&IA)	–	Member
5.	Prof. R. S. Yadav, Dean (R&C)	–	Member
6.	Prof. Paulson Samuel, Dean (Students Welfare)	–	Member
7.	Dr. A. R. Paul, Head (Oftg.), AMD	–	Member
8.	Dr. Vishnu Agarwal, Head, BTD	–	Member
9.	Dr. Sushil Kumar, Head, Chem. Engg.	–	Member
10.	Dr. Tamal Ghosh, Head, Chemistry	–	Member
11.	Prof. P. K. Mehta, Head, CED	–	Member
12.	Prof. D. S. Kushwaha, Head, CSED	–	Member
13.	Prof. Rajesh Gupta, Head, EED	–	Member
14.	Prof. V. K. Srivastava, Chairperson, GIS Cell	–	Member
15.	Dr. Ravindra Tripathi, Head, HSSD	–	Member
16.	Dr. Mukesh Kumar, Head, Mathematics	–	Member
17.	Prof. K. N. Pandey, Head, MED	–	Member
18.	Dr. Naresh Kumar, Head, Physics	–	Member
19.	Dr. Tripti Singh, Head (Oftg.), SMS	–	Member
20.	Prof. D. K. Yadav, Chief Warden (Boys Hostels)	–	Special Invitee
21.	Prof. Anjana Pandey, Chief Warden (Girls Hostels)	–	Special Invitee
22.	Dr. Nitin Singh, Faculty In-charge (Admission)	–	Special Invitee
23.	Dr. Basant Kumar, Faculty In-charge (Examination)	–	Special Invitee

The Chairman extended warm welcome to the members and thanked them for taking their time out to attend the meeting.

Agenda item-wise proceedings are as under:

Item No. 01 : **To consider the evaluation scheme for forthcoming End Semester Examination 2021-22 (Even Semester)**

Resolution : The Committee deliberated on the proposal of the Examination Cell regarding evaluation scheme for forthcoming End Semester Examination 2021-22 (Even

Semester) for those batches who have studied partially in online mode and partially in offline mode. After detailed deliberation the Committee recommends that the 60 marks of End Semester Examination should be bifurcated in two components as 30 marks of examination of 1.5 hours (minimum) and 30 marks can be carried forward on the basis of CPI of previous semester[Max(Previous Semester CPI,SPI)]

This has been further decided that it is a onetime measure only for those students who have studied part of course in offline mode and part of the course in online mode.

This decision shall not be used as precedence in future.

The meeting concluded with the vote of thanks to the Chair.

06/04/2022
(F.I. Exam)

06/04/2022
Dean(Academic)

Director
The recommendations of the Heads & Deans meeting is submitted for your approval please.

06/04/2022
अधिष्ठाता (शैक्षिक)/Dean (Academic)
मो०ने०रा०प्रौ०सं० इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

6/4/2022
निदेशक
मो. ने. रा. प्रौ. सं. इलाहाबाद
इलाहाबाद

MNNIT WEBMAIL

Dean Academic default <academics@mnnit.ac.in>

Draft Minutes of the standing committee meeting held on 04.04.2022

3 messages

Dean (Academic) <academics@mnnit.ac.in> Tue, Apr 5, 2022 at 5:15 PM
To: Dean Academic default <deanacademic@mnnit.ac.in>, Vinay Kumar Srivastava FACULTY <vinay@mnnit.ac.in>, Dean Student Welfare <deansw@mnnit.ac.in>, "Prof. Paulson Samuel" <paul@mnnit.ac.in>, "Prof. A.K.Sachan SDPC" <sdpc@mnnit.ac.in>, "Prof. R. K. Nagaria SMPC" <smpc@mnnit.ac.in>, "Prof. Ram Awadh Mishra" <ramishra@mnnit.ac.in>, Chairman SUGC <sugc@mnnit.ac.in>, "Prof. Mukul Shukla" <mukulshukla@mnnit.ac.in>, Vijaya Bhadauria FACULTY <vijaya@mnnit.ac.in>, "Nitin Singh Lect. EED FACULTY" <nitins@mnnit.ac.in>

Sir/Madam,

Please find attached herewith the document in reference to the above mentioned subject.

Please find the attachment and incorporate any suggestions as required.

Regards,
--
अधिष्ठाता (शैक्षिक) कार्यालय || Office of the Dean (Academic)
मोतीलाल नेहरु राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद ||
Motilal Nehru National Institute of Technology Allahabad
प्रयागराज - २११००४ (उत्तर प्रदेश) भारत || Prayagraj - 211004 (UP) INDIA
****

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531K

Vijaya Bhadauria FACULTY <vijaya@mnnit.ac.in> Tue, Apr 5, 2022 at 11:43 PM
To: "Dean (Academic)" <academics@mnnit.ac.in>
Cc: Dean Academic default <deanacademic@mnnit.ac.in>, Vinay Kumar Srivastava FACULTY <vinay@mnnit.ac.in>, Dean Student Welfare <deansw@mnnit.ac.in>, "Prof. Paulson Samuel" <paul@mnnit.ac.in>, "Prof. A.K.Sachan SDPC" <sdpc@mnnit.ac.in>, "Prof. R. K. Nagaria SMPC" <smpc@mnnit.ac.in>, "Prof. Ram Awadh Mishra" <ramishra@mnnit.ac.in>, Chairman SUGC <sugc@mnnit.ac.in>, "Prof. Mukul Shukla" <mukulshukla@mnnit.ac.in>, "Nitin Singh Lect. EED FACULTY" <nitins@mnnit.ac.in>

One line should be added at the end of agenda number 2
"keeping in view the time constraints an emergent meeting of senate may be called".
Rest is fine in my opinion.

Vijaya Bhadauria
[Quoted text hidden]

Dean (Academic) <academics@mnnit.ac.in> Wed, Apr 6, 2022 at 9:14 AM
To: Vijaya Bhadauria FACULTY <vijaya@mnnit.ac.in>

Thank you Ma'am for your valuable input.
[Quoted text hidden]

06.6.22 10.6.22
9.45 9.30
650

MINUTES

Minutes of the Senate Standing Committee meeting held on June 03, 2022 (Friday) at 11:00 P.M. in the chamber of the Dean (Academic).

Following persons were present in the meeting:

1.	Prof. R. K. Singh, Dean (Academic)	–	Chairman
2.	Prof. V. K. Srivastava, ECED (Senate Nominee)	–	Member
3.	Prof. Vijaya Bhadauria, Chairperson, SDPC	–	Member
4.	Prof. R. A. Mishra, Chairman, SMPC	–	Member
5.	Prof. Mukul Shukla, Chairman, SUGC	–	Member
6.	Prof. D.K.Yadav, Chief Warden(Boys) & Dean(SW) Oftg.	–	Special Invitee
7.	Prof. Anjana Pandey, Chief Warden(Girls)	–	Special Invitee

The Chairman extended warm welcome to the members and thanked them for taking their time out to attend the meeting.

Agenda item-wise proceedings are as under:

Item No. 01 : **To discuss upon the issue of students facing difficulties in attending classes due to prevailing hot weather conditions.**

Resolution : The Committee discussed upon the issue of students facing difficulties in attending classes due to prevailing hot weather conditions and agreed upon rescheduling of the academic timetable periods as per the following slots to relieve the students and faculty :

Period 1 : 7:30 AM to 8:20 AM
Period 2 : 8:20 AM to 9:10 AM
Period 3 : 9:10 AM to 10:00 AM
Period 4 : 10:00 AM to 10:50 AM
BREAK : 10:50 AM to 11:00 AM
Period 5 : 11:00 AM to 11:50 AM
Period 6 : 11:50 AM to 12:40 PM
Period 7 : 12:40 PM to 1:30 PM

Vijaya Bhadauria 3/6/22
3/6/22
3/6/22
03/06/22

It was also decided that the academic support staff of all Engineering Departments, Sciences Departments, Humanities Department and School of Management Studies will be available between 7 AM to 3 PM to facilitate in the above activities.

The meeting concluded with the vote of thanks to the Chair.

3/6/22
(Mukul Shukla)
Chairman, SUGC

3/6/22
(R. A. Mishra)
Chairman, SMPC

3/6/22
(Vijaya Bhadauria)
Chairperson, SDPC

03-06-22
(D.K.Yadav)
Dean (Students Welfare) Oftg.

3-6-2022
(V. K. Srivastava)
Professor, ECED

3/6/2022
(R. K. Singh)
Dean (Academic)

Director / Chairman, Senate

The recommendation of Standing Committee is put up before you for your kind Consideration and approval please, if deemed fit.

03/06/2022

approved as per
Chairman's

10/6/2022

Submitted
Pl. put up with
notice for electronic
signing of chairman

10/6/22

कार्यालय अधिष्ठाता [शैक्षिक]
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
प्रयागराज - २११००४ [उ०प्र०] भारत
Office of the Dean [Academic]
Motilal Nehru National Institute of Technology Allahabad
Prayagraj – 211004 [UP] India

Dated:-06-06-2022

Minutes of the Meeting of the Standing Committee (Grade Discrepancy) held on 06-06-2022 [Monday] at 12:00 Noon in the office of the Dean (Academic). Following members were present:

Prof. Mukul Shukla, Dean (Academic) (Oftg.) & Chairman SUGC	-	Chairman
Prof. V.K. Srivastava, ECED	-	Senate Nominee
Prof. D.K.Yadav, Dean [Student Welfare] [oftg.]	-	Member
Prof. Vijaya Bhadauria Chairperson SDPC	-	Member
Prof. R.A. Mishra, Chairman SMPC	-	Member
Prof. K.N.Pandey, MED	-	Special Invitee
Prof. H.S. Goyal, MED	-	Special Invitee
Dr. Y.G.Bala , MED	-	Special Invitee
Dr. R. K .Patel, MED	-	Special Invitee
Dr. Rajesh Shastri, HSS	-	Special Invitee
Dr. Sahadeo Padhye, Mathematics	-	Special Invitee
Dr. Dushyant Kumar Singh, CSED	-	Special Invitee
Dr. Basant Kumar F.I. [Examination]	-	Convener

1. The committee reviewed B.Tech 1st Semester applications, of grade discrepancy for End (odd) Semester Examination 2021-22. Out of 120 applications, changes in grades / marks were reported in 4 cases. Committee reviewed these cases and recommended the following:

SL. NO	REGISTRATION NUMBER	NAME OF STUDENT/ GROUP	COURSE CODE	COURSE NAME	GRADE		COMMENTS	NAME OF COURSE COORDINATOR / INSTRUCTOR
					OLD	NEW		
1.	20214076	Aditya Singh Yadav (G1)	HS11102	Communication skills and Workshop	C	B+	Change in grade due to increase in End Sem marks	Dr. Jyotsna Sinha
2.	20215150	Ashutosh Rakesh Singh (A1)	HS11201	Language Lab	F	B+	Change in grade due to adding of PA and PE marks	Dr. Jyotsna Sinha
3.	20211035	Amit Kumar (A1)	MA11101	Mathematics I	C	B+	Change in grade due to increase in Mid Sem marks	Dr. Sahadeo Padhye
4.	20218037	Shreyansh Jaiswal (H1)	ME11101	Engineering Graphics	B+	A	Change in Grade due to increase in Practical Exam marks	Dr. Ravindra Kumar Patel

2. The committee reviewed B.Tech (6th & 8th Semester), M.Tech (2nd Sem), MCA (6th Sem.), MBA (2nd & 4th Semester), M.Sc (2nd & 4th Semester) applications, of grade discrepancy for End (Even) Semester Examination 2021-22. Out of 80 applications, changes in grades / marks were reported in 12 cases. Committee reviewed these cases and recommended the following:

SL. NO	REGISTRATION NUMBER	NAME OF STUDENT/ GROUP	COURSE CODE	COURSE NAME	GRADE		COMMENTS	NAME OF COURSE COORDINATOR / INSTRUCTOR
					OLD	NEW		
1.	20194121	Jarpula Prakash	CS16101	Embedded Systems	E	D	Change in grade due to increase in TA marks	Dr. Dushyant Kumar Singh
2.	20194003	Shubham Dixit	CS16101	Embedded Systems	A	A+	Change in grade due to increase in TA marks	Dr. Dushyant Kumar Singh
3.	20198053	Arun Nagar	CS16101	Embedded Systems	B+	A	Change in grade due to increase in TA marks	Dr. Dushyant Kumar Singh
4.	20193053	Ayush Chaturvedi	ME16101	Computer Aided Manufacturing	B+	A	Change in grade due to increase in Mid Semester marks	Dr. Venkateswara Rao Komma
5.	20193062	Vikas Kumar	ME16201	Computer Aided Manufacturing Lab	C	B	Change of grade due to increase in PA marks	Dr. Venkateswara Rao Komma
6.	20193101	Vaibhav Raj Singh	ME16201	Computer Aided Manufacturing Lab	D	C	Change of grade due to increase in PA marks	Dr. Venkateswara Rao Komma
7.	20193123	Udit Prabhakar	ME16201	Computer Aided Manufacturing Lab	D	C	Change of grade due to increase in PA marks	Dr. Venkateswara Rao Komma
8.	20193147	Siddhartha Chaudhary	ME16201	Computer Aided Manufacturing Lab	D	C	Change of grade due to increase in PA marks	Dr. Venkateswara Rao Komma
9.	20192068	Somi Teez	EE16104	Power Plant Engineering	B+	A	Change in Grade due to increase in End Semester marks	Prof. Paulson Samuel
10.	2021DN09	Dhruv Srivastava	ME22310	Design Against Fatigue and Fracture	C	B	Change in grade due to increase in mid sem marks	Prof. K. N. Pandey
11.	20193095	Anshu Kumar Singh	ME16104	Automobile Engineering	B	A	Change in Grade due to increase in Mid Sem , & End Sem	Prof. H.S.Goyal
12	20193073	Ankit Pandey	ME16104	Automobile Engineering	B	C	Change in Grade due to decrease in End Semester marks	Prof. H.S.Goyal

3. The committee examined the cases for change / modification in result of some students. After due deliberations on these cases, the committee recommended the following:

Sl No	Name & Registration Number	Department	Course Coordinator	Course Code & Course Name	Reported Issues	Recommendation of Committee
1.	Umesh Kumar Singh (2017RME10)	Mechanical	Prof. A. K. Dubey	Open Seminar ME70904	Submission of I grade by mistake in place of - - it should be updated and result also needs to be modified	**Recommended for updation as reported**
2.	Pawan Kumar (2016RCE52)	Civil	Prof. Rakesh Kumar	Open Seminar (CE71004)	Course Code of Open Seminar needs to be modified as per the approved Dp-01 form	**Recommended for updation as reported**

6-6-2022

Sl No	Name & Registration Number	Department	Course Coordinator	Course Code & Course Name	Reported Issues	Recommendation of Committee
3.	Jaspreet Singh (2016RBT01)	Biotechnology	Prof. Shivesh Sharma	Thesis Performance (BT6041)	Credit allocated for the course to be modified from 16 credits to 20 credits.	Recommended for updation as reported
4.	Naziya Aslam (2019RCS52)	Computer Science	Dr. Shashank Srivastava	Thesis Performance (CS70201)	Wrong entry of the semester during course entry	Recommended for updation as reported

4. The Committee considered the case put up by Dr. V.R. Komma & Dr. Y. G. Bala, regarding the discrepancy in the marks of 37 students in the subject Computer Aided Manufacturing Lab (ME16201) taught in 6th Semester Mechanical Engineering Branch, due to some technical mistake in Excel file data processing. Therefore, committee recommends that a fresh grade sheet should be submitted by the course coordinator; subsequently re-tabulation may be done to rectify the result of the affected students.

The Meeting ended with thanks to the Chair.

6/06/2022
Dr. Basant Kumar
Faculty In-Charge Examination

06/06/2022
Prof. R.A. Mishra
Chairman, SMPC

Vijaya RM Lal 6/6/22
Prof. Vijaya Bhadauria
Chairperson, SDPC

06/06/22
Prof. D. K. Yadav
Dean (Student Welfare) (Oftg.)

6-6-2022
Prof. V.K. Srivastava
(Senate Nominee)

06/06/22
Prof. Mukul Shukla
Chairman, SUGC & Dean (Academic)(Oftg.)

Director

Standing Committee minutes enclosed.

May kindly approve.

10/06/22
(M. Shukla)
Dean (Acad) - Offg

Kindly submit fresh grade to consider for re-tabulation and no such mistake in future

16/6/22

निदेशक
मो. ने. रा. प्रौ. सं. इलाहाबाद
इलाहाबाद

अधिष्ठाता (शैक्षिक)/Dean (Academic)
मो॰ने॰रा॰प्रौ॰सं॰ इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

MINUTES

Minutes of the Senate Standing Committee meeting held on June 24, 2022 (Friday) at 05:00 P.M. in the chamber of the Dean (Academic).

Following persons were present in the meeting:

1.	Prof. R. K. Singh, Dean (Academic)	–	Chairman
2.	Prof. V. K. Srivastava, ECED (Senate Nominee)	–	Member
3.	Prof. Paulson Samuel, Dean (Students Welfare)	–	Member
4.	Prof. Vijaya Bhadauria, Chairperson, SDPC	–	Member
5.	Prof. R. A. Mishra, Chairman, SMPC & SUGC (Oftg.)	–	Member
6.	Dr. Sarsij Tripathi, F.I.(Exam) Oftg.	–	Special Invitee

The Chairman extended warm welcome to the members and thanked them for taking their time out to attend the meeting.

Agenda item-wise proceedings are as under:

Item No. 01 : **To discuss upon restoring the academic timetable periods as per the previous timings due to relief in hot weather conditions.**

Resolution : The Committee discussed upon restoring the academic timetable periods as per the previous timings due to relief in hot weather conditions and agreed upon restoring of the academic timetable periods as per the previous timings effective from July 4,2022.

The academic support staff of all Engineering Departments, Sciences Departments, Humanities Department and School of Management Studies will be available as per the previous normal timings to facilitate in the above activities.

Item No. 02 : **To discuss upon restoring the lab periods as per the previous timings due to relief in hot weather conditions.**

Resolution : The Committee discussed upon restoring the lab periods as per the previous timings due to relief in hot weather conditions and agreed upon restoring of the periods scheduled for lab in the academic timetable from 2 periods to 3 periods as per the previous timings effective from July 4,2022.

24/6/2022 24/6/2022 Vijaya 24/6/22 24-6-2022 24-6-2022

Item No. 03 : **To discuss rescheduling of Mid Sem exams of BTech. 2nd Sem scheduled from 11-13 July 2022 to 25-27 July,2022 in order to arrange sufficient examination classrooms and conducting lecture classes smoothly for B. Tech. 2nd Sem.**

Resolution : The Committee discussed upon rescheduling of Mid Semester exams of BTech.. 2nd Semester from 11-13 July 2022, to 25-27 July,2022 and it was observed that conducting both the exams (BTech. 2nd Semester Mid Semester and BTech. 4th Semester/ MCA 2nd and 4th Semester End Semester examination) during 25-27 July,2022 will help in arranging sufficient examination classrooms and invigilators.. Further, the same will minimally affect conducting lecture classes smoothly for B Tech 2nd Sem.

Therefore it has been resolved to reschedule the mid sem examinations of BTech. 2nd Semester and align them with BTech. 4th Semester / MCA 2nd and 4th Semester End Semester examination) during 25-27 July,2022.

The meeting concluded with the vote of thanks to the Chair.

24-06-22
(R. A. Mishra)
Chairman, SMPC & SUGC (oftg.)

Vijaya Bhadauria 24/6/22
(Vijaya Bhadauria)
Chairperson, SDPC

24/6/2022
(Paulson Samuel)
Dean (Students Welfare)

24-6-2022
(V. K. Srivastava)
Professor, ECED

24/06/2022
(R. K. Singh)
Dean (Academic)

Director
Recommendations of Standing Committee as note-Aute is submitted for your kind consideration and approval please.

24/06/2022
अधिष्ठाता (शैक्षिक)/Dean (Academic)
मो०ने०रा०प्रौ०सं० इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

30/6/22
Director
Motilal Nehru National Institute of Technology Allahabad
Prayagraj-211004 U.P. (India)

ANNEXURE–II

08/7/22
05:45PM

विद्युत अभियंत्रण विभाग / Electrical Engineering Department
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
Motilal Nehru National Institute of Technology Allahabad
प्रयागराज-211004 (भारत) /Prayagraj-211004 (India)

पत्रांक...770.../वि0अ0वि0/2022 दिनांक: July 08, 2022

अध्यक्ष
एस0एम0पी0सी0

महोदय,

कृपया विभाग द्वारा आयोजित Board of Academic (BoAC) कि बैठक **दिनांक: जून 09, 2022** के उपरांत **दिनांक: जुलाई 07, 2022** को हुये एस0एम0पी0सी0 बैठक में, एस0एम0पी0सी0 सदस्यों के साथ, पी0जी0 [Power Electronics & Drives, Power System and Control & Instrumentation] पाठ्यक्रमों पर विचार-विमर्श में जो निष्कर्ष हुआ, वह कार्यवृत्त [DMPC Minutes] के रूप में संग्लन है।

सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

[राजेश गुप्ता]
आचार्य एवं विभागाध्यक्ष

संग्लन:-

- DMPC Minutes
- BoAC Minutes
- Consent of BoAC Members
- Course Structure & Curriculum for M.Tech Programme in Electrical Engineering with Specialization in Power Electronics & Drives (Effective from Session 2022-23)
- Course Structure & Curriculum for M.Tech Programme in Electrical Engineering with Specialization in Power System (Effective from Session 2022-23)
- Course Structure & Curriculum for M.Tech Programme in Electrical Engineering with Specialization in Control & Instrumentation (Effective from Session 2022-23)

प्रतिलिपि:-

1. अधिष्ठाता [शैक्षिक], सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

[राजेश गुप्ता]
आचार्य एवं विभागाध्यक्ष

Put up in the meeting
11-07-2022

विद्युत अभियंत्रण विभाग / Electrical Engineering Department
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
Motilal Nehru National Institute of Technology Allahabad
प्रयागराज-211004 (भारत)/ Prayagraj-211004 (India)

पत्रांक...../वि0अ0वि0/2022 दिनांक: July 07, 2022

चेयरमैन एस0एम0पी0सी0

Minutes of the meeting of the Departmental Master's Program Committee

Minutes of the Departmental Masters' Program Committee Departmental (DMPC) Meeting held on July 07, 2022 at 11:00 A.M. in the Seminar Hall, EED. The following members were present:

1.	Prof. Rajesh Gupta	Chairperson & Head
2.	Prof. Paulson Samuel	Member
3.	Prof. Asheesh Kumar Singh	Member
4.	Prof. Richa Negi	Convener DMPC
5.	Dr. Deepak Kumar	Member
6.	Dr. Navneet Kumar Singh	Member
7.	Dr. Niraj Kumar Choudhary	Member
8.	Dr. Prashant Kumar Tiwari	Member
9.	Dr. Dipayan Guha	Member
10.	Dr. Suman M	Member
11.	Prof. R.A. Mishra	External member, ECED

The following agenda, item-wise were taken up and discussed in the meeting:

The Board of Academic (BoAC) was conducted as 09.06.2022 in EDC, Conference Room, MNNIT Allahabad. The minutes of the meeting is attached.

Following are the resolution of DMPC Meeting:

S. No.	Resolution
1.	The **M. Tech., [Power Electronics & Drives, Power System and Control & Instrumentation), EED, course curriculum** has been received from the BoAC committee and found in order as recommended.
2.	The committee recommended that the Program Elective VI, for all three M. Tech. programme can be made flexible. The student can complete the Program Elective VI course between the start of the month of May (2nd semester) and end of the odd semester (3rd semester), i.e., between the end of their 2nd and 3rd Semesters.

The meeting ended with thanks to the Chair.

[Prof. Rajesh Gupta] [Prof. Paulson Samuel] [Prof. Asheesh Kumar Singh] [Prof. Richa Negi]

[Dr. Deepak Kumar] [Dr. Navneet Kumar Singh] [Dr. Niraj Kumar Choudhary] [Dr. Prashant K. Tiwari]

[Dr. Dipayan Guha] [Dr. Suman M] [Prof. R.A. Mishra]

विद्युत अभियंत्रण विभाग / Electrical Engineering Department
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
Motilal Nehru National Institute of Technology Allahabad
प्रयागराज-211004 (भारत) /Prayagraj-211004 (India)

पत्रांक...740...../वि0अ0वि0/2022 दिनांकः July 04, 2022

अध्यक्ष
Board of Academic (BoAC)

महोदय,

कृपया विभाग द्वारा आयोजित Board of Academic (BoAC) कि बैठक **दिनांक: जून 09, 2022** को संस्थान के EDC कान्फेंस कक्ष में सम्पन्न हुई। उक्त बैठक में सभी Board of Academic (BoAC) के सदस्य उपस्थित [ऑनलाइन/ऑफलाइन] रहे एवं सभी सदस्यों के साथ यू0जी0 एवं पी0जी0 पाठ्यक्रमों पर विचार-विमर्श हुआ, जो छायाप्रति के रूप में संग्लन है।

सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

[राजेश गुप्ता]
आचार्य एवं विभागाध्यक्ष

संग्लनः-

- BoAC Minutes
- Consent of BoAC Members
- Detailed comments on PG curriculum is attached as separate file.
- Complete course curriculum along with detailed syllabus and CO-PO mapping of all the subjects for three M. Tech. specializations are attached.

विद्युत अभियंत्रण विभाग / Electrical Engineering Department
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
Motilal Nehru National Institute of Technology Allahabad
प्रयागराज-211004 (भारत) /Prayagraj-211004 (India)

पत्रांक...../वि0अ0वि0/2022 दिनांकः जुलाई ...04..., 2022

Minutes of the Board of Academics (BoAC) Meeting

Minutes of the meeting of the **Board of Academics committee (BoAC) held on June 9th, 2022 (Thursday) in the Conference room**, Executive Development Centre (EDC), of the Institute.

Following members of the BoAC attended the meeting:

External Member:-

1. Prof. R.K. Pandey - External Member, IIT (BHU), Varanasi
2. Prof. Santanu Mishra - External Member, IIT, Kanpur **[Attended -Online]**
3. Mr. Ashish Kumar Shrivastava - External Member, Chief Manager (Design), HAL Lucknow

Internal Member:-

1. Prof. Mukul Shukla - Chairman / Dean Academic (Offg.)
2. Prof. Rajesh Gupta - Convener / Head of Department
3. Chairman, SUGC - Member
4. Prof. Ravindra K. Singh - Member **[Attended -Online]**
5. Prof. R.K. Tripathi - Member
6. Prof. Shubhi Purwar - Member
7. Prof. Paulson Samuel - Member **[Attended -Online]**
8. Prof. Asheesh K. Singh - Member
9. Prof. Richa Negi - Member
10. Dr. Nitin Singh - Member & Associate Professor
11. Dr. Deepak Kumar - Member & Assistant Professor
12. Dr. Navneet Kumar Singh - Special Invited Member
13. Dr. Niraj Kumar Choudahry - Special Invited Member
14. Dr. M. Venkatesh Naik - Special Invited Member
15. Dr. Prashant Kumar Tiwari - Special Invited Member
16. Dr. Saumendra Sarangi - Special Invited Member
17. Dr. Dipayan Guha - Special Invited Member

The Head of the Electrical Engineering Department welcomed both internal and external BOAC members in the meeting. The Chairman & Dean Academic (Offg.) briefed the committee members about the new education policy 2020 (NEP 2020) and requirement of

4/7/2022

revision in the curriculum for both UG and PG programs. He further informed to the committee that primarily the first year of all B. Tech. programs of the institute need to be fixed for the session 2022-23. The institute has already finalized a broad structure of the B. Tech. Ist year of all the departments with the flexibility for the department to incorporate department specific subjects in both first and second semesters.

The meeting held in two sessions on 09/06/2022 with morning session dedicated to B. Tech. Electrical Engineering program of the department and afternoon session dedicated to three M. Tech. Programme of Electrical Engineering:

- **Control & Instrumentation**
- **Power Electronics & Drives**
- **Power System.**

1st Morning session: 10:00 AM to 1: 00 PM

Convener DUGC and his team made a presentation on B. Tech. Electrical Engineering program of the department, for all four years. Comments from the members have been compiled as follows.

1. To interchange subject (Electrical Workshop, 1-0-2) PCE scheduled in III sem. with the subject (Simulation Tools for Electrical Engineering 1-0-2) CES scheduled in II sem.
The same change has been incorporated.

2. Increasing number of Honors/Minor subjects from 3 to 4, in order to award Specialization/Minor in Electrical Engineering.
Accordingly Honors-I, II/Minor-I, II in VII sem has been increased to Honors-I, II, III/Minor-I, II, III. The fourth Honors-IV/Minor-IV has already been included in VIII sem.

3. It was suggested to Group the subjects in form of three departmental specializations (Power System, Control System, Power Electronics).
Accordingly all Honors (Honor-I, II, III, IV) should have subjects listed in such a way that students can choose subjects suitable for their specialization. The same correction has been incorporated.

4. Minor subjects should also be listed in a manner that student should choose one subject each from group of minors (Minor -I, II, III, IV).
The modification has been incorporated.

Note:

(i) Complete course curriculum along with detailed syllabus and CO-PO mapping of all the subjects of B. Tech. Electrical Engineering is attached.

9-17/2022

2nd Afternoon session:

Convener DMPC and her team made a presentation on all three M. Tech. Electrical Engineering program of the department, for all four semesters both for regular and part-time programs. Comments from the members have been compiled as follows.

1. Changes in course structure was proposed in new curriculum. It was suggested by BOAC members to make it in line with the new ordinance for Master's Program 2021-22, especially in terms of credit requirement.
The credit correction has been incorporated such that each semester has 20 credit with total 80 credit requirement for award of M. Tech degree.

2. The different syllabi were discussed in detail and some changes were suggested in them.
All suggestions have been incorporated.

3. Rename the subject Minor Project as Term Project.
The suggested renaming has been done.

4. The 'State of the Art' should be renamed as 'State of the Art Seminar'.
The suggested renaming has been done.

Note:

(ii) Detailed comments on PG curriculum is attached as separate file.

(iii) Complete course curriculum along with detailed syllabus and CO-PO mapping of all the subjects for three M. Tech. specializations are attached.

The meeting concluded with the vote of thanks to all the members and Chairman.

[Rajesh Gupta]
Convener & Head, EED

Consent in all BoAC Members for BoAC Meeting on 09-06-2022 in EDC Room
[Board of Academic (BoAC) Minutes]

Name of BoAC Members	Consent / Comments for BoAC Members
Prof. R.K. Pandey External Member, IIT (BHU), Varanasi	Dear Prof Gupta Ji, The Minutes of BoAC are approved. Please do the needful. With best wishes and regards, Dr. Rajendra Kumar Pandey
Prof. Santanu Mishra External Member, IIT, Kanpur **[Attended -Online]**	Dear Prof. Gupta, I give my consent on the minutes and satisfied with the attached BTech and Mtech curriculum revision as per suggestion. Good luck. Santanu
Mr. Ashish Kumar Shrivastava External Member, Chief Manager (Design), HAL Lucknow	I agree with the minutes of the meeting and attached revised B. Tech. and M. Tech curriculum. As discussed, I am attaching the syllabus of new course suggested during meeting in word format to enable you editing as per Institute/Faculty requirement. Ashish Kumar Shrivastava
Prof. Mukul Shukla Chairman & Dean Academic (Offg.)	Dear Prof. Gupta I give my consent on the circulated minutes. B rgds Dr. Mukul Shukla
Prof. Rajesh Gupta Convener & Head of Department	I agree with the minutes of the meeting of BOAC and circulated B. Tech and M. Tech. structure and syllabus. Regards Rajesh Gupta
Chairman SUGC Member	Dear Prof. Gupta I give my consent on the circulated minutes. B rgds Dr. Mukul Shukla
Prof. Ravindra K. Singh Member **[Attended -Online]**	I agree with the proposal. Prof. R. K. Singh
Prof. R.K. Tripathi Member	Agreed with the proposal. -R. K. Tripathi
Prof. Shubhi Purwar Member	I agree with the minutes. Shubhi Purwar

9/7/2022

Prof. Paulson Samuel Member **[Attended -Online]**	I agree. Paulson Samuel
Prof. Asheesh Kumar Singh Member	I agree with the minutes. साभार / Regards डा. आशीष कुमार सिंह
Prof. Richa Negi Member	Dear sir I agree with the minutes. Thanks Richa Negi
Dr. Nitin Singh Member	I agree with the recorded minutes. Nitin Singh
Dr. Deepak Kumar Member	Dear Sir, I agree with the minutes. Regards Deepak Kumar

1

Course Structure & Curriculum

For

M. Tech. Programme

In

Electrical Engineering

With Specialization in

Control & Instrumentation

(Effective from Session 2022-23)

Regular & Part Time

Department of Electrical Engineering
Motilal Nehru National Institute of Technology Allahabad
Teliarganj, Prayagraj-211004, Uttar Pradesh

MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY ALLAHABAD

VISION

To establish a unique identity for the institute amongst national and international academic and research organizations through knowledge creation, acquisition, and dissemination for the benefit of society and humanity.

MISSION

- To generate high quality human and knowledge resources in our core areas of competence and emerging areas to make valuable contribution in technology for social and economic development of the nation. Focused efforts to be undertaken for identification, monitoring, and control of objective attributes of quality and for continuous enhancement of academic processes, infrastructure and ambience.
- To efficaciously enhance and expand, even beyond national boundaries, its contribution to the betterment of technical education and offer international programmes of teaching, consultancy, and research.

DEPARTMENT OF ELECTRICAL ENGINEERING

VISION

To produce globally competitive technical manpower with sound knowledge of theory and practice, with a commitment to serve the society and to foster cutting edge research in Electrical Engineering pertaining to the problems currently faced by the country and the world.

MISSION

1. Develop state of art lab facilities for research and consultancy.
2. Develop infrastructure and procure cutting edge tools/equipment.
3. Develop relevant content and capability for quality teaching.
4. Improve symbiotic relationship with Industry for collaborative research and resource generation.

Program Outcomes of M. Tech in Control & Instrumentation

POs	
PO 1	Ability to apply knowledge of control and instrumentation for design and development of control systems for diverse engineering applications, suitable for industries, academia, and research requirements.
PO 2	An ability to independently carry out research /investigation and development work to solve practical problems in the field of Control & Instrumentation
PO 3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.
PO 4	An ability to write and present a substantial technical report/document in order to communicate ideas and solutions of research problem through publication in journals and conference proceedings.
PO 5	Possess good leadership, communication skill and sound technical knowledge for effective teamwork.
PO 6	Motivation for continuous and self-learning for knowledge update and sustainability.

M. Tech. (Electrical Engineering) with specialization in Control & Instrumentation

Overall Credit structure

Category	Program Core (PC)		Program Electives (PE)	Total
	Core Essentials	Thesis/ SOA/ minor project		
Credits	16	40	24	80

Program Core

Subject Code	Subject Name	L	T	P	Credits
EE21101	Advanced Control System	3	0	2	4
EE21102	Optimal Control	3	0	2	4
EE22101	Industrial Instrumentation	3	0	2	4
EE22102	Nonlinear Control	3	0	2	4
EE2X103	Term project	0	0	6	4
EE23601	Thesis –I	0	0	18	12
EE23651	State-of-the-art Seminar	0	0	6	4
EE24601	Thesis –II	0	0	30	20
Total credits					**56**

Program Electives (PE-I & II) – 1st Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Process Control & Instrumentation	3	1	0	4
EE 2XXXX	Neuro-fuzzy Control Systems	3	1	0	4
EE 2XXXX	Microprocessor & Microcontroller Based Systems	3	1	0	4
EE 2XXXX	Biomedical Instrumentation	3	1	0	4
EE 2XXXX	Introduction to Probability Theory & Stochastic Process	3	1	0	4
EE 2XXXX	Control Techniques in Power Electronics	3	1	0	4
EE 2XXXX	Electric Vehicle Technology	3	1	0	4

Program Electives (PE-III) – 1st Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Embedded Systems	3	1	0	4
EE 2XXXX	Fuzzy logic and control	3	1	0	4
EE 2XXXX	Optimization Techniques	3	1	0	4
EE 2XXXX	Artificial Intelligence in Engineering	3	1	0	4
EE 2XXXX	Expert Systems	3	1	0	4
EE 2XXXX	Robotics and Automation	3	1	0	4
EE 2XXXX	Research Methodology	3	1	0	4
EE 2XXXX	Digital Signal Processing	3	1	0	4
EE 2XXXX	Linear Algebra	3	1	0	4
EE 2XXXX	Virtual Instrumentation	3	1	0	4
EE 2XXXX	Neural Network & Deep Learning	3	1	0	4

Program Electives (PE-IV & V) – 2nd Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Cyber Security	3	1	0	4
EE 2XXXX	Computer Aided Design of Electrical Systems	3	1	0	4
EE 2XXXX	Stochastic control and Optimization	3	1	0	4
EE 2XXXX	Adaptive Control	3	1	0	4
EE 2XXXX	System Identification & Estimation	3	1	0	4
EE 2XXXX	Special Topics in Control System	3	1	0	4
EE 2XXXX	Electrical Energy Conservation & Auditing	3	1	0	4
EE 2XXXX	Electricity Industry Structure & Regulations	3	1	0	4
EE 2XXXX	Modern Digital and Embedded Controllers	3	1	0	4

Program Electives (PE–VI) – 3rd Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Digital System Simulation	3	1	0	4
EE 2XXXX	Robot modelling and control	3	1	0	4
EE 2XXXX	Smart sensor & actuators	3	1	0	4
EE 2XXXX	Advanced Digital Control	3	1	0	4
EE 2XXXX	Power Plant Operation & Controls	3	1	0	4
EE 2XXXX	Network Control System	3	1	0	4

Course Structure for M. Tech. (Regular)

Sem	Course Name, L-T-P					Lecture courses	Contact hours/ week				Credits
							L	T	P	Total	
I	Advanced Control system (3-0-2)	Optimal Control (3-0-2)	PE-I (3-1-0)	PE-II (3-1-0)	PE-III (3-1-0)	5	15	3	4	22	20
II	Industrial Instrumentation (3-0-2)	Nonlinear Control (3-0-2)	Term Project (0-0-6)	PE-IV (3-1-0)	PE-V (3-1-0)	4	12	2	10	28	20
III	Thesis –I (0-0-18)	State-of-the-art Seminar (0-0-6)		PE-VI / MOOC*/ Online* (3-1-0)		1	3	1	24	30	20
IV	Thesis –II (0-0-30)					0	0	0	30	30	20

*This course can be completed between the start of the month of May (2nd semester) and end of the odd semester (3rd semester), i.e., between the end of their 2nd and 3rd Semesters.

Course Structure for M. Tech. (Part Time)

Sem	Course Name, L-T-P			Lecture courses	Contact hours/ week				Credits
					L	T	P	Total	
I	Advanced Control system (3-0-2)	Optimal Control (3-0-2)		2	6	0	4	10	8
II	Industrial Instrumentation (3-0-2)	Nonlinear Control (3-0-2)		2	6	0	4	10	8
III	PE-I (3-1-0)	PE-II (3-1-0)	PE-III (3-1-0)	3	9	3	0	12	12
IV	PE-IV (3-1-0)	PE-V (3-1-0)	Term Project (0-0-6)	2	6	2	6	14	12
V	Thesis –I (0-0-18)	State-of-the-art Seminar (0-0-6)	PE-VI / MOOC*/ Online* (3-1-0)	1	3	1	24	30	20
VI	Thesis –II (0-0-30)			0	0	0	30	30	20

*This course can be completed between the start of the month of May (2nd semester) and end of the odd semester (3rd semester), i.e., between the end of their 2nd and 3rd Semesters.

<table>
<tr><td>Course Title</td><td colspan="3">Advanced Control System</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Core</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">1. Signals and Systems
2. Network theory
3. Linear Control System</td></tr>
<tr><td>Course Aim</td><td colspan="3">This course aims to discuss modern control techniques for CT/DT systems.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course the student will be able to:
CO1: Use matrix algebra for the study of systems of linear equations.
CO2: Develop and analyze state space models for CT/DT systems.
CO3: Characterize the behavior of elementary feedback control systems.
CO4: Design a control system satisfying the design specifications.
CO5: Analyze stability of the closed and open loop systems.</td></tr>
<tr><td>Mapping between COs &POs</td><td colspan="3"><table>
<tr><td></td><td>PO1</td><td>PO2</td><td>PO3</td><td>PO4</td><td>PO5</td><td>PO6</td></tr>
<tr><td>CO1</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO2</td><td>High</td><td>Medium</td><td>Medium</td><td>Low</td><td>Low</td><td>Low</td></tr>
<tr><td>CO3</td><td>High</td><td>Medium</td><td>Medium</td><td>Low</td><td>Low</td><td>Low</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO5</td><td>High</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>Medium</td></tr>
</table></td></tr>
</table>

Module 1:

Differential/difference equations, **Laplace transform/z-transform Revisited**, Vector algebra, eigenvalue and eigenvectors, Singular value decomposition (SVD), definiteness and Sylvester's criterion, singular values, H_2, H_∞ and L_p norms.

Module 2:

Digitalcontrol system, components of sampled-data control system, Nyquist/Shannonhttps://www.sciencedirect.com/topics/computer-science/shannon-sampling-theorem sampling theorem, hold circuits, Quantization, Digital PID controller.

Module 3:

Modelling of continuous-time/discrete-time systems, Impulse Response, Transfer function/pulse transfer function, state-space modelling, homogeneous/non-homogeneous solutions of LTI/LSI systems, similarity transformations, canonical forms, state space realization of transfer matrices and vice-versa, controllability and observability, stabilizability and detectibility, Pole placement and observer-based controllers, separation principle, Full-order/Minimal-order observer design.

Module 4:

BIBO/Asymptotic Stability, Local/global stability, uniform and exponential stability, Lyapunov stability, Stability of linearized systems, Jury stability, Bi-linear transformation, dead-beat response of DT system.

References:

1. Chin-Tsong Chen; "Linear system theory and design," Oxford Univ PI' (Sd), 4 edition,2012.
2. T. Kailath, "Linear system theory," Prentice-Hall, Inc.i 1 " edition, 1980.
3. M. Gopal, "Modern control system theory," New Age International, 1993.
4. K. Ogata, "System dynamics," Prentice Hall, 4 edition, 2003.
5. Ben Noble, "Applied linear algebra," Pearson, J edition, 1987.
6. AshishTewari, "Modern Control Design with MATLAB and SIMULINK," John Wiley &Sons, Ltd, 2012.
7. K. Ogata, "Discrete time control systems," Prentice Hall, 2 edition, 1995.
8. B. C. Kuo, '\Digital control systems," Oxford University Press, 2 edition, 1995.

Course Title	**Optimal Control**		
Course Code	EE 2XXXX	Credit	4
Core/ Elective	Core	Semester	1
Prerequisite Knowledge	**1.** Advanced Mathematics **2.** Network theory **3.** Linear Control System		
Course Aim	This course aims to discuss optimal and robust control systems.		
Course Outcomes (COs)	**At the end of the course the student will be able to:** **CO1:** have in-depth knowledge and critical understanding of the theory and principles of optimal control systems and their applications. **CO2:**analyze and design a robust control system.		

	CO3: Use calculus of variation, minimum principle and dynamic programming to solve continuous and discrete time problems. **CO4**: apply LQR and LQG concepts for a robust control system.
Mapping between COs &POs	

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Medium	Low	Low	High	Medium
CO 2	High	High	High	High	High	High
CO 3	Medium	Low	High	High	Medium	Medium
CO 4	High	High	Low	Medium	Medium	High

Module 1:

Optimal Problem formulation, Performance index, optimization without/with equality/inequality constraints, Lagrange multiplier, small gain theorem.

Module 2:

Function & Functional, The calculus of variation, functional of a single function, functional involving several functions, CT/DT LQR, steady state closed-loop control and sub-optimal feedback, tracking problems.

Module 3:

Bellman's principle of optimality, computational procedure for solving control problems, continuous-time systems, discrete-time systems, Hamilton-Jacobi-Bellman equation, linear regulator problems.

Module 4:

Kharitonov's criteria, robust output-feedback design, Observers and Kalman filter LQG/loop-transfer recovery, Least mean square optimization problem, H-infinity design,model-matching problem.

References:

1. K.Zou, J.C.Doyle, "Essentials of robust control," Prentice Hall; I edition; 1997.
2. M. Green, D. Limebeer, "Linear robust control," Dover Publications; Reprint edition, 2012.
3. Kwakernak and Sivan, "Linear Optimal Control," WileycBlackwell,1972.
4. Anderson and Moore, "Linear Optimal Control" Prentice-Hall 1990
5. B.A. Francis, "A Course in Hoo Control Theory," Springer Verlag 1987.

Course Title	**Nonlinear Control**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Core	Semester	2
Prerequisite Knowledge	**1.** Linear Control System **2.** Advanced Mathematics		
Course Aim	To discuss different control and stability schemes for nonlinear dynamical systems.		
Course Outcomes (COs)	**After completion of the course students shall be able to:** **CO1:** Have thorough knowledge of analytical tool to study nonlinear dynamical system. **CO2:**Analyze limit cycle and stability of nonlinear system using Lyapunov theory. **CO3:**Design of nonlinear controller using Sliding mode control, Feedback linearization and Backstepping technique. **CO4:** Effectively use MATLAB and SIMULINK in the analysis, design, simulation, and real-time Implementation of control systems.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Medium	Low	Low	High	High
CO 2	Medium	High	High	High	High	Medium
CO 3	Medium	Low	High	High	High	Medium
CO 4	Medium	High	Low	High	Medium	High

Introduction to nonlinear systems; Linearization; Comparison of linear and nonlinear systems; Fundamentals of describing function method: describing function analysis of nonlinearities such as saturation, dead-zone, on-off non-linearity, backlash, hysteresis; Analysis of nonlinear systems using phase plane technique, limit cycles; Stability analysis of nonlinear systems: Lyapunov stability theorem for Nonlinear system; Variable Structure Control; Sliding Mode Control; Higher Order Sliding; Feedback linearization: linearization; back stepping control.

References:

1. M. Vidyasagar, "Nonlinear system analysis," Society for Industrial and AppliedMathematics, Second Edition, 2002.
2. D. Graham, "Analysis of nonlinear control systems," Wiley, New York, 1985.
3. N. Minorsky, "Theory ofnonlinear control systems," McGraw-Hili, New York, 1969.
4. H. K. Khalil, "Nonlinear systems," Prentice Hall; Third Edition,200!.
5. J. J. E. Siotine, "Applied nonlinear control," Prentice-Hall, 1991.

Course Title	**Industrial Instrumentation**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Core	Semester	2
Prerequisite Knowledge	Power Electronics, Electrical Machines, Control system		
Course Aim	To teach different instrumentation systems for measurement of process variables with signal conditioning circuits.		
Course Outcomes (COs)	**After completion of the course students shall be able to:** **CO1:**Review of transducers for strain, velocity, acceleration, vibration, pressure, level, force, flow, temperature, etc.,Optic& LASER Instrumentation; Smart instrumentation **CO2:**Signal conditioning - Instrumentation amplifiers, logarithmic amplifiers, isolation amplifiers, sample and hold, active filters, etc. **CO3:**Design - Specification, error considerations; Selection & design of typical subsystems; Data converters ADCs & DACs; Design of data instrumentation systems **CO4:** Networking methods and their applications in instrumentation; Industrial standards; Electrical hazards and safety, Wireless technology, Smart sensor & actuators.		

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	High	Medium	Low	Low	Medium	High
CO2	Medium	High	Low	Low	Medium	High
CO3	High	Medium	Low	Low	Medium	High
CO4	High	Medium	Low	Low	Medium	High

Review of transducers for strain, velocity, acceleration, vibration, pressure, level, force, flow, temperature, etc., Optic & LASER Instrumentation; Smart instrumentation.
Signal conditioningDesign - Specification, error considerations; Selection & design of typical subsystems;Instrumentation amplifiers, logarithmic amplifiers, isolation amplifiers, sample and hold, active, filters, etc.
Data converters: ADCs & DACs.
Design of data instrumentation systems,Networking methods and their applications in instrumentation; Industrial standards; Electricalhazards and safety, Wireless technology, Smart sensor & actuators.

References:

1. E.O. Doebelin, "Measurement Systems - Application and Design," Tata, McGraw Hill, 6thedition 2012.
2. D. Patranabis, "Principles of Industrial Instrumentation," Tata McGraw Hill, 3,d edition2010.
3. S. K. Singh, "Industrial Instrumentation and Control," Tata McGraw Hill, 3,d edition 2008.

4. D.P. Eckman, "Industrial Instrumentation," Wiley Eastern Ltd, jSl edition, 2004.
5. A.S.Morris, R.Lengari, "Measurement and Instrumentation-Theory & Application,"Academic Press; 2nd edition 2015.
6. Ronald L. Krutz, "Interfacing techniques in digital design with emphasis onMicroprocessors," Wiley, 1988, ISBN ..0,171082899,9780471082897.
7. David F. Hoeschele, "Analog [0 digital ancl digital to analog conversion techniques,"Wiley-Inter science, 2nd edition, 1994.
8. John Park, Steve Mackay, E. Wright, "Data Communication for Instrumentation andControl," Newnes; I edition August 11,2003.

<table>
<tr><td>Course Title</td><td colspan="3">Process Control & Instrumentation</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Control system, Industrial Instrumentation</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the process control variables and related instrumentation systems.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">After completion of the course students shall be able to:
CO1:understand the basic principles and importance of process control in industrial process plants.
CO2:understand the various control schemes used in process plants.
CO3:explain the use of block diagrams & the mathematical basis for the design of control systems.
CO4:explain the importance and application of good instrumentation for the efficient design of process control loops for process engineering plants.
CO5: specify the required instrumentation and final elements to ensure that well-tuned control is achieved.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><td></td><td>PO1</td><td>PO2</td><td>PO3</td><td>PO4</td><td>PO5</td><td>PO6</td></tr>
<tr><td>CO1</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td><td>Low</td><td>Low</td></tr>
<tr><td>CO2</td><td>Low</td><td>Low</td><td>Medium</td><td>Medium</td><td>Low</td><td>High</td></tr>
<tr><td>CO3</td><td>Medium</td><td>Medium</td><td>Low</td><td>Low</td><td>Low</td><td>low</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>Medium</td><td>Medium</td><td>High</td></tr>
<tr><td>CO5</td><td>Low</td><td>Medium</td><td>Low</td><td>Low</td><td>Low</td><td>Low</td></tr>
</table>
</td></tr>
<tr><td></td><td colspan="3">Introduction to Process Control, Mathematical Modeling: Development of mathematical models,Modeling considerations for control purposes. Dynamic Behaviour of Chemical Processes:Computer simulation and the linearization of nonlinear systems, Transfer functions and the input-output models, Dynamics and analysis of first, second and higher order systems. FeedbackControl Schemes: Concept of feedback control, Dynamics and analysis of feedback-controlledprocesses, Stability analysis, Controller design, Frequency response analysis and its applicationsAdvanced Control Schemes: Feedback controlof systems with dead time or inverse response, Control systems with multiple loops, Feedforward and ratio 'control. Instrumentation: Final control elements, Measuring devices for flow,temperature, pressure and level.

References
1. Harriot, P. "Process control," Tata McGraw-Hili Education, 1964.
2. Singh, S.K. "Computer Aided process control," PHI Learning Pvt. Lrd., 2004.
3. Seborg,Edgar, Mellichamp, "Process dynamics and control," John Wiley & Sons, Inc., 2nd</td></tr>
</table>

	Edition, 2000. 4. Marlin,T.E. "Process control -:Designing processes & control systems," McGraw-HiliHigher Education; 2 edition, 2000. 5. Bennet, S. "Real time computer control," Pearson India, 2 Edition, 2003.

<table>
<tr><td>Course Title</td><td colspan="3">Neuro-Fuzzy Control System</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Advanced mathematics
Control system</td></tr>
<tr><td>Course Aim</td><td colspan="3">To discuss the theory of neuro-fuzzy control system for developing intelligent control algorithms.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">After completion of the course students shall be able to:
CO1:Understand the working of human brain and ANN in general and its application as controller in different areas of engineering
CO2: Understand the fuzzy logic and implementing it as controller for different
CO3: Simulate the different models of ANN controller, fuzzy logic controller and neuro-fuzzy controller
CO4: Apply neuro-fuzzy controller to the real time problem they undertake during their thesis and write research papers related to it.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><td></td><td>PO 1</td><td>PO 2</td><td>PO 3</td><td>PO 4</td><td>PO 5</td><td>PO 6</td></tr>
<tr><td>CO 1</td><td>High</td><td>High</td><td>Low</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>CO 2</td><td>Medium</td><td>Medium</td><td>High</td><td>Low</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO 3</td><td>High</td><td>Low</td><td>High</td><td>Medium</td><td>High</td><td>High</td></tr>
<tr><td>CO 4</td><td>High</td><td>High</td><td>Low</td><td>Medium</td><td>Medium</td><td>High</td></tr>
</table>
</td></tr>
<tr><td></td><td colspan="3">Introduction, neuron model, activation functions, perceptions, multilayer network, Backpropagation, re-current networks, supervised and unsupervised learning, principle component analysis, modeling, identification, prediction and control using neural network controllers.

Basicsof sets and fuzzy arithmetic, crisp sets, operation, relation and composition of sets, Fuzzification and defuzzification methods, Fuzzy logic, software and hardware application to closed loopcontrol, TSK Fuzzy Models, Fuzzy controllers.

References
1. Simon Haykin, "Neural networks - A comprehensive foundation," Prentice Hall, 2003.
2. M. T. Hagan, "Neural network design, Cengage Learning," 2nd edition, 2008
3. D. T. Pham and X Liu, "Neural network for identification, prediction and control," Springer,1995
4. Klir George 1., Yuan Bo, "Fuzzy Sets and Fuzzy Logic: Theory and Applications," Prentice-Hall (1996)
5. B. Kosko, "Neural Networks and Fuzzy Systems," Prentice-Hall, 1994</td></tr>
</table>

	6. T. J. Ross, "Fuzzy Logic with Engineering Applications Wiley-Blackwell;" 3rd editic 2010.

<table>
<tr><td>Course Title</td><td colspan="3">Microprocessor & Microcontroller Based Systems</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Digital Electronics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the basic of micro controllers and its applications</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">After completion of the course students shall be able to:
CO1:To understand the basic architecture of the micro controllers.
CO2: To understand the memory interfacing.
CO3:To understand the different set of commands.
CO4:To study parallel processing of the controllers.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><td></td><td>PO 1</td><td>PO 2</td><td>PO 3</td><td>PO 4</td><td>PO 5</td><td>PO 6</td></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 3</td><td>Medium</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>High</td><td>Medium</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td></tr>
</table>
</td></tr>
<tr><td></td><td colspan="3">Introduction to the general structure of advanced microprocessors and microcontrollers, Discussions on architectures, instruction sets, memory hierarchies, pipelining and RISC principles, interfacing to input and output devices, user interface design, real-time systems, and table-driven software, single chip microcomputers, Interrupt structures, Parallel/serial I/O, Analog I/O, DMA operations, Peripheral controllers, Laboratory based experiments and projects with these devices.

References:
1. John B. Peatman, Design with PIC Microcontrollers, Pearson Education Asia, 2000.
2. John B. Peatman, Design with Microcontrollers, McGraw Hill, USA,1995.
3. Barry B Brey, INTEL Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486 Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4, and Core2 with 64- Bit Extensions Architecture, Programming, and Interfacing, Eighth Edition, PHI 2009.</td></tr>
</table>

<table>
<tr><td>Course Title</td><td colspan="3">Biomedical Instrumentation</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Instrumentation systems</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the basic of instrumentation systems for biomedical applications.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">After completion of the course students shall be able to:
CO1: Basic concepts of biomedical instrumentation
CO2:Understand the method of measuring important parameters of human body like cardiovascular system brain, respiration system etc.
CO3:Use of advanced technology in the field of diagnostic of different diseases.
CO4:Modifications and redesign of existing biomedical instrumentation systems.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
<tr><td>CO1</td><td>Medium</td><td>Medium</td><td>Low</td><td>Low</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO2</td><td>High</td><td>Medium</td><td>Low</td><td>Low</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO3</td><td>Medium</td><td>High</td><td>Medium</td><td>Medium</td><td>Low</td><td>High</td></tr>
<tr><td>CO4</td><td>Medium</td><td>Low</td><td>High</td><td>High</td><td>Low</td><td>High</td></tr>
</table>
</td></tr>
<tr><td></td><td colspan="3">Introduction to Biomedical Instrumentation; Basic concepts of Medical Instrumentation:Generalized medical Instrumentation System, Medical Measurement constraints, classification ofBiomedical Instruments.
Anatomy and Physiology, Biomedical electrode sensors and transducers; Various types of electrodes used irl ECG, EEG and EMG, Measurement of EEG, EMG and their diagnostic Applications in Medicine, Flow and pressure measuring instruments in biomedical engineering.
Instrumentation in Diagnostic Cardiology: Pacemakers and Defibrillators; EEG and EMGInstrumentation; Instrumentation in Respiration; Artifacts and noise med ical instrumentation.
Instrumentation in Diagnostic Ultrasound, Instrumentation in medical imaging, Fibre optics and LASER in biomedical instrumentation.
Instrumentation in Intensive Care Units, Instrumentation in operating room.
Biomedical safety Instrumentation: Medical safety, Regulation and Standards, Preventivemaintenance. Computers and Telernedicine, New technologies and advances in medicalinstrumentation.</td></tr>
</table>

	References 1. Cormwell L. et aI., "Bio medical Instrumentation & Measurements," PHI 2 edition, 1990. 2. Khandpur R.S., "Hand book of biomedical instrumentation," Tata Mcgraw-Hill, 1992. 3. Shakti Chatterjee, Aubert Miller, "Biomedical Instrumentation Systems," CengageLearning. Cehgage Learning, I edition, 20 IO. 4. R. Anandanatarjan, "Biomedical Instrumentation and Measurements," PHI, 2011. 5. Carr & Brown, "Introduction to Biomedical Equipment," Prentice Hall, 4 edition, 2000. 6. Webster JG, "Medical Instrumentation: Application and Design," 4th eel., John Wiley &Sons, New York, 2009.

<table>
<tr><td>Course Title</td><td colspan="3">Introduction to Probability Theory & Stochastic Process</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Probability theory
Control system</td></tr>
<tr><td>Course Aim</td><td colspan="3">To revisit probability theory and demonstrate stochastic processes.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">After completion of the course students shall be able to:
CO1: Understand concepts of probability, conditional probability.
CO2: Understand and implement some of the commonly encountered random variables, in particular the Gaussian random variable
CO3: Relate probability theory to real statistical analysis,
CO4:Apply the theory of stochastic processes to analyze linear systems
CO5:Apply the above knowledge to solve basic problems in filtering, prediction and smoothing.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><td></td><td>PO1</td><td>PO2</td><td>PO3</td><td>PO4</td><td>PO5</td><td>PO6</td></tr>
<tr><td>CO1</td><td>Medium</td><td>High</td><td>Low</td><td>Low</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO2</td><td>Medium</td><td>High</td><td>Low</td><td>Low</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO3</td><td>Medium</td><td>High</td><td>Medium</td><td>Medium</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO4</td><td>Medium</td><td>Medium</td><td>Low</td><td>Low</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO5</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>Low</td><td>High</td></tr>
</table>
</td></tr>
<tr><td></td><td colspan="3">Discrete-type random variables - random variables and probability mass function, mean andvariance, conditional probabilities -independence, Bayes' formula. discrete distributions: Bernoulli, binomial, geometric, Poisson maximum likelihood estimation, Continuous-type random variables - cumulative distribution functions, probability density function independence, Bayes' formula - continuous distributions: uniform, exponential, Gaussian, chi-square - functions of random variables , Joint distributions, transformation of probability functions under maps, joint Gaussian distribution, Minimum mean square error estimation, Basic ideas of the probabilistic method-the first and second moment techniques.

References
1. Robert Brown and Patrick, Hwang, "Introduction to Random Signals and Applied Kalman Filtering," 3rd Ed, John Wiley and Sons Inc. 1997.
2. Goong Chen, Guanrong Chen, Shih-Hsun Hsu, "Linear stochastic control system," CRC Press, 1995.
3. Jason L. Speyer and Walter 1-1. Chung, "Stochastic Processes, Estimation and Control," PHI,2013.
4. J. S. Meditch, "Stochastic Optimal Estimation and Control," New York, McGraw Hill 1969.
5. M. Mitzenmacher and E. Upfal, "Probability and computing: Randomized Algorithms and Probabilistic Analysis," Cambridge University Press, 2005.</td></tr>
</table>

	6. P.E. Pfeiffer, "Conditional Independence in Applied Probability," Birkhauser; 1979 7. Dimitri P. Bertsekas and John N. Tsitsiklis, "Introduction To Probability," Athena Scientific; 2nd edition (I June 2008)

<table>
<tr><td>Course Title</td><td colspan="3">Control Techniques in Power Electronics</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power electronics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the different control techniques of the converters</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: To introduce the control of switched converters through a generic converter for DC-DC, DC-AC, AC-DC and DC-DC conversion and its closed loop operation.
CO2: To analyze the steady state and dynamic performance using state-space modelling and discrete-time analysis.
CO3: To analysis stability of power electronics converters using small signal modelling and transfer function approach through conventional root-locus and bode-plot methods.
CO4: To consider advance control methods such as hysteresis current control and sliding mode control in power electronics converters for tracking of desired current or voltage.
CO5: To consider the various digital controllers such as Microcontrollers, DSP, ASIC, FPGA etc. for power electronics converters.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>Medium</td><td>Low</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 3</td><td>High</td><td>Medium</td><td>Low</td><td>Low</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>High</td><td>High</td><td>Low</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>CO 5</td><td>Low</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
</table>
</td></tr>
<tr><td colspan="4">Introduction: Control of power electronics converters, Switched power converters, Power switching devices, Generic power converters, AC-DC, DC-AC, AC-AC, DC-DC converters control.

State Space modeling of switched converters: State space Models of Electrical Networks, Transient and steady state response of switched converters using state models, Instantaneous solution of load current, Device conduction, Pulse width modulation (PWM), single phase H-bridge and three phase inverter, sinusoidal pulse width modulation (SPWM) analysis of VSI.

Averaging models and Dynamic Analysis: Output and state feedback switching controllers, Averaged models, small-signal models and transfer functions of dc-dc converters, buck, boost, buck-boost converters, Conventional stability analysis, Root-locus method, Frequency response analysis.

Discrete-time Analysis: Discretization of continuous models, Digital control of converter systems, Sampling and ZOH, simulation of Power Electronics converters.

Variable Structure Systems: Variable structure and Sliding Mode control, Linear switched systems, Phase-plane and describing function analysis.

Current Controllers: Hysteresis, Ramp-comparison, Predictive Current controllers, design and analysis,</td></tr>
</table>

switching frequency dependency on parameters, current control loop design and analysis, closed loop transfer function, bode plots and bandwidth.

Multilevel Converters and Control: Cascaded, Diode-clamp and Flying Capacitor multilevel converters, Multicarrier modulations

Implementation of Power Electronics Controllers: Analog controllers, Computer Control, DSP implementation, ASIC's and embedded controller, FPGA's and Virtual Instrumentation.

References:

1. N. Mohan, T. M. Undeland and W. P. Robbins, *Power Electronics, Converters, Applications and Design*, Third Edition, Wiley India,2006.
2. M. H. Rashid, *Power Electronics Handbook*, Third Edition, Elsevier,2011.
3. M. P. Kazmierkowski, R. Krishnan and F. Blaabjerg, *Control in Power Electronics (Selected Problems)*, Academic Press, Elsevier Science (USA),2002.
4. H. S. Ramirez and R. S. Ortigoza, *Control Design Techniques in Power Electronics Devices*, Springer Verlag, London,2006.
5. V. Ramanarayanan, *Course Material on Switched Mode Power Conversion*, Second Edition, IISc Bangalore, India,2006.
6. D. O. Neacsu, *Power Switching Converters (Medium and High Power)*, CRC Press, Taylor & Francis Group, LLC, US, 2006.
7. B Wu, *High Power Converter and AC Drives*, IEEE Press, John Wiley & Sons.,2006.
8. T. L. Skvarenina, *The Power Electronics Handbook*, CRC Press,2002.

<table>
<tr><td>Course Title</td><td colspan="3">Electric Vehicle Technology</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Electronics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the Electrical vehicles and their operation</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: Able to understand the electric vehicle design, architecture and types of EV.
CO2: Competence in designing the power electronic converters for electric vehicle charging applications
CO3: Ability in analyzing the energy storage systems for EVs and carry research on the same
CO4: Proficiency in design and control of electric motors for EVs
CO5: Able to understand and create the solutions for the impact of EV on grid</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3"><table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th></tr>
<tr><td>CO 1</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>CO 3</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO 4</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>CO 5</td><td>Low</td><td>Low</td><td>High</td><td>High</td><td>High</td></tr>
</table></td></tr>
<tr><td colspan="4">General Introduction, History of Electric Vehicles (EV), Evolution of Batteries, E-Mobility – advantages, Preference for EV over ICE Vehicles, EV types - Battery EV, Fuel Cell EV, Hybrid EV, Plug-In EV; Policies and Regulations for Faster EV Adoption.
Energy Storage Options for EV Applications-battery types, Li-ion Batteries- Characteristics and Parameters, Modeling and Estimation; Battery Management System; Safety strategies (passive/active) of Li-ion batteries; Alternate energy storage technology.
Electric Motors for EV Applications, Performance requirements, Types of motors, Magnetic materials, Thermal issues and management, Electromagnetic Analysis and Design, Sizing of propulsion motor.
Power Electronic Converters for EV Applications: Si-based devices, Wide-band gap devices, Power losses, Reliability assessment, Role of Power Electronic Converters, Battery charging topologies, Traction drives, Voltage source inverters, Modulation techniques, Sizing of power electronics converters.
Drive-trains: Hybrid Electric and Electric Drive-trains, Energy Management Strategies.
Modeling and Sizing of Batteries used in EVs, EV Battery Management Systems, Critical battery states (State of Charge, State of Energy, State of Health, State of Power, State of Temperature); Safety technologies.
EV Charging Methods(CC/CV), Charging Infrastructures, Standards, Location of Charging Stations, Integration of EV load in Power System - Impact of EV charging on grid, EV charging strategies, Mitigation Techniques.
EVs in Grid Support: Flexibility Services, Vehicle to Everything (V2X), Barriers in V2X Infrastructure, Ancillary services, Dynamic Tariff with EVs.
Communication systems, Integrated Vehicle Health Monitoring.
Reference Books :
1. Sandeep Dhameja, Electric Vehicle Battery Systems, Elsevier, First Edition, 2002</td></tr>
</table>

2. John Fenton & Ron Hodkinson, *Lightweight Electric/Hybrid Vehicle Design*, Elsevier Oxford, 2000.
3. Seth Leitman, Bob Brant, *Build Your Own Electric Vehicle*, McGraw Hill, Third Edition, 2013.
4. Iqbal Husain, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, Second Edition, 2010.
5. MehrdadEhsani, YiminGao, and Ali Emadi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, Second Edition2009.
6. Various IEEE/Science direct journals

Course Title	**Cyber Security**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-IV and PE-V)	Semester	2
Prerequisite Knowledge	1. Control System 2. Instrumentation 3. Neuro-fuzzy control system		
Course Aim	To understand the different Cyber attacks and their prevention techniques		
Course Outcomes (COs)	CO1: Understand the core principles behind CPS CO2: Identify safety specifications and critical properties CO3: Understand abstraction in system design CO4: Learn techniques for attack detection and attack mitigation.		

Mapping of COs with POs

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	High	Low	High	High	Low	High	High
CO2	High	Low	High	High	High	High	High
CO3	High	High	High	High	High	High	High
CO4	High	High	High	High	Low	High	High

Unit 1: Dynamical Systems Modeling

i. Cyber-Physical Systems (CPS) in the real world
ii. Dynamical Systems : stability and performance
iii. Different notions of stability
iv. Controller Design techniques
v. Sensors and Actuators for Physical Processes

Unit 2: CPS Compute/Scheduling

i. Real time scheduling theory
ii. CAN bus scheduling
iii. Packet drops and their effects on stability/performance
iv. Delay/Deadline-miss aware control design

Unit 3: Secure CPS

i. Distributed CPS
ii. Attack Models
iii. Attack detection techniques in CPS
iv. Attack mitigation in CPS

Unit4:

Smart Grid Security and Privacy : Automated Generation Control attack mitigation

References:

1. E. A. Lee and S. A. Seshia , Introduction to Embedded Systems - A Cyber-Physical Systems Approach, 2014.

2. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
3. J. J. E. Slotine, Applied nonlinear control, Prentice-Hall,1991
Brown, P., Sensors and Actuators: Technology and Applications, Library Press, 2016

<table>
<tr><td>Course Title</td><td colspan="3">Computer Aided Design of Electrical Systems</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-IV)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Basic Electrical Engineering, Power system, Control system</td></tr>
<tr><td>Course Aim</td><td colspan="3">To analyze the application of the various motors in electric traction</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1:Ability to develop the analysis electrical circuits if software
CO2:To understand how the circuits will behave during the transient
CO3: To understand the various utilization of the Circuit
CO4: To implement a real time circuit in software.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3"><table>
<tr><td></td><td>PO 1</td><td>PO 2</td><td>PO 3</td><td>PO 4</td><td>PO 5</td><td>PO 6</td></tr>
<tr><td>High</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>High</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
</table></td></tr>
</table>

UNIT 1: Use of International Standards, Electrical Codes & Standards - BS, NEC, IEE, IEEE, NFPA, IEC Design Basis, std. practices/procedure and specifications, Understanding, Basic Electrical Formulae, Basic Design requirement based on the type of various plants, Intra-discipline co-ordination with civil, process, mechanical, piping, telecom HVAC etc.

UNIT 2: Wiring Accessories & Cable Management Systems, Cable Selection and Sizing and cable laying methods, Selection and sizing of electrical equipment used in various projects, Preparation of equipment specifications, High Voltage system requirements including substation design.

UNIT 3: Lighting systems, Lighting Fixtures (Types &Applications), Lighting Design- Illumination Lux Levels, Emergency & Exit Lighting System, Specialized Engineering like Heat Tracing systems and cathodic protection design, Design of Earthlings system, Lightning system and lightning protection system, Method of Lightening protection, Basic Consideration for Protection (RferStd IS 2309,NFC 72-102),Low current systems- Fire alarm & detection system, CCTV system etc.

UNIT 4: Generation, Transmission & Distribution of Electricity, Design of power distribution, Earthingin Power Stations and Substations, Earthing Associated with Overhead Power Lines and lighting protection systems, Equipment vendor drawing review and approval.

UNIT 5: Electrical System Drafting (CAD)- Preparation of lighting layouts, Preparation of Power Layouts, Preparation of Single Line Diagrams (SLD) or Riser Diagrams, Preparation of Electrical General

Installation Details & Sections, Preparation of LV or Electrical Room Details, Procurement Requirements and installation standards., Inspection of Equipment/system.

Text/ Reference Books:

1. S. Marran, "Electrical System Design and Specification Handbook for Industrial Facilities," Prentice Hall PTR, 1 Edition, 1998.
2. T. R. Bosela, "Electrical System Design," Prentice Hall, 1stEdition, 2002.
3. A. Thumannt and H. Franz, "Efficient Electrical Systems Design Handbook," Fairmont Press, 1stEdition, 2009.
4. K.B. Raina,"Electrical Design Estimating and Costing," New Age International, 2007

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Course Title	**Stochastic Control and Optimization**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Professional Elective-IV/V	Semester	2
Prerequisite Knowledge	Advanced Mathematics Control theory Probability and random processes		
Course Aim	This course introduces basic theories and methodologies for analysis and design of stochastic control systems.It provides a comprehensive introduction to stochastic control, with applications		
Course Outcomes (COs)	**After the successful completion of this course, students are able to:** CO1: Understand basic principles of probability theory and stochastic dynamical systems including Markov chains. CO2: Rigorously formulate stochastic control problems as Markov Decision Process (MDP) problems. CO3: Solve Linear Quadratic stochastic control problems. CO4: apply solve constraint optimization problems by applying hybrid optimization techniques.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	High	High	Medium	Medium	Low
CO 2	High	High	High	Medium	Low	Low
CO 3	High	High	High	Medium	Low	Medium
CO 4	High	High	Medium	Medium	Low	Medium

Module 1:

Introduction to stochastic control, Shortest path example, Probability and Monte Carlo, Markov chains, Structure of Markov chains, Markov decision processes,Dynamic programming, Approximate dynamic programming,The Bellman-Ford algorithm, Linear quadratic stochastic control, Linear exponential quadratic regulator, Model predictive control, Hidden Markov models, Risk averse control, nonlinear filtering.

Module 2:

Multi-valued optimization, hybrid optimization, meta-heuristic algorithms.

References:

1. K.J. Astron, Introduction to Stochastic Control Theory, Dover Pub.
2. J. Spall, Introduction to Stochastic Search and Optimization, Wiley-Interscience, New York, 2003.
3. Sheldon Ross, Introduction to Stochastic Dynamic Programming, Academic Press, New York, 1995.
4. S. Asmussen and P. W. Glynn, Stochastic Simulation, Springer Verlag, New York, 2007.

<table>
<tr><td>Course Title</td><td colspan="3">Adaptive Control</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">1. Control System
2. Optimal Control</td></tr>
<tr><td>Course Aim</td><td colspan="3">To discuss the design of adaptive control systems.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">After completion of the course students shall be able to:

CO1: explain self-tuning, adaptive, predictive and robust adaptive control systems.
CO2: explain self-tuning, adaptive, predictive and robust adaptive control systems.
CO3: understand adaptive control systems, their development and properties.
CO4: understand methods and tools for stability analysis of adaptive and learning systems.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3"><table>
<tr><td></td><td>PO1</td><td>PO2</td><td>PO3</td><td>PO4</td><td>PO5</td><td>PO6</td></tr>
<tr><td>CO1</td><td>Low</td><td>Low</td><td>Medium</td><td>Medium</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO2</td><td>High</td><td>Medium</td><td>Low</td><td>High</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO3</td><td>Medium</td><td>Low</td><td>High</td><td>Low</td><td>Low</td><td>Low</td></tr>
<tr><td>CO4</td><td>Low</td><td>Medium</td><td>Low</td><td>Medium</td><td>Medium</td><td>High</td></tr>
</table></td></tr>
<tr><td colspan="4">Introduction: Linear feedback, effects of process variations, adaptive schemes, adaptive controlproblem.
Real-Time Parameter Estimation: Least squares and regression models, estimating parameters indynamical systems, simulation of recursive estimation.
Self-tuning Regulators (STR): Pole placement design, indirect STR, direct STR, stochastic and predictive STR, applications.
Model-reference Adaptive Control (MRAC): The MIT rule, determination of adaptive gain,design of MRAS' using Lyapunov theory, BlBO stability, output feedback, relation between MRAS and STR, applications.
Gain Scheduling: The principles, design of gain scheduling controllers, nonlineartransformations, applications.
Robust adaptive control scheme, averaging-based analysis, adaptive control of nonlinear systems.</td></tr>
</table>

Practical issues and implementation, commercial products and applications.

Reference Books :

1. K. J. Astrom, B. Wittenmark, "Adaptive Control, Prentice Hail," 2 edition, 1994 .
2. P. A. Ioannou, J. Sun, "Robust Adaptive Control, Dover Publication," 2 edition, 2012.
3. H. K. Khalil, "Nonlinear Systems," Prentice Hall; 3 edition, 2001.
4. K. S. Narandra, A. M. Annaswamy, "Stable Adaptive Systems," Prentice Hall, EnglewoodClis, NJ, 1989.
5. S. Sastry, M. Bodson, "Adaptive Control: Stability, Convergence and Robustness," DoverPublications, 2011.

Course Title	**System Identification and Estimation**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Professional Elective-IV/V	Semester	2
Prerequisite Knowledge	Control System Probability theory		
Course Aim	This course aims to demonstrate the methodologies of system identification and estimation.		
Course Outcomes (COs)	After completion of the course students shall be able to: **CO1:** Apply basics of probability theory in system identification and system state estimation. **CO2:** Methods for non-parametric system identification and model validation. **CO3:** Estimation of parametric models and validation of the obtained system models. **CO4:** Design state estimator for linear deterministic and stochastic systems. **CO5:** Apply Kalman filter in various variants for system state and parameter estimations.		

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	High	Medium	High	Medium	Low	Medium
CO2	High	Medium	Medium	Low	Low	Low
CO3	High	Medium	Medium	Low	Low	Low
CO4	High	High	High	High	Low	Medium
CO5	High	High	High	High	Low	Medium

System Identification - Motivation and Overview, random variables and stochastic processes,stochastic static models, Disturbance models - random processes, representation of stationaryprocesses, white-noise process, auto-covariance function (ACF), ARMA models. Parametricmodel structures - ARX, ARMAX etc.

The identification problem, classical methods of identification of transfer functions models,Linear Regression - Least Squares estimates, Statistical properties of LS Estimates. WeightedLeast Squares, Recursive Least Squares, Maximum Likelihood Estimation. Minimum variance algorithm, stochastic approximation. Estimation of non-parametric models - impulse, step, response coefficients, frequency response models. Estimation of parametric models - notions of prediction and simulation, predictors for parametric models, prediction-error methods, Instrumental Variable method. Kalman-filters for state estimation Gauss Markov, Model for vector random processes. Model Structure Selection and Diagnostics - estimation of delay and order, residual checks, properties of parameter estimates, model validation.

References:

1. Pieter Eykhoff , "Trends and progress in system identification," Pergamon, 1981.
2. Raman K. Mehra, "System identification advanced and case studies," Elsevier Science; edition, 1976.
3. Jason L. Speyer, Walter H. Chung, "Stochastic processes, estimation and control," Society for Industrial and Applied Mathematics, 2008.
4. Gregory F. Lawler, "Introduction to stochastic processes," Chapman' and Hall/CRC; 2 edition, 2006.

<table>
<tr><td>Course Title</td><td colspan="3">Special Topics in Control System</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">1. Control System
2. Mathematics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To discuss different control strategies.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">After completion of the course students shall be able to:
CO1: Importance of Model Order Reduction: Time domain techniques and frequency domain techniques.
CO2: Concept of variable-structure controller and sliding control and application of switching control laws to practical systems.
CO3: To develop understanding of fuzzy logic systems and familiarity with Mamdani and TSK fuzzy logic controllers.
CO4: Developing analytical skills to design microcontroller, DSP controller and Embedded controller for specific requirement and to analyze its performance.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3"><table>
<tr><td></td><td>PO 1</td><td>PO 2</td><td>PO 3</td><td>PO 4</td><td>PO 5</td><td>PO 6</td></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>Low</td><td>Low</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO 2</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO 3</td><td>High</td><td>Low</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO 4</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td><td>High</td></tr>
</table></td></tr>
<tr><td colspan="4">Model Order Reduction: Importance of reduced order models, Time domain Techniques, Frequency Domain Classical techniques, Optimal Hankel Norm Approximation. Sliding modecontrol: Concept of variable-structure controller and sliding control, reaching condition andhigher order sliding mode, reaching mode, implementation of switching control laws. Reductionof chattering in sliding and steady state mode. Fuzzy Logic: Fuzzy arithmetic and fuzzy relations, Fuzzy logic controller, Adaptive fuzzy control, Stabilization using fuzzy models Microcontrollerand DSP control.

<u>Reference Books:</u>

1. G. Obinata and B.D.O. Anderson, "Model reduction for control system design," Springer-Verlag, London, 2001.
2. M. Jamshid, "Large-Scale Systems: Modeling, Control and Fuzzy Logic," Prentice Hall; 1stedition, 1996.
3. J. .I. E. Siotine, "Applied nonlinear control," Prentice Hall Englewood Cliffs, New Jersey.1991.</td></tr>
</table>

4. M. Chidambaran, "Computer Control of Processes," Alpha Science International Ltd, 2002.
5. V. I. Utkin, "Sliding modes in control and optimization," Springer- Verlag, 1992.
6. W. Pedrycz,"Fuzzy control and fuzzy systems," Research Studies Press, 1993.

<table>
<tr><td>Course Title</td><td colspan="3">Digital System Simulation</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-VI)</td><td>Semester</td><td>3</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">1. Control System
2. Digital Control</td></tr>
<tr><td>Course Aim</td><td colspan="3">To discuss different strategies for simulations of control systems.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">After completion of the course students shall be able to:
CO1: analyse and simulate real-time continuous-time and discrete-time systems;
CO2: design and develop various system languages for analysis of continuous-time and discrete-time systems.
CO3: apply modern optimization techniques for various engineering applications.
CO4: apply and analyse various approximation and numerical techniques for system simulation.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3"><table>
<tr><td></td><td>PO1</td><td>PO2</td><td>PO3</td><td>PO4</td><td>PO5</td><td>PO6</td></tr>
<tr><td>CO1</td><td>Medium</td><td>Medium</td><td>Medium</td><td>Medium</td><td>High</td><td>Low</td></tr>
<tr><td>CO2</td><td>Low</td><td>Low</td><td>Medium</td><td>Medium</td><td>Low</td><td>High</td></tr>
<tr><td>CO3</td><td>Medium</td><td>Medium</td><td>Low</td><td>High</td><td>Low</td><td>low</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>High</td><td>Medium</td><td>High</td></tr>
</table></td></tr>
<tr><td colspan="4">Introduction to digital system simulation, continuous and discrete system simulation, Queuingsystem simulation, A PERT network simulation, Inventory control system simulation andforecasting techniques, Design and evaluation of experiments on system simulation, systemsimulation languages with particular reference to GPSS, SIMULA & Continuous systemsimulation languages (CSSLs), Introduction to system models. Approximation of functions: Linear regression, polynomial regression, Fitting of exponential and trigonometric functions, Taylor Series, Chebyshev series and rational functions approximations. Differentiation andIntegration: Formulae for numerical differentiation, numerical integration, Simpson's rule.

<u>Reference Books:</u>

1.John F. Wakerly, "Digital design principles and practices," Prentice Hall; 4th edition, 2005.
2. G. Borriello, R. H. Katz, "Contemporary logic design," Pearson Prentice Hall, 2005.
3. Howard G. Johnson, "1-1 igh-speed digital design- A handbook of black magic," Prentice Hall; I edition, 1993.
4. M. Abramovici, M. Breuer & A. Friedman, "Digital systems testing and testable design," Wiley-Blackwell; Revised edition, 1994.</td></tr>
</table>

<table>
<tr><td>Course Title</td><td colspan="3">Robot modelling and control</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-VI)</td><td>Semester</td><td>3</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">1. Control System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To develop models of Robot and design different control strategies.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">After completion of the course students shall be able to:
CO1: Define the coordinates and the corresponding kinematic parameters for robotic manipulators.
CO2: Solve forward and inverse kinematic equations.
CO3: Drive robot dynamic model using Lagrange's equations of motion.
CO4: Design robot motion trajectories to meet the design specifications and requirements.
CO5: Use of different sensors in robotics.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3"><table>
<tr><td></td><td>PO1</td><td>PO2</td><td>PO3</td><td>PO4</td><td>PO5</td><td>PO6</td></tr>
<tr><td>CO1</td><td>Low</td><td>Medium</td><td>Low</td><td>Low</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO2</td><td>Low</td><td>Medium</td><td>Medium</td><td>Low</td><td>Low</td><td>Low</td></tr>
<tr><td>CO3</td><td>Medium</td><td>Medium</td><td>Medium</td><td>Low</td><td>Low</td><td>Low</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td></tr>
<tr><td>CO5</td><td>High</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td></tr>
</table></td></tr>
<tr><td colspan="4">Basic Concepts in Robotics, Robotics system components, Homogeneous Transformation, Representation of Transformations, Direction cosine representation, Basic and Composite Rotation matrices, Rotation matrix with Euler angle representation, Specification for position and orientation of end-effectors, Robot arm Kinematics: The direct kinematics problem, Inverse Kinematics for Euler angles and Direction cosine angle, Denavit Hartenberg convention and its applications, Robot arm Dynamics: Forward Dynamics, Inverse Dynamics, Lagrange-Euler formation and Applications., Actuators- Hydraulic actuators, Pneumatic actuators, Electrical Actuators, DC Servo motor and other actuators.

Sensors- Positional and velocity sensors, Tactile sensors, proximity and range sensors, Force and Torque sensors, Uses of sensors in robotics.</td></tr>
</table>

Reference Books:

1. John J. Craig, "Introduction to robotics, mechanics and control," Prentice Hall; 3 eclition, 2004.
2. John .I. Craig, "Adaptive control of mechanical manipulators," Addison- Wesley Pub (Sci), 1987.
3. F.L. Lewis, S. Jagannathan, A. Yesildirek, "Neural network control of robot manipulators," CRC Press, 1998.
4. F. L. Lewis, Abdallah C. T., and Dawson D.M., "Control of robot manipulators," Macmillan Publishing Co, Oxford, UK, 1993.

Course Title	**Smart Sensor & Actuators**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-VI)	Semester	3
Prerequisite Knowledge	1. Control System 2. Instrumentation System		
Course Aim	To discuss different smart sensors and actuators.		
Course Outcomes (COs)	After completion of the course students shall be able to: **CO1:** understand the performance of sensors & actuators. **CO2:** demonstrate the static and dynamic characteristics of sensors. **CO3:** explain the operating principle of various types of sensors & actuators. **CO4:** understand the applications of sensors and actuators		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Low	Medium	Low	Low	Low
CO 2	Low	Medium	Medium	Low	Low	Low
CO 3	Low	Low	Medium	Low	Low	Low
CO 4	High	Medium	Medium	Low	Low	Medium

Performance specification and analysis of sensors: analog and digital motion sensors, opticalsensors, temperature sensors, magnetic and electromagnetic sensors, acoustic sensors, chemical sensors, radiation sensors, torque, force and tactile sensors etc.

The current technology of sensors: electronic, photonic, micro fluidics and new materials.

Integration of electronics with sensors.

Actuators: stepper motors, DC and AC motors, hydraulic actuators, magnet and electromagnetic actuators, acoustic actuators.

Introduction to interfacing methods: bridge circuits, AID and DIA converters, microcontrollers.

Reference Books:

1. Ida, N.; Sensors, Actuators, and their Interfaces;20 14; ScitechPublishing.
2. Handbook of Modern Sensors, 2nd Ed. By Jacob Fraden.
3. Semiconductor Sensors, Edited by S. M. Sze.
4. Wireless Sensor Networks: F. Zhao, C. Guibas, Elsevier, Morgan Kaufmann, 2004.

Course Title	**Advanced Digital Control**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-VI)	Semester	3
Prerequisite Knowledge	1. Control System 2. Signals and Systems		
Course Aim	To discuss different advanced digital control schemes and controllers.		
Course Outcomes (COs)	After completion of the course students shall be able to: **CO1:** formulate the mathematical model of digital control systems. **CO2:** determine the stability of discrete time systems using different techniques. **CO3:** design various advanced digital controllers for sampled-data control systems. **CO4:** demonstrate the design and applications of industrial and embedded digital controllers in real-time testbeds.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Low	Medium	Low	Low	Low
CO 2	Low	Medium	Medium	Low	Low	Low
CO 3	Low	Low	Medium	Low	Low	Low
CO 4	High	Medium	Medium	Low	Low	Medium

Module 1: Digital Control System

Sampled-data Control System, Components of Digital Control System: A/D Converter, Quantizer, Encoder, Hold Circuits, Ideal LP filter.

Nyquist–Shannon sampling theorem, Aliasing, Anti-aliasing filter.

Module 2: Modelling and Stability analysis using conventional approach

Z-transform revisited, Modified Z-transform, Difference equation, Pulse transfer function, Closed-loop sampled-data system, Bi-linear transformation, Impulse invariance method, Jury Stability, Routh-Hurwitz with w-plane.

Module 3: Modelling and Stability analysis using State-space approach

State-space modelling, State transition matrix, Cayley–Hamilton theorem, Discretization of Continuous Time state-space model, Lyapunov stability.

Module 4: Design of Digital Controllers

Conventional approaches: Root locus, Frequency domain design, Compensators, Dead-beat responses.

State feedback controllers, Observer-aided digital controllers, Digital LQR, Model predictive controller (MPC), Quasi-sliding mode controller (QSMC).

Filters Design: IIR, FIR

Module 5: Industrial and Embedded Controllers

SCADA, DSP-based Controllers, The Texas Instruments TMS320 DSP's, Field programmable gate array

(GA).

Reference Books:

1. Katsuhiko Ogata, Discrete-time control systems, 2nd Edt., PHI.
2. Kuo, Digital Control System, 2nd Edt., Oxford University Press.
3. M. Gopal, Digital Control System, New Age Pub.

Course Title	Power Plant Operation & Controls		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-V I)	Semester	3
Prerequisite Knowledge	Power electronics, Electrical Machines		
Course Aim	To teach how to conserve the energy and different aspects of Audit		
Course Outcomes (COs)	CO1: To teach the operation of different electrical energy generating plant CO2: To understand the different operating constraints and their control actions CO3: To evaluate the different the safety measures of the power plant CO4: To evaluate the scope and feasibility of power generation from renewables		

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	M	M
CO2	H	H	H	H	M	H
CO3	H	H	M	M	M	M
CO4	H	H	H	H	M	H

UNIT 1:

Conventional Sources of electrical energy: Steam, hydro, nuclear, diesel and gas, their scope and potentialities for energy conversion. Generation : Different factors connected with a generating station, load curve, load duration curve, energy load curve, base load and peak load plants.

UNIT 2:

Thermal stations : Selection of site, size and no. of units, general layout, major parts, auxiliaries, generation costs of steam stations. Hydro stations : Selection of site, mass curve, flow duration curve, hydrograph, classification of hydro plants, types of hydro turbines, pumped storage plants.
Nuclear stations : Main parts, location, principle of nuclear energy, types of nuclear reactors, reactor control, nuclear waste disposal.

UNIT 3:

power plant process and of unit cycle principles, hazards and the appropriate precautions associated with the plant and process systems Effective communication techniques,instrumentation and control features including permissive conditions, interlocks, alarm and trip conditions, requirements for the competent, safe and reliable operation of plant,abnormal plant and process conditions and the associated incident response mechanisms

UNIT 4:
Power station control and interconnection: Excitation systems, excitation control, automatic voltage regulator action, advantage of interconnection.

UNIT 5:
Alternate energy sources: Solar, wind, geo-thermal, ocean-thermal, tidal wave, MHD and biomass.renewable sources of alternative power generation and their operational requirements.

References

1. Deshpande, M.V., Elements of Electrical Power Station Design, 5th ed.,PHI, 2013.
2. B. R . Gupta,, Generation of Electrical Energy, S. Chand, New Delhi, 2013.
3. Nag, P.K., Power Plant Engineering, 3rd ed., Tata Mc-Graw Hill Education, 2013.
4. Raja, A.K., Srivastava, A.P. and Dwivedi, M., Power Plant Engineering, New Age International Private Limited, New Delhi, 2006

Course Title	**Electrical Energy Conservation & Auditing**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-IV and PE-IV)	Semester	2
Prerequisite Knowledge	Power System		
Course Aim	To teach how to conserve the energy and different aspects of Audit		
Course Outcomes (COs)	CO 1 Explain the basics of Energy audit. CO 2 To understand the Different equipment's used for energy Audit CO 4 To understand the requirement of the various economic analysis. CO 5 Computation of various economic aspect.		

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
Mapping of COs with POs	CO 1	High	Medium	High	High	Medium	High
	CO 2	Medium	High	High	High	Medium	High
	CO 3	Low	High	High	High	Medium	Medium
	CO 4	Medium	High	Medium	High	Medium	Medium
	CO5	High	High	High	High	High	High

Unit - I
Basic Principles of Energy Audit and management Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Pie charts – Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems – Principles of energy management – Initiating, planning, controlling, promoting, monitoring, reporting – Energy manager, Bureau of Energy Efficiency: Energy conservation building code, Accredited energy auditor.

Unit - II
Power Factor and energy instruments Power factor – Methods of improvement – Location of capacitors – Power factor with non linear loads – Effect of harmonics on Power factor – Numerical problems. Energy Instruments – Watt–hour meter – Data loggers – Thermocouples – Pyrometers – Lux meters – Tong testers – Power analyzer.

Unit - III

Space Heating and Ventilation – Air–Conditioning (HVAC) and Water Heating: Introduction – Heating of buildings – Transfer of Heat–Space heating methods – Ventilation and air–conditioning – Insulation– Cooling load – Electric water heating systems – Energy conservation methods

Unit - IV

Economic Aspects and Analysis Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts), GREEN BUILDINGS: Barriers to green buildings, green building rating tools, material selection, operating energy, façade systems, ventilation systems, transportation, water treatment systems, water efficiency, building economics, Leed and IGBC codes.

Unit - V

Computation of Economic Aspects Calculation of simple payback method – Net present worth method – Power factor correction – Lighting – Applications of life cycle costing analysis – Return on investment.

Reference Books :

1. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
2. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
3. Energy management hand book by W.C.Turner, John wiley and sons.
4. Energy management and conservation –k v Sharma and pvenkataseshaiah-I K International Publishing House pvt.ltd,2011.
5. http://www.energymanagertraining.com/download/Gazette_of_IndiaP artIISecI-37_25-08-2010.pdf
6. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012
7. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995

Course Title	**Electricity Industry Structure & Regulations**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-V & IV)	Semester	2
Prerequisite Knowledge	Power System, Electrical Machines		
Course Aim	To teach how to conserve the energy and different aspects of Audit		
Course Outcomes (COs)	CO1: Explain the basic allocation of generators to operate at the optimal point CO 2 To teach the hydro thermal operation according to the optimal point CO 3To teach different techniques to handle the nonlinear complex problem CO 4. To understand the effect of various control techniques on power systemoperation		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Medium	High	High	Medium	High
CO 2	Medium	High	High	High	Medium	High
CO 3	Low	High	High	High	Medium	Medium
CO 4	Medium	High	Medium	High	Medium	Medium

UNIT 1:

Structure of electrical Industry: Introduction to electricity Industry, overview, Electricity Demand and supply relation of different region, Different types power producers, transmission companies and their regulations, The distribution companies and regulation for the distribution companies.

UNIT 2:

Global markets for crude oil, Markets for refined petroleum products, Basic economics of power generation, transmission and distribution ,Economic dispatch of power plants, Rate of return regulation for electric utilities, Long range planning in the power sector, Different models to reduce the losses in the industry.

UNIT 3:

Regulation: Regulations of the Grid, the mechanics of rate of return regulation, Economic dispatch and operations of electric Utilities discounted cash flow models and metrics for evaluating energy projects, regulation for generation companies, Restructuring and deregulation in the electric power Industry.

UNIT 4:

Different Models: Discounted cash flow models and metrics for evaluating energy products, corporate finance and discount rate, taxes, subsidies, economic challenges in the integration of renewables, incentives for renewable sources

References

1. Wood. A. J. and Wollenberg B. F., Power Generation, Operation and Control, 3rd edition, Willey Publication, 2014.
2. Saadat H., Power System Analysis, 1st International Edition, Tata Mc-Graw Hill Publishing Company Limited, 2008.
3. Kundur P., Power System Stability and Control, EPRI Series, McGraw- Hill, 1998. 2. Nagrath I. J. and Kothari D. P. , "Power System Engineering", 2nd edition, Tata Mc-Graw Hill Publishing Company, 2008.

Course Title	**Modern Digital and Embedded Controllers**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-V & IV)	Semester	2
Prerequisite Knowledge	Digital Electronics and Micro processors		
Course Aim	To teach internal structure, operation and application of the various controllers		
Course Outcomes (COs)	At the end of the course, students will be able CO1: To explain the various micro controller available and study the structure. CO 2 To understand the basic I/O of FPGA and DSP based controllers CO 3: To understand the serial and parallel operation in DSP and FPGA controllers CO 4 To understand the operation of the PLC controllers.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	High	High	High	Low	High	High
CO2	High	High	High	High	High	High
CO3	High	High	High	High	High	High
CO4	High	High	High	Low	High	High

UNIT 1: Microcontroller Basics-8-Bit and 16-bit Microcontroller Internal Block Diagram, CPU, ALU, address bus, data bus, control signals, Working Registers, SFRs, Clock and Reset circuits, Stack and use of Stack Pointer, Chip Peripheral Interfaces-Interfacing concept and design rule.

UNIT 2: FPGA based controller: Architecture, logic for different operations, parallel operation, Set of inputs, FPGAs- Resource Sharing, Implementation technology – PLD's, Custom Chips, Standard Cell and Gate arrays – FPGA Architectures – SRAM based FPGAs – Permanently programmed FPGAs –FPGA logic cells, I/O block architecture: Input and Output cell characteristics, clock input, Timing. FPGA applications to power electronic systems, Gating Pulse generation for AC-AC converter, AC-DC converter, PWM generation for Buck Converter, SPWM generation - Main design rules of an FPGA-based controller: Control algorithm refinement (design of a time continuous controller, internal delay issues, digital re-design, sampling issues, quantization issues). Architecture refinement (algorithm architecture matching, IP-modules reusability, Hardware-In-the-Loop (HIL) validation.

UNIT 3: DSP based controllers: Architecture, logic for different operations, parallel operation, Set of inutps,Dspace based controller

UNIT 4: Atmel AVR ATMEGA 8 Micro-controller: Introduction, Major features, Architecture, Application and programming, PLC for various control application, ladder logic.

Reference Books:

1. The 8051 Microcontroller and Embedded systems-using assembly and C, Muhammad Ali Mazidi

and Janice Gillespie Mazidi and Rollin D. McKinaly,PHI,2006/pearson,2006
2. Embedded Systems Design using the TI MSP430 series, Cris Nagy, Newnes, Elsevier.

Course Title	**Embedded Systems**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Control System		
Course Aim	To teach the basics of Embedded System and apply embedded system on practical application		

Introduction to an Embedded systems design: Introduction to Embedded system (ES), Embedded system project management, ESD and co-design issues in system development process, design cycle in the development phase for an embedded system, use of target system or its emulator and in-circuit emulator, use of software tools for development of an ES.

RTOS & its overview: Real time operating system: Task and task states, tasks and data, semaphores and shared data operating system, services, message queues, timer function, events, memory management, interrupt routines in an RTOS environment, basic design using RTOS.

Microcontroller: Role of processor selection in embedded system (Microprocessor vs Microcontroller), 8051 Microcontroller: architecture, basic assembly language programming concepts, instruction set, addressing modes, logical operation, arithmetic operations, subroutine, interrupt handling, timing subroutines, serial data transmission, serial data communication.

Embedded System Development: Embedded system evolution trends. Round - Robin, robin with interrupts, function-one-scheduling architecture, algorithms. Introduction to assembler compiler-cross compilers and Integrated Development Environment (IDE). object oriented interfacing, recursion, debugging strategies, simulators.

Networks for Embedded Systems: The I2C Bus, The CAN bus, SHARC link ports, Ethernet, Myrinet, Internet, Introduction to Bluetooth: specification, core protocol, cable replacement protocol. IEEE 1149.1 (JTAG) Testability: boundary scan architecture.

References:

1. Raj Kamal, Embedded Systems, TMH
2. K.J. Ayala, The 8051 Microcontroller, Penram International
3. J B Peatman, Design with PIC Microcontrollers, Prentice Hall
4. David E. Simon,An Embedded Software Primer, Pearson Education
5. John Catsoulis, Designing Embedded Hardware,O'reilly,
6. Frank Vahid, Tony Givargis, Embedded System Design, John Wiley & Sons, Inc
7. Karim Yaghmour,Building Embedded Linux Systems, O'reilly
8. Michael Barr, Programming Embedded Systems,O'reilly
9. Alan C. Shaw, Real-time systems & software, John Wiley & sons, Inc

Course Title	**Fuzzy Logic and Control**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Any Engineering Specialization		
Course Aim	To teach the students to learn fuzzy logic and implement the fuzzy logic for various real time applications		

Module 1: Type-I Fuzzy Logic
Introduction to fuzzy logic, Fuzzy & Crisp Sets, Fundamental elements of fuzzy logic controllers: MFs, Rule base, Fuzzy fication, Defuzzification, Mamdani/TSK fuzzy model, Fuzzy-aided control system design and analysis.

Module 2: Type-II Fuzzy Logic
Merits and demerits over Type-I fuzzy logic, Elements of Type-II fuzzy logic, Design and applications of Fuzzy logic-II controller

Module 3: Hybrid fuzzy controller, ANFIS design and analysis, Applications to dynamical systems/estimation.

References:

1. Mendel JM. Uncertain Rule-Based Fuzzy Logic Systems: Introduction and New Directions. Prentice Hall PTR, 2001.
2. Mendel JM. Uncertain Rule-based Fuzzy Systems: Introduction and New Directions. Second Edition, Springer 2017.
3. Zadeh LA. Fuzzy sets. Inform Control 1965; 8: 338-353.

<table>
<tr><td>Course Title</td><td colspan="3">Optimization Techniques</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective (PE III)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Linear algebra, Control System, Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the basic of optimization techniques</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO1: To introduce basic optimisation techniques.
CO2: To understand the linear optimisation techniques and their applications.
CO3: To understand the non-linear optimisation techniques and their applications.
CO4: To study evolutionary based algorithms for optimisation techniques</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 3</td><td>Medium</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>High</td><td>Medium</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
</table>

Classical optimization techniques: Single variable optimization, multivariable optimization with constraints and without constraints, necessary and sufficient conditions.

Linear programming (LP): Two variable problems-graphical solutions, formulation of LP problems in more than two variables, standard form, Simplex algorithm, special cases-2 phase's method, Big-M method, duality and dual LP problems. Application of LP in Transportation problem-balanced and unbalanced transportation problems. Use of North West corner rule, least cost method, Vogel approximation method. Assignment problems- Hungarian method.

Non-linear programming (NLP): Philosophy of numerical methods, search methods for one dimensional problems- Fibonacci and Golden section methods. Unconstrained and constrained optimization, univariate method , Pattern search method , Steepest descent method, cutting plane method , penalty function method, basic idea of dynamic programming.

Evolutionary algorithms (EA): Genetic algorithm, particle swarm optimization, Tabu search, simulat annealing and ant colony optimization, Multi objective optimization using EA, Pareto solutions.

References:

1. S.S. Rao, Engineering Optimization: Theory and Practice. New York: Wiley. 2009.
2. K. Deb, Multiobjective Optimization using Evolutionary Algorithms. New York; Wiley. 2002.
3. G.P. Liu, J.B. Yang and J.F. Whidborne, Multiobjective Optimization and Control. PHI. 2008.
4. A. D. Belegundu, and T. R. Chandrupatla, Optimization Concepts and Applications in Engineering, Pearson Education (Singapore). 2003.
5. R. L. Rardin, Optimization in Operation Research. Prentice-Hall. 1999.
6. A. Schirisieer, Theory of linear and integer programming, John Wiley and Sons, 1986.
7. D. Leunberger, Linear and Nonlinear programming, Add. Wesley, 1984.

Course Title	**Artificial Intelligence in Engineering**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Control System		
Course Aim	To teach the application of artificial intelligence in engineering		

Basic Principles: Introduction, Experimental Evaluation: Over-fitting, Cross-Validation. Sample complexity. VC-dimension, Regularization, Theory of generalization, Bias-Variance trade off, Reinforcement Learning.

Supervised Learning: Linear and Logistic Regression, Decision Tree Learning, k-NN classification, SVMs, Ensemble learning: boosting, bagging.

Neural Network: Artificial Neural Networks: Perceptron, Multilayer networks and back propagation. Radial Basis function NN , Applications in electrical engineering

Probabilistic Models: Maximum Likelihood Estimation, MAP (Maximum a-posteriori), Bayes Classifiers, Naive Bayes. Markov Networks, Bayesian Networks, Factor Graphs, Inference in Graphical Models. Applications of probabilistic models

Unsupervised Learning: K-means and Hierarchical Clustering, Gaussian Mixture Models, PAC learning. EM algorithm, Hidden Markov Models. Applications in electrical Domain

References:

1. Tom Mitchell, Machine Learning, McGraw Hill, 1997.

2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer 2006.

3. Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, John Wiley & Sons, 2006.

4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning: Data Mining,

Inference, and Prediction, Springer 2009.

<table>
<tr><td>Course Title</td><td colspan="3">Expert Systems</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective (PE III)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power electronics, Electrical Machines</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO1: To use basic concepts of expert systems
CO2: Implement a rule-based expert system and Evaluate Expert System tools
CO3: Apply knowledge representation and Design a knowledge base
CO4: To Use and apply fuzzy logic in various control applications</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 2</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 3</td><td>Low</td><td>High</td><td>High</td><td>High</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO5</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
</table>
L=Low, M=Medium, H=High</td></tr>
<tr><td colspan="4">Introduction, Expertise and Heuristic knowledge, knowledge based systems, Structure of knowledge based systems, Logic and automated reasoning, Predicate logic, logical inference, Resolution, Truth maintenance systems, Rule based reasoning, Forward chaining , Backward chaining, Rule based architectures, conflict resolution schemes, Associative networks, Frames and Objects, uncertainty management, Baynesian approaches, Certainty factors, Dempeter-Shefer theory of Evidence, Fuzzy sets and Fuzzy logic, knowledge Acquisition search strategies and matching techniques.
Inference based knowledge generation

References:
1) Peter Jackson, "Introduction to expert systems," Addison-Wesley, 3 edition, 1998.
2) Archino .J. Gonzalez Douglas D. Dankel and Douglas D. Dankel II, "The Engineering of knowledge based systems," Prentice Hall, 1993.</td></tr>
</table>

3) Dan W. Patterson, "An introduction to artificial intelligence and expert systems," Prentice Hall, 1990.
4) Sasikumar et al., "Rule based expert systems," Narosa Publishing, 1996.
5) Janusz S. Kowal ik; "Knowledge based problem solving," Prentice Half, I?86.
6) Frederick Hayes-Roth, Donald A. Waterman and Douglas B. Lenat, "Building expert systems," Addison-Wesley Longman Publishing Co., Inc. Boston, MA, USA, 1983

Course Title	**Robotics and Automation**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Control System		

UNIT 1:

Introduction: Past, Present & Future; Robot Terminology; Applications, Components and Subsystems; Classification of Robot etc. End Effectors, Different types of grippers and their design concepts etc. Motion Analysis: Homogeneous transformations as applicable to rotation and translation – problems.

UNIT 2:

Robot Kinematics: Specifications of matrices, D-H notation joint coordinates and world coordinates, Forward and inverse kinematics – problems. Differential transformation and manipulators, Jacobians – problems

Dynamics: Lagrange – Euler and Newton – Euler formations – Problems.

UNIT 3:

Trajectory Planning: Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion, straight line motion–Robot programming, languages and software packages. Robot actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors etc.

UNIT4:

Automation : Introduction, Types of systems - mechanical, electrical, electronics, fluidics; Hydraulics Systems and components; Pneumatic Systems Control; Applications of relays/switches; Measuring systems, Transducers; Programmable controllers; Automatic orientation and assembly; Design of components for assembly. Cost considerations and case studies. design and operation of automatic systems-Pneumatic Controls, Electropneumatic Controls, Programmable Logic Controller (PLC) etc.

References:

1. Robotics and Control by Mittal R.K Mittal and I.J. Nagrath,TMH

2. Introduction to Robotics, Analysis, Systems, Applications by Saeed B. Niku, PHI Publications.

3. CAM and Automation by M.P. Groover, PHI Learning

4. Robotics –Control, sensing, TMH

5. Robotics Fundamental concepts and analysis, Ghosal Ashitava, Oxford

6. Robotics Technology and Flexible Automation by S.R. Deb and S. Deb S., " Tata McGraw Hill Education Pvt. Ltd, 2010.

7. Introduction to Robotics by John J. Craig, Pearson

Course Title	**Research Methodology**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Any Engineering Specialization		
Course Aim	To teach the students how to perform the analysis and write technical papers		

Introduction: A quick glance on research, Conceptualizing a research design Reviewing the literature.

Formulating a Research Problem: Identifying variables, Constructing hypotheses, Establishing the validity and reliability, Constructing an instrument for data collection, Measurement and Scaling Techniques, Sampling Fundamentals, Methods of Data Collection, Defining the Research Problem.

Developing a research plan and writing and presenting a research proposal (Mid-sem Exam). Experimentation.

Processing data: Analysing Data, Analysis of Variance and Covariance, Testing of Hypotheses, Multivariate Analysis Techniques, Chisquare Test, Displaying data. Research methodology and practice evaluation.

Writing and presentation of a research report (End Sem Exam).

References books

1. Research Methodology: Methods and Techniques, C R Kothari.

Course Title	**Digital Signal Processing**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Signal Systems		
Course Aim	To teach the different signal processing techniques		
Course Outcomes (COs)	At the end of the course, students will be able **CO1:** To understand the different frequency domain analysis. **CO2:** To understand the Signal detection, modulation techniques, frequency translation. **CO3:** To learn the Issues involved in DSP processor design-speed **CO4:** To study the applications using DSP Processor		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Medium	High	High	High	Medium
CO 2	High	High	Medium	High	Medium	High
CO 3	Medium	Medium	High	High	High	Medium
CO 4	High	Medium	Medium	High	High	Medium

L=Low, M=Medium, H=High

DFT- Walsh- Hadamard transforms, discrete convolution and correlation, FFT algorithms, Digital filters-flow graph and Matrix representation, IIR and FIR filter design, Signal processing algorithm, waveform generation, Quadrature signal processing, Signal detection , modulation techniques, frequency translation, over ranging, Issues involved in DSP processor design-speed, cost, accuracy, pipelining, parallelism, quantization error, etc., Key DSP hardware elements - Multiplier, ALU, Shifter, Address Generator, etc., Software development tools-assembler, linker and simulator, Applications using DSP Processor - spectral analysis.

References:

1. V. Oppenheim and R. W. Schafer, Digital Signal Processing. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1975.
2. A. Bateman and W. Yates, Digital signal processing design, W H Freeman & Co, 1989.
3. A. Antoniou, Digital filters analysis and design, McGraw-Hill Science/Engineering/Math; Second Edition, USA, 2000.

Course Title	**Linear Algebra**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Any Engineering Specialization		

Algebraic Structures: Sets, functions, Group, homomorphism of groups, Ring, Field, Vector Space, Subspaces, direct sum, metric space, inner product space, Lp space, Banach Space, Hilbert Space. Linear independence, basis, dimension, orthonormal basis, finite dimensional vector spaces, isomorphic vector spaces, Examples of finite and infinite dimensional vector spaces, RN , CN .

Linear Transformations: Linear Transformations, four fundamental subspaces of linear transformation, inverse transformation, rank nullity theorem, Matrix representation of linear transformation, square matrices, unitary matrices, Inverse of a square matrix, Change of basis, coordinate transformation, system of liner equations, existence and uniqueness of solutions,

projection, least square solution, pseudo inverse.

Matrix Methods and Transforms: Eigen values, Eigen vectors, Generalized Eigen vectors, Diagonalizability, orthogonal diagonalization, Symmetric, Hermitian and Unitary matrices (transformations), Jordan canonical form, Fourier basis, DFT as a linear transformation, Translation invariant linear transformation, wavelet basis, wavelet transforms.

References:

1. G. F. Simmons, Topology and Modern Analysis, McGraw Hill

2. Frazier, Michael W. An Introduction to Wavelets through Linear Algebra, Springer Publications.

3. Hoffman Kenneth and Kunze Ray, Linear Algebra, Prentice Hall of India.

Course Title	**Virtual Instrumentation**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	EMMI, Control System		
Course Aim	To teach the students about virtual instrumentation and its applications.		

Course Outcomes (COs)	At the end of the course, students will be able **CO 1:** Appreciate the difference between conventional and virtual instrumentation and the pros and cons of both. **CO 2:** To perform graphical programming with various programming constructs in LabVIEW and be able to make VIs and Sub-VIs for simple and complex operations. **CO 3:** Use various data structures and various numeric and logical operations on them to do complex data processing. **CO 4:** Be familiar with various display functions for displaying output and input variables. **CO 5:** Be able to use data acquisition methods and file I/O and be familiar with various DAQ hardware and Instrumentation buses.

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	Medium	High	Medium	Medium	Medium	Medium
CO 2	High	High	High	High	High	High
CO 3	High	Medium	High	High	High	High
CO 4	High	Low	Medium	High	Medium	Medium
CO 5	High	Low	High	High	High	High

L=Low, M=Medium, H=High

Introduction, Virtual instrumentation (VI) advantages, Graphical programming techniques, Data flow programming, VI's and sub VI's, Structures, Arrays and Clusters, Data acquisition methods, File I/O, DAQ hardware, PC hardware: operating systems, Instrumentation buses, ISA, PCI, USB, PXI, Instrument control, Data communication standards, RS-232C, GPIB, Real time operating systems, Reconfigurable I/O, FPGA.

References:

1. Jovitha Jerome, *Virtual Instrumentation Using Lab VIEW*, PHI Learning Pvt. Ltd, New Delhi, 2009.
2. S. Gupta and J. John, *Virtual Instrumentation Using Lab VIEW, Tata McGraw-Hill,* New Delhi, 2005.
3. R.H. Bishop, *Lab VIEW 7 Express Student Edition,* Prentice Hall, 2003.
4. National Instruments, *Lab VIEW User Manual, USA, 2003.*
5. National Instruments, *Lab VIEW Real Time User Manual, USA, 2001.*

Course Title	**Neural Network & Deep Learning**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Coding Skills, Linear Algebra		

Course Aim	To teach the students to obtain basic knowledge on Neural Network & Deep Learning
Course Outcomes (COs)	At the end of the course, students will be able **CO 1:** To Model Neuron and Neural Network, and to analyze ANN learning, and its applications. **CO 2:** To perform Pattern Recognition, Linear classification. **CO 3:** To develop different single layer/multiple layer Perception learning algorithms **CO 4:** To design of another class of layered networks using deep learning principles.
Mapping of COs with POs	

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	L	L	L	L	M	H
CO 2	L	L	L	L	M	H
CO 3	L	L	L	L	M	H
CO 4	L	L	L	L	M	H

L=Low, M=Medium, H=High

Introduction to Neural Networks: Neural Network, Human Brain, Models of Neuron, Neural networks viewed as directed graphs, Biological Neural Network, Artificial neuron, Artificial Neural Network architecture, ANN learning, analysis and applications, Historical notes.

Learning Processes: Introduction, Error correction learning, Memory-based learning, Hebbian learning, Competitive learning, Boltzmann learning, credit assignment problem, Learning with and without teacher, learning tasks, Memory and Adaptation.

Single layer Perception: Introduction, Pattern Recognition, Linear classifier, Simple perception, Perception learning algorithm, Modified Perception learning algorithm, Adaptive linear combiner, Continuous perception, Learning in continuous perception. Limitation of Perception.

Multi-Layer Perceptron Networks: Introduction, MLP with 2 hidden layers, Simple layer of a MLP, Delta learning rule of the output layer, Multilayer feed forward neural network with continuous perceptions, Generalized delta learning rule, Back propagation algorithm.

Introduction to Deep learning: Neuro architectures as necessary building blocks for the DL techniques, Deep Learning & Neocognitron, Deep Convolutional Neural Networks, Recurrent Neural Networks (RNN), feature extraction, Deep Belief Networks, Restricted Boltzman Machines, Autoencoders, Training of Deep neural Networks, Applications and examples(Google, image/speech recognition)

References:

1) Simon Haykins, "Neural Network- A Comprehensive Foundation", Pearson Prentice Hall, 2nd Edition, 1999. ISBN-13: 978-0-13-147139-9/ISBN-10: 0-13-147139-2
2) Zurada and Jacek M, "Introduction to Artificial Neural Systems", West Publishing Company, 1992, ISBN: 9780534954604
3) Vojislav Kecman,"Learning & Soft Computing", Pearson Education, 1st Edition, 2004, ISBN:0-262-11255-8.
4) M T Hagan, H B Demoth, M Beale, "Neural Networks Design", Thomson Learning, 2002. ISBN-

10: 0-9717321-1-6/ ISBN-13: 978-0-9717321-1-7.
5) Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer Publisher; 1st ed. 2018 edition
6) François Chollet, "Deep Learning with Python", Manning Publisher; 1st edition, 2017

Course Title	**Network Control System**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-V I)	Semester	3
Prerequisite Knowledge	Control Systems, Linear Control System, Non Linear Control system		
Course Aim	1. This course offers an introduction to control systems using communication networks for interfacing sensors, actuators, controllers, and processes. 2. This course includes analyzing and designing the dynamics of multi-agent network systems.		
Course Outcomes (COs)	At the end of the course, students are able to: **CO 1:** perform network analysis using graph theory. **CO 2:** construct and analyze a discrete-time model for a dynamical system. **CO 3:** analyze a multivariable dynamic system and design an appropriate controller for the system. **CO 4:** assess/evaluate the stability, performance and robustness of a closed-loop system.		
Mapping of COs with POs			

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1						
CO 2						
CO 3						
CO 4						

L=Low, M=Medium, H=High

Review of linear systems and Lyapunov stability; Features of control networks; Theory of nonnegati matrices (Perron–Frobenius theory); Elements of graph theory (with an emphasis on algebraic graph theory); Graph Laplacians. Consensus Problem: cooperative control, leader-follower architecture. Linear matrix inequalities and switched systems; Stability analysis of networked control systems in presence of communication delays and packet loss. Multi-Agent System (MAS): Introduction; Different types of agents; Features and structure of MAS; Agent development software (JADE); Distributed optimization using multi-agent systems and Applications in real-time problems.

References

1) M. Mesbahi and M. Egerstedt Graph Theoretic Methods in Multiagent Networks.
2) L. Farina and S. Rinaldi Positive Linear Systems.
3) M. Mesbahi and M. Egerstedt, "Graph Theoretic Methods in Multiagent Networks", Princeton Univercity Press, NJ, 2010.
4) W. Ren and R.W. Beard, "Distributed Consensus in Multi-vehicle Cooperative Control: Theory and Application", Springer-Verlag, London, 2008.
5) F. Lewis, H. Zhang, K. Hengster-Movric and A. Das, "Cooperative Control of Multi-Agent Systems: Optimal and Adaptive Design Approaches", Springer-verlag, London, 2014.
6) R. B. Bapat, "Graphs and Matrices", Hindustan Book Agency, Springer-Verlag, London,
7) 2011.
8) L. Krick, M. E. Broucke and B. A. Francis "Stabilisation of infinitesimally rigid formations of multi-robot networks", International Journal of Control, Vol. 82, No. 3, 2009.
9) W. Ren, R. W. Beard, and E. M. Atkins, "Information Consensus in Multivehicle Cooperative Control", IEEE Control Systems Magazine, April-2007.
10) Z. Li, Z. Duan, G. Chen and L. Huang, "Consensus of Multi-agent Systems and Synchronization of Complex Networks: A Unified Viewpoint", IEEE Transactions on Circuits and Systems-I: Regular Papers, Vol. 57-1, 2010.
11) H. Zhang, F. L. Lewis and A. Das, "Optimal Design for Synchronization of Cooperative Systems: State Feedback, Observer and Output Feedback", IEEE Transactions on Automatic Control, vol. 56, no. 8, 2011.
12) S. Wang et al., "A Data-Driven Multi-Agent Autonomous Voltage Control Framework Using Deep Reinforcement Learning," in IEEE Transactions on Power Systems, vol. 35, no. 6, pp. 4644-4654, Nov. 2020.

Course Structure & Curriculum

For

M. Tech. Programme

In

Electrical Engineering

With Specialization in

Power Electronics & Drives

Regular & Part Time

(Effective from Session 2022-23)

Department of Electrical Engineering
Motilal Nehru National Institute of Technology Allahabad
Teliarganj, Allahabad-211004, Uttar Pradesh

MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY ALLAHABAD

VISION

To establish a unique identity for the institute amongst national and international academic and research organizations through knowledge creation, acquisition, and dissemination for the benefit of society and humanity.

MISSION

- To generate high quality human and knowledge resources in our core areas of competence and emerging areas to make valuable contribution in technology for social and economic development of the nation. Focused efforts to be undertaken for identification, monitoring, and control of objective attributes of quality and for continuous enhancement of academic processes, infrastructure and ambience.
- To efficaciously enhance and expand, even beyond national boundaries, its contribution to the betterment of technical education and offer international programmes of teaching, consultancy, and research.

DEPARTMENT OF ELECTRICAL ENGINEERING

VISION

To produce globally competitive technical manpower with sound knowledge of theory and practice, with a commitment to serve the society and to foster cutting edge research in Electrical Engineering pertaining to the problems currently faced by the country and the world.

MISSION

1. Develop state of art lab facilities for research and consultancy
2. Develop infrastructure and procure-cutting edge tools/equipment
3. Develop relevant content and capability for quality teaching
4. Improve symbiotic relationship with Industry for collaborative research and resource generation.

Program Outcomes of M. Tech in Power Electronics & Drives

POs	
PO 1	Ability to apply knowledge of power electronics and drives for design and development of power electronics systems for diverse engineering applications, suitable for industries, academia and research requirements.
PO 2	An ability to independently carry out research /investigation and development work to solve practical problems in the field of Power Electronics & Drives.
PO 3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.
PO 4	An ability to write and present a substantial technical report/document in order to communicate ideas and solutions of research problem through publication in journals and conference proceedings.
PO 5	Possess good leadership, communication skill and sound technical knowledge for effective team work.
PO 6	Motivation for continuous and self-learning for knowledge update and sustainability.

M. Tech. (Electrical Engineering) with specialization in Power Electronics & Drives

Overall Credit structure

Category	Program Core (PC)		Program Electives (PE)	Total
	Core Essentials	Thesis/ SOA/ minor project		
Credits	16	40	24	80

Program Core

Subject Code	Subject Name	L	T	P	Credits
EE 21111	Power Electronics	3	0	2	4
EE 21112	Advanced Electrical machines	3	0	2	4
EE 22111	Electrical Drives	3	0	2	4
EE 22112	Advanced Power Electronics	3	0	2	4
EE 2X103	Term project	0	0	6	4
EE 23602	Thesis -I	0	0	18	12
EE 23652	State-of-the-art seminar	0	0	6	4
EE 24602	Thesis -II	0	0	30	20
Total credits					**56**

Program Electives (PE-I & II) – 1st Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Power Semiconductor devices	3	1	0	4
EE 2XXXX	Flexible AC Transmission Systems	3	1	0	4
EE 2XXXX	Renewable Energy & Grid Integration	3	1	0	4
EE 2XXXX	Microprocessor & Microcontroller Based Systems	3	1	0	4
EE 2XXXX	Control Techniques in Power Electronics	3	1	0	4
EE 2XXXX	Electric Vehicle Technology	3	1	0	4
EE 2XXXX	Sustainable and Renewable Energy	3	1	0	4
EE 2XXXX	Electrical Machines Design	3	1	0	4

Program Electives (PE-III) – 1st Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Embedded Systems	3	1	0	4
EE 2XXXX	Fuzzy logic and control	3	1	0	4
EE 2XXXX	Optimization Techniques	3	1	0	4
EE 2XXXX	Artificial Intelligence in Engineering	3	1	0	4
EE 2XXXX	Expert Systems	3	1	0	4
EE 2XXXX	Robotics and Automation	3	1	0	4
EE 2XXXX	Research Methodology	3	1	0	4
EE 2XXXX	Digital Signal Processing	3	1	0	4
EE 2XXXX	Linear Algebra	3	1	0	4
EE 2XXXX	Virtual Instrumentation	3	1	0	4
EE 2XXXX	Neural Network & Deep Learning	3	1	0	4

Program Electives (PE-IV & V) – 2nd Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Cyber Security	3	1	0	4
EE 2XXXX	Computer Aided Design of Electrical Systems	3	1	0	4
EE 2XXXX	Electric Traction and Vehicles	3	1	0	4
EE 2XXXX	Distribution Automation	3	1	0	4
EE 2XXXX	HVDC Transmission	3	1	0	4
EE 2XXXX	Electrical Safety	3	1	0	4
EE 2XXXX	Active Power Conditioning	3	1	0	4
EE 2XXXX	Electromagnetic Interference & Compatibility	3	1	0	4
EE 2XXXX	Electrical Energy Conservation & Auditing	3	1	0	4
EE 2XXXX	Electricity Industry Structure & Regulations	3	1	0	4
EE 2XXXX	Modern Digital and Embedded Controllers	3	1	0	4

Program Electives (PE–VI) – 3rd Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Intelligent Control of Drives	3	1	0	4
EE 2XXXX	Energy Storage Systems	3	1	0	4
EE 2XXXX	Power Electronic Converters for Microgrids	3	1	0	4
EE 2XXXX	Power Plant Operation & Control	3	1	0	4
EE 2XXXX	Reliability Engineering	3	1	0	4
EE 2XXXX	Advanced Digital Control	3	1	0	4

Course Structure for M. Tech. (Regular)

Sem	Course Name, L-T-P					Lecture courses	Contact hours/ week				Credits
							L	T	P	Total	
I	Power Electronics (3-0-2)	Advanced Electrical machines (3-0-2)	PE-I (3-1-0)	PE-II (3-1-0)	PE-III (3-1-0)	5	15	3	4	22	20
II	Electrical Drives (3-0-2)	Advanced Power Electronics (3-0-2)	Term Project (0-0-6)	PE-IV (3-1-0)	PE-V (3-1-0)	4	12	2	10	28	20
III	Thesis –I (0-0-18)	State-of-the-art Seminar (0-0-6)		PE-VI / MOOC*/ Online* (3-1-0)		1	3	1	24	30	20
IV	Thesis –II (0-0-30)					0	0	0	30	30	20

*This course can be completed between the start of the month of May (2nd semester) and end of the odd semester (3rd semester), i.e., between the end of their 2nd and 3rd Semesters.

Course Structure for M. Tech. (Part Time)

Sem	Course Name, L-T-P			Lecture courses	Contact hours/ week				Credits
					L	T	P	Total	
I	Power Electronics (3-0-2)	Advanced Electrical machines (3-0-2)		2	6	0	4	10	8
II	Electrical Drives (3-0-2)	Advanced Power Electronics (3-0-2)		2	6	0	4	10	8
III	PE-I (3-1-0)	PE-II (3-1-0)	PE-III (3-1-0)	3	9	3	0	12	12
IV	PE-IV (3-1-0)	PE-V (3-1-0)	Term Project (0-0-6)	2	6	2	6	14	12
V	Thesis –I (0-0-18)	State-of-the-art Seminar (0-0-6)	PE-VI / MOOC*/ Online* (3-1-0)	1	3	1	24	30	20
VI	Thesis –II (0-0-30)			0	0	0	30	30	20

*This course can be completed between the start of the month of May (2nd semester) and end of the odd semester (3rd semester), i.e., between the end of their 2nd and 3rd Semesters.

Course Title	**Power Electronics**		
Course Code	EE 2XXXX	Credit	4
Core/ Elective	core	Semester	1
Prerequisite Knowledge	Power Electronics,		
Course Aim	To teach the different switching techniques In Power electronics		
Course Outcomes (COs)	**CO 1.** To understand the different controlled rectifiers. **CO 2.** To understand the different DC-DC conversions. **CO 3.** To understand DC-AC conversion and their issues. **CO 4.** To understand frequency control techniques. **CO 5.** To understand he operation of the different solid state breaking		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	Medium	High	Medium	Medium	Medium	Medium
CO 2	High	High	High	High	High	High
CO 3	High	Medium	High	High	High	High
CO 4	High	Low	Medium	High	Medium	Medium
CO 5	High	Low	High	High	High	High

L=Low, M=Medium, H=High

Introduction: Power Electronics Systems, Role of Power Electronics in the field of electric power control, Power electronics converters.

Broad overview of Switching Power Devices: Static and dynamic characteristics of switching devices: SCR- BJT- MOSFET- IGBT- GTO.

Controlled Rectifiers: AC to DC Converters, Phase controlled Rectifiers operation on resistive and inductive loads, use of free-wheeling diode, Single -Phase and Three phase controlled and Fully

controlled bridge rectifiers, Semi-converters, Dual converters, Effect of source impedance on converter, Line commuted inverters.

Choppers: DC to DC Converters, Principle of operation and control technique of chopper, classification of Choppers, current and voltage waveforms for resistive, inductive and motor loads, Power Transistor and MOSFET based chopper circuits, step up chopper and its application.

Inverters : DC to AC Converters, Single-phase and Three-phase (six-step) inverters, voltage and current waveforms, Bridge Inverter, voltage control & PWM strategies of VSI., Series and parallel inverters, Methods of voltage control, and various techniques of phase width modulation. Comparisons of voltage source and current source inverters and their applications.

Cycloconverters: AC to AC Converters, single-phase and three-phase Step-up and Step down cycloconverter, Full bridge and half

Applications- Static circuit breakers, Static frequency converter, Power factor control, regulation of voltage or current in high power applications, motor controls and power amplifiers.

Reference Books:

1. M. H. Rashid, Power Electronics Circuits, Devices and Applications, Prentice Hall India, Third Edition, New Delhi, 2004.
2. V. Agarwal and K. Kant, Power Electronics, BPB Publications, New Delhi 2008.
3. G. K. Dubey, S. R. Doradla, A. Joshi and R. M. K. Sinha, Thyristorised Power Controllers, New Age international, Second Edition, New Delhi, 2002.
4. P. C. Sen, Power Electronics, Tata McGraw-Hill Education, New Delhi, 2008.
5. P. S. Bimbhra, Power Electronics, Khanna Publishers, Fifth Edition, New Delhi, 2014.
6. N. Mohan, First Course on Power Electronics and Drives, MNPERE, USA, 2003.
7. N. Mohan, T. M. Undeland and W. P. Robbins, Power Electronics, Converters, Applications and Design, Wiley India, Third Edition, 2006.
8. R .S. Ramstrand, Power Electronics.
9. M. H. Rashid, Power Electronics Handbook, Elsevier, Third Edition, 2011.

Course Title	**Advanced Electrical Machines**		
Course Code	EE 2XXXX	Credit	4
Core/ Elective	core	Semester	1
Prerequisite Knowledge	Power Electronics, Electrical Machines		
Course Aim	To teach the different operation of special machines		

Course Outcomes (COs)

CO 1. To study operational and constructional features of Brushless DC Machines.
CO 2. To learn the modelling of machines coupled to power electronic circuits.
CO 3. To understand generalized approach to machine parameters identification.
CO 4. To understand Reduced-Order Machine Equations.
CO 5. To understand the operation of the switched reluctance motor.

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	Medium	High	Medium	Medium	Medium	Medium
CO 2	High	High	High	High	High	High
CO 3	High	Medium	High	High	High	High
CO 4	High	Low	Medium	High	Medium	Medium
CO 5	High	Low	High	High	High	High

L=Low, M=Medium, H=High

Review and analysis: Direct-Current Machines, reference frame theory, Symmetrical Induction Machines, Synchronous Machines, Theory of Brushless dc Machines, winding functions and machine design, machine equations for improving analysis and modelling of machines coupled to power electronic circuits, analysis of unbalanced operation, generalized approach to machine parameters identification, Linearized Machine Equations, Reduced-Order Machine Equations, Switched reluctance motor.

Reference Books:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, and Steven Pekarek, Analysis of Electric Machinery and Drive Systems, Wiley-IEEE Press, Third Edition, 2013.
2. T.A. Lipo, and T. M. Jahns, Introduction to Electric Machines and Drives, University of Wisconsin, First edition, 2015.
3. D. W. Novotny and T. A. Lipo, Vector Control and Dynamics of AC Drives, Clarendon Press, First edition, 1996.
4. Peter Vas., Sensor less vector and direct torque control, Oxford 1998.
5. K. Venkataratnam, Special Electrical Machines, University Press (India) Pvt. Ltd. 2008.
6. R. Krishnan, Switched Reluctance Motor Drives, CRC Press 2001.
7. T. A. Lipo, Analysis of Synchronous Machines, 2nd Edition, CRC Press 2012N. Mohan, First Course on Power Electronics and Drives, MNPERE, USA, 2003.
8. N. Mohan, T. M. Undeland and W. P. Robbins, Power Electronics, Converters, Applications and Design, Wiley India, Third Edition, 2006.
9. R .S. Ramstrand, Power Electronics.
10. M. H. Rashid, Power Electronics Handbook, Elsevier, Third Edition, 2011.

<table>
<tr><td>Course Title</td><td colspan="3">Electrical Drives</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Core</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Electronics, Electrical Machines, Control system</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the electrical machines controlled by the power electronics controller.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course students will (Number may vary)
CO 1. To study operational and constructional features of Brushless DC Machines.
CO 2. To study variable reluctance motor .
CO 3. To understand vector control of electrical machines.
CO 4. To understand the variable frequency motor drive.
CO 5. To realize the application of motors in transportation and electric traction</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>Medium</td><td>High</td><td>Medium</td><td>Medium</td><td>Medium</td><td>Low</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>High</td><td>High</td><td>Medium</td><td>Low</td></tr>
<tr><td>CO 3</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td><td>Low</td></tr>
<tr><td>CO 4</td><td>High</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 5</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>Medium</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Review of classical speed control methods for DC motors, induction motor and synchronous motors, Applications of solid state controller such as choppers, rectifiers, inverters and cyclo-converters in drive system and their performance characteristics, Closed loop control of solid state DC drives. DC motor, stepper motor and variable reluctance motor drives. Variable frequency control of ac drives, Vector control of induction motor and synchronous motors, AC and DC</td></tr>
</table>

motor drives in transportation system & traction, Case studies.

Reference Books:

1. J. M. D. Murphy, Power electronics control of AC motors, Perganon Press, New York, 1988.
2. P. C. Sen, Thyristor DC drives, Wiley Inter Science Publication, 1981.
3. Vineeta Agarwal, Fundamentals of Electric drives, Agarwal Publishing House, First Edition, New Delhi.
4. G. K. Dubey, Fundamentals of Electric drives, Narosa Publishing House, Second Edition, New Delhi, 2001.
5. B. K. Bose, Modern Power Electronics & AC Drives, Pearson, New Delhi, 2002.
6. V. Subramanayam, Thyristor control of Electric drives, Tata McGraw Hill Publication, 1994.
7. S. B. Dewan, Thyristorized power controller drives, Wiley Inter Science Publication, New York, 1981.

Course Title	**Advanced Power Electronics**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Core	Semester	2
Prerequisite Knowledge	Power Electronics, Electrical Machines, Control system		
Course Aim	To teach the switching topologies for power conversion.		

Course Outcomes (COs)

CO1: To introduce basic switched converters and coverage of both non-isolated and isolated DC-DC converter, its steady state and dynamic analysis.

CO2: To present switched DC-AC inverter and various modulation techniques for both single and three-phase applications.

CO3: To provide understanding of soft switching operation through resonant circuits in order to minimise switching losses.

CO4: To present PWM and switch-mode AC_DC rectifiers in order to improve power factor and total harmonic distortions on AC side and controlled DC output voltage.

CO5: To introduce various advanced power electronics converters and its applications in power utility, distribution system and renewable energy systems

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Medium	High	Medium	High	Medium
CO 2	High	High	Medium	Medium	Medium	High
CO 3	Medium	Medium	High	Medium	Low	Medium
CO 4	High	Medium	Medium	Medium	High	Medium
CO 5	High	High	High	Medium	High	High

L=Low, M=Medium, H=High

DC-DC converters modelling and control: Review of basic Switched DC-DC converter circuits: Buck, Boost, Buck-boost, SEPIC, Cuk converters; Analysis of non-ideal switches and circuit elements in DC-DC converters, Parasitic effects on steady state characteristics, efficiency

calculation, voltage transfer characteristics with continuous and discontinuous inductor current, Dynamics of converters; State-space averaging, Small signal transfer functions, Voltage and current mode of control.

Isolated and PWM DC-DC converters: Switching power supplies, Unidirectional and bidirectional core excitation, Forward and Flyback Converters, Push-Pull, Full-Bridge and Half-Bridge converters, Steady state and dynamic characteristics, Modeling and Control, Pulse width modulation (PWM) with unipolar and bipolar voltage switching.

DC-AC Inverters: Voltage source and current source inverters, Half-bridge, full-bridge and 3-phase inverter circuits, Fundamental frequency modulation, Sinusoidal pulse-width modulation (SPWM), Space vector modulation (SVM), Compensation for dead time and device voltage drops.

Resonant converters: Hard switched and Soft Switched Converter, Zero-voltage and zero-current switching, Classification of resonant converters, Series and parallel loaded resonant circuits, Continuous and discontinuous mode of operation, Resonant-Switch converters, Zero-current switched (ZCS) DC-DC converter, Zero-voltage switched (ZVS) DC-DC converter.

Modern Rectifiers: Power and harmonics in non-sinusoidal AC systems, Pulse-width modulated rectifiers, Modeling, analysis, and control of low-harmonic rectifiers, Boost, flyback, and other topologies of an ac-dc controlled rectifiers, Switched mode rectifiers, Rectifier/inverter with bi-directional power flow.

Advanced converter topologies and Applications: Multilevel inverter topologies, Z-source inverters, Matrix-converters, Applications: Current controlled voltage source inverters (CCVSI), Active power filters (APF), Uninterrupted power supplies (UPS) etc.

Reference Books:

1. N. Mohan, T. M. Underland and W. P. Robbins, Power Electronics, Converters, Applications and Design, Wiley India, Third Edition, 2006.
2. M. H. Rashid, Power Electronics Handbook, Elsevier, Third Edition, 2011.
3. V. Ramanarayanan, Course Material on Switched Mode Power Conversion, IISc Bangalore, India, Second Edition, 2006.
4. N. Mohan, First Course on Power Electronics and Drives, MNPERE, USA, 2003.
5. J. G. Kassakian, M. F. Schlecht and G. C. Verghese, *Principles of Power Electronics*, Addison Wesley, New York, 1991.
6. R. W. Erickson and D. Maksimovic, Fundamentals of Power Electronics, Second Edition, Kluwer

Academic Publications, 2001.

7. D. W. Hart, Introduction to Power Electronics, Prentice Hall International, Upper Saddle River, NJ ,1997.
8. Erickson and Maksimovic, Fundamentals of Power Electronics, Second Edition, Springer Science Business 2000.

<table>
<tr><td>Course Title</td><td colspan="3">Power Semiconductor Devices</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Electronics, Electrical Machines, Control system</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the different semiconductor devices used for power electronics.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: To introduce basic EMI due to switching.

CO2: To understand the operation of the different current and voltage-controlled devices.

CO3: To understand the different firing and protection circuits.

CO4: To study the different thermal protection techniques of the devices</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>Medium</td><td>Medium</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 3</td><td>Medium</td><td>Medium</td><td>High</td><td>Medium</td><td>Low</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>High</td><td>Medium</td><td>Medium</td><td>Medium</td><td>High</td><td>Medium</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td></td><td colspan="3">Power switching devices overview: Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy On-state and switching losses – EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics and ratings

Current controlled and voltage controlled devices: Review of power electronics devices: Power BJT, Power MOSFET, IGBT, GTO, etc. – Construction, Principle of voltage controlled devices, types, static and switching characteristics, steady state and dynamic models, Negative temperature co-efficient and secondary breakdown, Other</td></tr>
</table>

emerging devices GTO, MCT, SiC, FCT, RCT, IGCT etc.

Firing and protecting circuits: Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubber.

Thermal protection : Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour, phase cooling; Guidance for hear sink selection – Thermal resistance and impedance, Electrical analogy of thermal components, heat sink types and design – Mounting types, Packaging and power modules.

Reference Books:

1. B.W Williams, *Power Electronics, Devices, Drivers and Applications,* Wiley, New York, 1987.
2. M. H. Rashid, *Power Electronics Circuits, Devices and Applications*, Prentice Hall India, Third Edition, New Delhi, 2004.
3. Vineeta Agarwal and Krishna Kant, *Power Electronics,* BPB Publications, New Delhi 2008.
4. M. D. Singh and K.B Khanchandani, *Power Electronics*, Tata McGraw-Hill, New Delhi 2003.
5. N. Mohan, T. M. Undeland and W. P. Robbins, *Power Electronics, Converters, Applications and Design*, Wiley

<table>
<tr><td>Course Title</td><td colspan="3">Flexible AC Transmission Systems</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System, Power Electronics, Control System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the application of various power electronic devices to improve the power transfer capability and voltage profile</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: To give an overview of existing transmission systems its limitation in enhancement of power flow capability.

CO2: To enumerate the role of power electronics controllers to control the real power flow and reactive power compensation in the transmission systems.

CO3: To give students the understanding of structure, operation and control of various FACTS controllers with emphasis on design & problem solving capability.

CO4: To emphasize on the difference between the Thyristorized and VSC based FACTS controllers and their merits.

CO5: To deliver students the application aspects of FACTS controllers, its extension to distribution systems and distributed generations, and its future scope.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3"><table>
<tr><td></td><td>PO 1</td><td>PO 2</td><td>PO 3</td><td>PO 4</td><td>PO 5</td><td>PO 6</td></tr>
<tr><td>CO 1</td><td>Low</td><td>Medium</td><td>Low</td><td>High</td><td>Low</td><td>High</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO 3</td><td>High</td><td>Medium</td><td>High</td><td>Low</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>High</td><td>High</td><td>Medium</td><td>Low</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO 1</td><td>Low</td><td>Medium</td><td>Low</td><td>High</td><td>Low</td><td>Medium</td></tr>
</table>
L=Low, M=Medium, H=High</td></tr>
</table>

	Introduction to FACTS, challenges and needs, Power Flow in AC transmission line, Power flow control, Description and definition of FACTS controllers, Static power converter structures, Voltage-sourced and current-sourced converters, Converter output and harmonic control, power converter control issues, Shunt Compensation: SVC, STATCOM, Operation and control, Configurations and applications, Series Compensation: TCSC, mitigation of sub-synchronous resonance, SSSC, Combination of shunt-series compensation: UPFC, Power flow studies with FACTS controllers, operational constraints, IPFC, UPQC, other FACTS Controllers: TCPAR, TCBR etc. ***Reference Books:*** 1. N. G. Hingorani and L. Gyugyi, Understanding FACTS, IEEE Press, New York, 1999. 2. K.R. Padiyar, FACT's Controllers in Transmission & Distribution, New Age International, New Delhi, 2007. 3. V. K. Sood, HVDC and FACTS Controllers: Applications of Static Converters in Power Systems, Kluwer Academic Publishers, Canada, April 2004. 4. A. Enrique, C.R. F. Esquivel and others, Modelling and Simulation in Power Networks, John Wiley.& Sons Ltd., England, 2004.

<table>
<tr><td>Course Title</td><td colspan="3">Renewable Energy & Grid Integration</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Electrical Machines, Electrical Circuits</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the basic of Renewable energy based sources and their control techniques</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: To analyse the Wind Energy System.
CO2: To analyse the PV based system.
CO3: To understand the requirement of the MPPT technique.
CO4: To study Hybrid energy system</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 3</td><td>Medium</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>High</td><td>Medium</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td></td><td colspan="3">Wind energy conversion systems, Wind turbines, Turbine characteristics, Various electrical generators, Induction generators, doubly-fed induction generator, Synchronous generator and permanent magnet synchronous generator (PMSG), Power conversion through power electronics converters, Maximum Power point tracking (MPPT), Controlled rectifiers and DC-DC converters for MPPT, Voltage source inverters, Modelling and control of WECS for grid interface, Standalone and grid interface application, Solar photovoltaic (PV) system, classifications, PV characteristics, MPPT methods, DC-DC converters and VSI, roof-top and domestic PV systems, Grid connected PV system, Fuel cells, classification and characteristics,</td></tr>
</table>

power electronics interfaces, Hybrid systems, Other renewable sources of energy, Integration of renewable energy systems.

Components required for grid integration, Energy storage components and integration with the grids, Large energy storage technologies (MW), Rechargeable batteries, Supercapacitors, Superconducting magnetic energy storage, Flywheel energy storage, Compressed air energy storage, Grid integration issues and standards. Adequate converter topologies, tariff related to renewable energy interface.

Microgrid structure and operation.

Reference Books:

1. M. R. Patel, Wind and Solar Power Systems, Tailor & Francis, CRC Press, USA, 2006.
2. M. H. Rashid, Power Electronics Handbook, Elsevier, Third Edition, 2011.
3. Bin Wu, Yongqiang Lang, NavidZargari, Power Conversion and Control of Wind Energy Systems, Wiley, 2011.
4. Anaya-Lara, N. Jenkins et al, Wind Energy Generation Modelling and Control, Wiley, 2009.
5. B. Fox et al, Wind Power Integration Connection and system operational aspects, IET, London, 2007.
6. A. Ghosh and G. Ledwich, Power Quality Enhancement using Custom Power Devices, Kluwer Academic, USA, 2002.
7. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, Second Edition, Wiley-IEEE Press, 2016.

Course Title	**Microprocessor & Microcontroller Based Systems**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-I and PE-II)	Semester	1
Prerequisite Knowledge	Digital Electronics		
Course Aim	To teach the basic of micro controllers and its applications		
Course Outcomes (COs)	**CO1:** To understand the basic architecture of the micro controllers . **CO2:** To understand the memory interfacing. **CO3:** To understand the different set of commands. **CO4:** To study parallel processing of the controllers.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Medium	High	High	High	Medium
CO 2	High	High	Medium	High	Medium	High
CO 3	Medium	Medium	High	High	High	Medium
CO 4	High	Medium	Medium	High	High	Medium

L=Low, M=Medium, H=High

Introduction to the general structure of advanced microprocessors and microcontrollers, Discussions on architectures, instruction sets, memory hierarchies, pipelining and RISC principles, interfacing to input and output devices, user interface design, real-time systems, and table-driven software, single chip microcomputers, Interrupt structures, Parallel/serial I/O, Analog I/O, DMA operations, Peripheral controllers, Laboratory based experiments and projects with these devices.

Reference Books:

1. John B. Peatman, Design with PIC Microcontrollers, Pearson Education Asia, 2000.
2. John B. Peatman, Design with Microcontrollers, McGraw Hill, USA,1995.
3. Barry B Brey, INTEL Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486 Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4, and Core2 with 64- Bit Extensions Architecture, Programming, and Interfacing, Eighth Edition, PHI 2009.

<table>
<tr><td>Course Title</td><td colspan="3">Control Techniques in Power Electronics</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power electronics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the different control techniques of the converters</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: To introduce the control of switched converters through a generic converter for DC-DC, DC-AC, AC-DC and DC-DC conversion and its closed loop operation.

CO2: To analyze the steady state and dynamic performance using state-space modelling and discrete-time analysis.

CO3: To analysis stability of power electronics converters using small signal modelling and transfer function approach through conventional root-locus and bode-plot methods.

CO4: To consider advance control methods such as hysteresis current control and sliding mode control in power electronics converters for tracking of desired current or voltage.

CO5: To consider the various digital controllers such as Microcontrollers, DSP, ASIC, FPGA etc. for power electronics converters.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3"><table>
<tr><td></td><td>PO 1</td><td>PO 2</td><td>PO 3</td><td>PO 4</td><td>PO 5</td><td>PO 6</td></tr>
<tr><td>CO 1</td><td>Low</td><td>Medium</td><td>Low</td><td>High</td><td>Low</td><td>High</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO 3</td><td>High</td><td>Medium</td><td>High</td><td>Low</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>High</td><td>High</td><td>Medium</td><td>Low</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO 1</td><td>Low</td><td>Medium</td><td>Low</td><td>High</td><td>Low</td><td>Medium</td></tr>
</table>L=Low, M=Medium, H=High</td></tr>
</table>

Introduction: Control of power electronics converters, Switched power converters, Power switching devices, Generic power converters, AC-DC, DC-AC, AC-AC, DC-DC converters control.

State Space modeling of switched converters: State space Models of Electrical Networks, Transient and steady state response of switched converters using state models, Instantaneous solution of load current, Device conduction, Pulse width modulation (PWM), single phase H-bridge and three phase inverter, sinusoidal pulse width modulation (SPWM) analysis of VSI.

Averaging models and Dynamic Analysis: Output and state feedback switching controllers, Averaged models, small-signal models and transfer functions of dc-dc converters, buck, boost, buck-boost converters, Conventional stability analysis, Root-locus method, Frequency response analysis.

Discrete-time Analysis: Discretization of continuous models, Digital control of converter systems, Sampling and ZOH, simulation of Power Electronics converters.

Variable Structure Systems: Variable structure and Sliding Mode control, Linear switched systems, Phase-plane and describing function analysis.

Current Controllers: Hysteresis, Ramp-comparison, Predictive Current controllers, design and analysis, switching frequency dependency on parameters, current control loop design and analysis, closed loop transfer function, bode plots and bandwidth.

Multilevel Converters and Control: Cascaded, Diode-clamp and Flying Capacitor multilevel converters, Multicarrier modulations

Implementation of Power Electronics Controllers: Analog controllers, Computer Control, DSP implementation, ASIC's and embedded controller, FPGA's and Virtual Instrumentation

Reference Books:

1. N. Mohan, T. M. Undeland and W. P. Robbins, *Power Electronics, Converters, Applications and Design*, Third Edition, Wiley India, 2006.
2. M. H. Rashid, *Power Electronics Handbook*, Third Edition, Elsevier, 2011.
3. M. P. Kazmierkowski, R. Krishnan and F. Blaabjerg, *Control in Power Electronics (Selected Problems)*, Academic Press, Elsevier Science (USA), 2002.
4. H. S. Ramirez and R. S. Ortigoza, *Control Design Techniques in Power Electronics Devices*, Springer Verlag, London, 2006.
5. V. Ramanarayanan, *Course Material on Switched Mode Power Conversion*, Second Edition, IISc Bangalore, India, 2006.

6. D. O. Neacsu, *Power Switching Converters (Medium and High Power)*, CRC Press, Taylor & Francis Group, LLC, US, 2006.
7. B Wu, *High Power Converter and AC Drives*, IEEE Press, John Wiley & Sons., 2006.
8. T. L. Skvarenina, *The Power Electronics Handbook*, CRC Press, 2002.

Course Title	**Electric Vehicle Technology**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-I and PE-II)	Semester	1
Prerequisite Knowledge	Power Electronics		
Course Aim	To teach the Electrical vehicles and their operation		
Course Outcomes (COs)	CO1: Able to understand the electric vehicle design, architecture and types of EV. CO2: Competence in designing the power electronic converters for electric vehicle charging applications CO3: Ability in analyzing the energy storage systems for EVs and carry research on the same CO4: Proficiency in design and control of electric motors for EVs CO5: Able to understand and create the solutions for the impact of EV on grid		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	Low	Medium	Low	High	Low	High
CO 2	High	High	High	Low	Medium	Medium
CO 3	High	High	Medium	Medium	Medium	Medium
CO 4	High	High	Medium	Low	Medium	Medium
CO 1	Low	Medium	Low	High	Medium	Medium

L=Low, M=Medium, H=High

Electric Vehicle Technology

General Introduction, History of Electric Vehicles (EV), Evolution of Batteries, E-Mobility – advantages, Preference for EV over ICE Vehicles, EV types - Battery EV, Fuel Cell EV, Hybrid EV, Plug-In EV; Policies and Regulations for Faster EV Adoption.

Energy Storage Options for EV Applications-battery types, Li-ion Batteries- Characteristics and Parameters, Modeling and Estimation; Battery Management System; Safety strategies (passive/active) of Li-ion batteries; Alternate energy storage technology.

Electric Motors for EV Applications, Performance requirements, Types of motors, Magnetic materials, Thermal issues and management, Electromagnetic Analysis and Design, Sizing of propulsion motor.

Power Electronic Converters for EV Applications: Si-based devices, Wide-band gap devices, Power losses, Reliability assessment, Role of Power Electronic Converters, Battery charging topologies, Traction

drives, Voltage source inverters, Modulation techniques, Sizing of power electronics converters.

Drive-trains: Hybrid Electric and Electric Drive-trains, Energy Management Strategies.

Modeling and Sizing of Batteries used in EVs, EV Battery Management Systems, Critical battery states (State of Charge, State of Energy, State of Health, State of Power, State of Temperature); Safety technologies.

EV Charging Methods(CC/CV), Charging Infrastructures, Standards, Location of Charging Stations, Integration of EV load in Power System - Impact of EV charging on grid, EV charging strategies, Mitigation Techniques.

EVs in Grid Support: Flexibility Services, Vehicle to Everything (V2X), Barriers in V2X Infrastructure, Ancillary services, Dynamic Tariff with EVs.

Communication systems, Integrated Vehicle Health Monitoring

Reference Books :

1. Sandeep Dhameja, Electric Vehicle Battery Systems, Elsevier, First Edition, 2002
2. John Fenton & Ron Hodkinson, *Lightweight Electric/Hybrid Vehicle Design*, Elsevier Oxford, 2000.
3. Seth Leitman, Bob Brant, *Build Your Own Electric Vehicle*, McGraw Hill, Third Edition, 2013.
4. Iqbal Husain, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, Second Edition, 2010.
5. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, Second Edition 2009.
6. Various IEEE/Science direct journals

Course Title	**Sustainable and Renewable Energy**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-I and PE-II)	Semester	1
Prerequisite Knowledge	Power electronics, Power System and Electrical machines		
Course Aim	To teach the renewable energy technologies and their control techniques		
Course Outcomes (COs)	CO1: Ability to develop the new renewable energy technologies to meet the power demand of the nation. CO2: Competence in designing the power electronic converters for solar, wind and fuel cell sources CO3: Ability to design and control the novel electrical generators for renewable energies CO4: Understand the concepts of energy storage systems for renewable energy systems		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Medium	High	High	Low	High
CO 2	High	High	High	Medium	Medium	Medium
CO 3	High	High	Medium	Medium	Medium	Medium
CO 4	High	High	Medium	Low	Medium	Medium
CO 1	Medium	Medium	Medium	High	Medium	Medium

L=Low, M=Medium, H=High

Unit 1: Sustainable and Renewable energy

Difference between sustainable and renewable energy sources (RES), types of RES and brief introduction about working of each, status of RES in the world and previous three years IRENA renewable capacity highlights. Role of electrical engineering in RES- role of power electronics, role of electric generators, role of storage systems, role of control schemes, role of transmission and distribution lines and role of FACTs devices.

Unit 2: Power Electronics for RES

Power converters and control for PV system: Design of dc/dc converter, single phase and three phase

inverter with PV as a source, Different MPPT algorithms, Grid interfacing-with isolation, without isolation, PV-Inverters with D.C. to D.C. converters-on low frequency side and high frequency side with isolation, without isolation. Voltage step-up using D.C.-D.C. converter- with and without battery storage, Voltage controller for Fuel cell using D.C. – D.C. converter, Inverter interaction with fuel cell for A.C. loads, A.C. Voltage build-up and controller for fuel cells- using power converters and transformers (isolation). Three phase AC voltage controllers-AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, matrix converters- Standalone operation of fixed and variable speed wind energy conversion systems.

Unit 3: Electrical generators for RES

Electric generators for wind energy conversion systems- state of art challenges, control techniques, solutions.

Electric generators for hydro power plants- state of art challenges, control techniques, solutions.

Electric generators for biomass, geothermal RES.

Unit-4: Energy storage systems for EV

Various types of energy storage systems, electrical domain, chemical domain, electrochemical domain, Batteries, Super capacitors, Superconducting Magnetic Energy Storage (SMES), charging methodologies, SoC, SoH estimation techniques. Hydrogen production and storage, fuel cells. Applications of Energy storage in distributed generation. Sodium Sulphate battery

Reference Books :

1. Sudipta Chakraborty, Marcelo G. Simões, and William E. Kramer, Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration, Springer.
2. S. N. Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.
3. B.H.Khan Non-conventional Energy sources Tata McGraw-hill Publishing Company, New Delhi, 2009.
4. Rashid .M. H "power electronics Hand book", Academic press, 2001.
5. G.D.Rai, "Non-conventional energy sources", Khanna publishes, 1993.
6. Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995.
7. R. Pendse, "Energy Storage Science and Technology", SBS Publishers & Distributors Pvt. Ltd., New Delhi, (ISBN – 13:9789380090122), 2011.
8. Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, "The Role of Energy Storage with Renewable Electricity Generation", National Renewable Energy Laboratory (NREL) – A National Laboratory of the U.S. Department of Energy – Technical Report NREL/ TP6A2-47187, January 2010.

<table>
<tr><td>Course Title</td><td colspan="3">Electrical Machines Design</td></tr>
<tr><td>Course Code</td><td>EE X2XXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-I and PE-II)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Electric Machine</td></tr>
<tr><td>Course Aim</td><td colspan="3">To analyze the Design Aspects of Various Machines</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: To know the basic considerations of machine design, heat dissipation, cooling and calculation of various quantities
CO2: To learn the design of core, yoke, winding, dimensions of transformer and its cooling
CO3: To know the design of various aspect of rotating machine as specific electric and magnetic loadings, selection of frame size, Core and armature design
CO4: To understand the rotor design of induction machine and field design of dc and synchronous machine
CO5: To know about computer aided design and various software package available for verifying the various aspects of machine design</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3"><table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>Low</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td><td>Low</td></tr>
<tr><td>CO 3</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO 4</td><td>High</td><td>Low</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>CO 5</td><td>High</td><td>Low</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
</table>L=Low, M=Medium, H=High</td></tr>
</table>

UNIT 1 –BASIC CONSIDERATIONS:
Basic concept of design, limitation in design, standardization, modern trends in design and manufacturing techniques, Classification of insulating materials. Modes of heat dissipation & temperature rise time curves. Methods of cooling ventilation (induced & forced, radial & axial), direct cooling & quantity of cooling medium. Calculation of total MMF and magnetizing current. Specific permeance and leakage reactance

UNIT 2 –TRANSFORMER DESIGN:
Output equation design of core, yoke and windings, overall dimensions, Computation of no load current to voltage regulation, efficiency and cooling system designs.

UNIT 3 –DESIGN OF ROTATING MACHINES – I:
Output equations of rotating machines, specific electric and magnetic loadings, factors affecting size of rotating machines, separation of main dimensions, selection of frame size, Core and armature design of dc and 3-phase ac machines

UNIT 4 –DESIGN OF ROTATING MACHINES – II:
Rotor design of three phase induction motors. Design of field system of DC machine and synchronous machines, Estimation of performance from design data

UNIT 5 –COMPUTER AIDED DESIGN:
Philosophy of computer aided design, advantages and limitations. Computer aided design approaches analysis, synthesis and hybrid methods. Concept of optimization and its general procedure. Flow charts and 'c' based computer programs for the design of transformer, dc machine; three phase induction and synchronous machines.

UNIR 6: Various commercial Software packages for electrical machine design

Text/ Reference Books:
1. A. K. Sawhney, "A Course in Electrical Machine Design," Dhanpat Rai &Sons., 6thEdition, 2014.
2. K.G. Upadhyay, "Conventional and Computer Aided Design of Electrical Machines", Galgotia Publications Pvt. Ltd., 1stEdition, 2004.
3. M.G. Say, "The Performance and Design of AC Machines," Pitman & Sons, 1985.
4. S.K. Sen, "Principle of Electrical Machine Design with Computer Programming," Oxford and IBM Publications.

<table>
<tr><td>Course Title</td><td colspan="3">Cyber Security</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power system, Distribution Automation</td></tr>
<tr><td>Course Aim</td><td colspan="3">To understand the different Cyber attacks and their prevention techniques</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: Understand the core principles behind CPS
CO2: Identify safety specifications and critical properties
CO3: Understand abstraction in system design
CO4: Learn techniques for attack detection and attack mitigation.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO1</td><td>Low</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>CO2</td><td>Low</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO3</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
</table>
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</td></tr>
</table>

Unit 1: Dynamical Systems Modeling

i. Cyber-Physical Systems (CPS) in the real world
ii. Dynamical Systems : stability and performance
iii. Different notions of stability
iv. Controller Design techniques
v. Sensors and Actuators for Physical Processes

Unit 2: CPS Compute/Scheduling

i. Real time scheduling theory
ii. CAN bus scheduling
iii. Packet drops and their effects on stability/performance
iv. Delay/Deadline-miss aware control design

Unit 3: Secure CPS

i. Distributed CPS
ii. Attack Models
iii. Attack detection techniques in CPS
iv. Attack mitigation in CPS

Unit4:

Smart Grid Security and Privacy : Automated Generation Control attack mitigation

Reference Books:

E. A. Lee and S. A. Seshia , Introduction to Embedded Systems - A Cyber-Physical Systems Approach, 2014.
Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
J. J. E. Slotine, Applied nonlinear control, Prentice-Hall, 1991
Brown, P., Sensors and Actuators: Technology and Applications, Library Press, 2016.

<table>
<tr><td>Course Title</td><td colspan="3">Computer Aided Design of Electrical Systems</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Basic Electrical Engineering, Power system, Control system</td></tr>
<tr><td>Course Aim</td><td colspan="3">To analyze the application of computers in designing the electrical systems</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: Ability to develop the analysis electrical circuits if software
CO2: To understand how the circuits will behave during the transient
CO3: To understand the various utilization of the Circuit
CO4: To implement a real time circuit in software.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
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<tr><td>CO2</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO3</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
</table>

UNIT 1: Use of International Standards, Electrical Codes & Standards - BS, NEC, IEE, IEEE, NFPA, IEC Design Basis, std. practices/procedure and specifications, Understanding, Basic Electrical Formulae, Basic Design requirement based on the type of various plants, Intra-discipline co-ordination with civil, process, mechanical, piping, telecom HVAC etc.

UNIT 2: Wiring Accessories & Cable Management Systems, Cable Selection and Sizing and cable laying methods, Selection and sizing of electrical equipment used in various projects, Preparation of equipment specifications, High Voltage system requirements including substation design.

UNIT 3: Lighting systems, Lighting Fixtures (Types & Applications), Lighting Design- Illumination Lux Levels, Emergency & Exit Lighting System, Specialized Engineering like Heat Tracing systems and cathodic protection design, Design of Earthlings system, Lightning system and lightning protection system, Method of Lightening protection, Basic Consideration for Protection (Rfer Std IS 2309,NFC 72-102), Low current systems- Fire alarm & detection system, CCTV system etc.

UNIT 4: Generation, Transmission & Distribution of Electricity, Design of power distribution, Earthing in Power Stations and Substations, Earthing Associated with Overhead Power Lines and lighting protection systems, Equipment vendor drawing review and approval.

UNIT 5: Electrical System Drafting (CAD)- Preparation of lighting layouts, Preparation of Power Layouts, Preparation of Single Line Diagrams (SLD) or Riser Diagrams, Preparation of Electrical General Installation Details & Sections, Preparation of LV or Electrical Room Details, Procurement Requirements and installation standards., Inspection of Equipment/system.

Text/ Reference Books:

1. S. Marran, "Electrical System Design and Specification Handbook for Industrial Facilities," Prentice Hall PTR, 1 Edition, 1998.
2. T. R. Bosela, "Electrical System Design," Prentice Hall, 1stEdition, 2002.
3. A. Thumant and H. Franz, "Efficient Electrical Systems Design Handbook," Fairmont Press, 1stEdition, 2009.
4. K.B. Raina,"Electrical Design Estimating and Costing," New Age International, 2007.

<table>
<tr><td>Course Title</td><td colspan="3">Electric Traction and Vehicles</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Electronics , Electrical Machines</td></tr>
<tr><td>Course Aim</td><td colspan="3">To analyze the application of the various motors in electric traction</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: Ability to develop the control techniques for traction DC and AC motors
CO2: Competence in selecting traction motor ratings suitable for various track conditions
CO3: Know how to hybridize the vehicles based on their power source
CO4: Proficiency in configuring electric vehicle system.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><td></td><td>PO 1</td><td>PO 2</td><td>PO 3</td><td>PO 4</td><td>PO 5</td><td>PO 6</td></tr>
<tr><td>CO1</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>CO2</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO3</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
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</td></tr>
</table>

Electric Traction Services, Nature of Traction Loads, Conventional and Modern Traction Drives, Traction Motors, Tractions Drives, Braking Systems, Semiconductor Converter Controlled drives, Induction and Synchronous motor drives, VSI/CSI drives, Polyphase ac motors for traction Drives, Diesel Electric traction, Energy Conservation, Interlocking and sequencing operations and protection.

Introduction to Alternative Vehicles, Electric Vehicles, Hybrid Electric Vehicles, Electric and Hybrid, Vehicle Components, Vehicle Mass and Performance, Electric Motor and Engine Ratings, Well-to-Wheel Analysis, EV/ICEV Comparison, Electric Vehicle Market, Vehicle Mechanics, Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion Power Velocity and Acceleration, Tire–Road Force Mechanics, Propulsion System Design

Plug-In Hybrid Electric Vehicle, Power train Component Sizing, Mass Analysis and Packaging, Vehicle Simulation, Battery Energy Storage, Batteries in Electric and Hybrid Vehicles, Battery Modeling, Traction Batteries, Battery Pack Management, Alternative Energy Storage, Fuel Cells, Ultra capacitors, Compressed Air Storage, Flywheels Control of AC Machines.

Power train Components and Brakes, Cooling Systems, Vehicle Supervisory Controller, Mode Selection Strategy, Modal Control Strategies

Reference Books:

1. Sandeep Dhameja, Electric Vehicle Battery Systems, Elsevier, First Edition, 2002
2. John Fenton & Ron Hodkinson, Lightweight Electric/Hybrid Vehicle Design, Elsevier Oxford, 2000.
3. Seth Leitman, Bob Brant, Build Your Own Electric Vehicle, McGraw Hill, Third Edition, 2013.
4. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, Second Edition, 2010.
5. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, Second Edition 2009.

<table>
<tr><td>Course Title</td><td colspan="3">Distribution Automation</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System, control system, Power Electronics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the basic of Automation of Distribution Systems</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO 1. To study Automation of Distribution System.
CO 2. To study different Control Techniques.
CO 3. To understand the issues with Automated System.
CO 4. To understand the Cost benefit Analysis.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>Medium</td><td>High</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 3</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
</table>
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</td></tr>
</table>

UNIT 1: SUBSTATION AUTOMATION [10 HOURS]

Tools for distribution system planning and design. Substation Automation – Data acquisition from field devices and supervisory control of field devices, Substation Automation-Data acquisition from field devices and supervisory control of field devices, Different techniques of service restoration, substation reactive power control, Procedure to determine the best capacitor location, Asset Management

UNIT 2: FEEDER AUTOMATION [10 HOURS]

Feeder level Automation-Modern devices at Feeder level, Data acquisition from Field devices at feeder

level, supervisory control of field devices, Fault location, Fault isolation, Feeder reconfiguration, feeder reactive power control. Coordinated Control of ALL devices.

UNIT 3: CUSTOMER LEVEL AUTOMATION [10 HOURS]

Customer level Automation-automatic meter reading, Remote programming of time-of-use (TOU) meters, Remote service connect / disconnect, Automated customer claims analysis. Demand Side management, Energy Audit for energy conservation. Remote LOAD control. Home management system, Home area network

UNIT 4: DIFFERENT CONTROL UNITS AND THEIR ISSUES [6 HOURS]

Automatic meter reading, Remote programming of time-of-use (TOU) meters, Remote service connect / disconnect Control hierarchy and control center architecture-RTU's, IEDs, PLCs, Use of GPS and GIS systems for Asset/Facilities management. Cyber Security Issues with Automation. Resiliency improvement using Automation.

UNIT 5: COST BENEFIT ANALYSIS [6 HOURS]

Cost benefit analysis of Distribution Automation Schemes-Review of distribution automation roadmaps of prominent utilities in Europe and US, Review of distribution automation in Indian utilities. DSO role and its functions.

Text/ Reference Books:

1. M. S. Nardone, "Direct Digital Control Systems: Application Commissioning," Kluwer, Springer US, 1 Edition, 1999.
2. K. Peter Brand and others Substation Automation Handbook
3. M.K. Khedkar, G.M. Dhole, "Electric Power Distribution Automation," University Science Press,2010.
4. A.S.Pabla, "Electric Power Distribution,"TMH,5th Edition, 2004

Course Title	**HVDC Transmission**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-IV and PE-V)	Semester	2
Prerequisite Knowledge	Power System, control system, Power Electronics		
Course Aim	To teach the basic of high voltage transmission and their issues		
Course Outcomes (COs)	**CO 1.** To study basic of the HVDC transmission system. **CO 2.** To study different converters in The HVDC . **CO 3.** To study different Control Techniques in The HVDC. **CO 4.** To analyze the different filters for the HVDC System		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	High	High	High	Low	High	High
CO2	High	High	High	High	High	High
CO3	High	High	High	High	High	High
CO4	High	High	High	Low	High	High

L=Low, M=Medium, H=High

Introduction: Growth and developments, Comparison of AC and DC transmission, Application of DC transmission, HVDC terminals and types; Description of DC transmission system, Substation layout, Planning for HVDC transmission, Modern trends in DC transmission

HVDC converter arrangement: Analysis and waveforms of HVDC converters as rectifier and inverter, delay angle, overlap angle, Number of pulses, Choice of converter configuration, Simplified analysis of Graetz circuit, 6-pulse, 12-pulse groups and their voltage waveform, Power factor of converter.

HVDC Converter types: Commutation types in converters; natural and forced/circuit, current

source converter (CSC) and voltage source converter (VSC), comparison between CSC and VSC, operating region, VSC-HVDC principle, PWM, capability curve.

HVDC converter control characteristics: Power flow in HVDC link, equivalent circuit, Compound converter control characteristics; constant extinction angle, constant current, constant ignition angle, positive current margin, negative current margin, Current margin control methods, Current control at rectifier, extinction angle control at inverter, Control hierarchy; bipole controller, pole controller, valve group controller, Control action after disturbance like phase distortion, AC faults, etc.

Harmonics and filters: Introduction, Generation of harmonics, Characteristic (2n±1) and non-characteristic (2n) harmonics, Harmonic cancellation via transformer connection, Design of AC filters, DC filters and their characteristics, AC harmonics filter calculations; impedance circle and polygon methods, Impact of harmonics on torsional oscillation.

Multi-terminal HVDC (MTDC) systems: Configurations and applications, Future MTDC using VSC for wind-farm integration, Control methods in MTDC; slave and master, VSC-HVDC protection schemes, hand shaking method in MTDC, Optical Current transformer

Reference Books:

1. K. R. Padiyar, HVDC Power Transmission System, Wiley Eastern Limited, New Delhi. Second Edition, 1990.
2. Edward Wilson Kimbark, Direct Current Transmission, Vol.-I, Wiley Interscience, New York, London, Sydney, 1971
3. Colin Adamson and Hingorani N G, High Voltage Direct Current Power Transmission, Garraway Limited, London, 1960.

J. Arrillaga, High Voltage Direct Current Transmission, Peter Pregrinus, London, 1983

<table>
<tr><td>Course Title</td><td colspan="3">Electrical Safety</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Electronics, Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the different safety measures of the electrical equipment and various standards of safety</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: Summarize the basic rules of electrical safety.
CO2: Gain skills in identifying the presence of electrical hazards and implementing measures to minimize risks
CO3: Assess and provide solutions to practical problems faced by the industries.
CO4: Employ Safe Work Practices when working with and around electricity</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
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Unit 1:

Contents: Review of electrical concept, Working principle of major electrical equipment, Typical supply situation, Standards and statutory requirements, Indian electricity acts and rules, Indian boiler acts and regulations statutory requirements from electrical inspectorate.

Unit 2:

International standards of electrical safety, Different Indian standards of electrical safety-First aid-cardiopulmonary resuscitation (CPR). Electrical hazards, Effect of electrical shock of human being, Effect of lightening current on installation and buildings, Energy leakage, Clearance and insulation, Excess energy, Current, Surges,

Unit 3:

Electrical causes of fire and explosion, Introduction To Earthing And Its Types, Advantages Of Different Types Of Earthings And Earthing For Different Systems Like Transformer, Alternators, DC Machines, Etc Importance of earthing in installation.

Unit 4:

Safety of transmission lines, substations, Transformer, circuit breakers and power control drives. National electrical safety code. General safety rules, Principles, Maintenance, Inspections.

Reference Books:

1. Krishnan, N.V., Safety Management in Industry, Jaico Publishing House, 1997.

2. Cooper W.F., Electrical Safety Engineering,3rd ed., Newnes, 2002.

3. Cadick, J., et. al., Electrical Safety Handbook, 4thed, McGraw Hill, 2013.

4. Bureau of Indian Standards, National Electrical Code 2011, Bureau of Indian Standards, New Delhi, 2011.

5. Manchanda, S.C., Manchanda"s the Indian Boilers Regulations, 1950 and the Indian Boilers Act, 1923 (Act No. V of 1923), 2nd ed., Delhi Law House, Delhi, 2009.

<table>
<tr><td>Course Title</td><td colspan="3">Active Power Conditioning</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Electronics, Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach improvement of power quality in power system</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: To introduce the wide application of power electronics in power system.

CO2: To convey the importance of power quality aspects in the distribution system and their characterization.

CO3: To discuss the conventional passive compensation methods including reactive power compensation and harmonics filter design.

CO4: To consider the various power system analytical methods useful for compensation and characterization, such as sequence components, reference frames and transformations, PQ theory etc.

CO5: To introduce the concept of power electronics based active power compensation in distribution system and design of power electronics converters.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
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<tr><td>CO2</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO3</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
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Introduction: Distribution and Transmission system, Power Quality issues, Application of Power Electronics in Power Systems, Custom Power (CP) and FACTS devices.

Power Quality Characterization and Analysis: Load power factor, Harmonic distortion indices, Transients, Unbalancing and symmetrical components, Voltage sag/swell and flicker indices, Power acceptability curves, Harmonic distortions limits: IEEE 519, IEC standards

Conventional Methods of Compensation: Load balancing, Capacitor banks design, higher pulse converter, Transformer connections, Harmonic filter design, Resonance effect

Reference Current Generation: Instantaneous PQ theory, Instantaneous symmetrical components, Moving average, Low pass and High pass filters, phase-locked loop (PLL)

Active Power Filters: Hybrid and Active Power Filters: Shunt, Series and Shunt-series active power filters, structure &control of APFs, Combination of active and passive hybrid power filters.

Custom Power Devices: Distribution static compensator (DSTATCOM), Dynamic voltage restorer (DVR), Unified power quality conditioner (UPQC): Structure, Modelling and Control

Reference Books:

1. A. Ghosh and G. Ledwich, Power Quality Enhancement using Custom Power Devices, Kluwer Academic Publisher, Boston, MA, 2002.
2. Bhim Singh, Ambarish Chandra, and Kamal Al-Haddad, Power Quality: Problems and Mitigation Techniques, Wiley, 2015.
3. G. J. Walkileh, Power Systems Harmonics, Springer Verlag, New York, 2001.
4. IEEE Standard 519-1992, IEEE recommended practices and requirements for harmonic control in electrical power systems, 1992.
5. R. C Dugan , S. Santoso, M. F. McGranaghan and H. W. Beaty, Electric Power System Quality, McGraw-Hill, New York, 2003. Page 27 of 29.
6. M. H. Rashid, Power Electronics Handbook, Elsevier, Third Edition, 2011.

<table>
<tr><td>Course Title</td><td colspan="3">Electromagnetic Interference & Compatibility</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">EM Waves & Transmission Lines , Wave Propagation,</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the Electromagnetic Interference and its disadvantages.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: Explain the real world EMC design to reduce electromagnetic Interference.

CO 2 Comprehend design aspects of Electronic systems without interference and with compatibility. CO 3 Compute the radiated and conducted interference measurements.

CO 4 Analyze and design Grounding and Cabling aspects with reference to EMI/EMC standards.

CO 5 Design Components that meet EMI/EMC Standards.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO1</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>CO2</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO3</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">UNIT-I (11 Lectures) INTRODUCTION: History and concept of EMI, Definitions of EMI/EMC, Electromagnetic environment, Practical experiences and concerns, frequency spectrum conservation, mechanisms of EMI generation, EMI testing, Methods of elimination of EMI and Biological effects of EMI

UNIT-II (11 Lectures) SOURCES OF EMI/EMC: Sources of Electromagnetic noise, typical noise paths, modes of noise coupling, designing for EM compatibility, lightening discharge, electro static discharge (ESD), electromagnetic pulse (EMP). Electromagnetic emissions, noise form relays and switches, non-linearity in circuits, passive inter modulation, transients in power supply lines, EMI from power electronic</td></tr>
</table>

equipment, EMI as combination of radiation and conduction. Open area test sites: OATS measurements, measurement precautions.

UNIT-III (10 Lectures) RADIATED/CONDUCTED INTERFERENCE MEASUREMENTS: Anechoic chamber, TEM cell, reverberating chamber, GTEM cell, comparison of test facilities, characterization of conduction currents / voltages, conducted EM noise and power line, conducted EMI from equipment, immunity to conducted EMI, characteristics of EMI filters and power line filter design.

Conducted Emissions , Conductive susceptibility , Radiated Emissions ,Radiated susceptibility

UNIT-IV (11 Lectures) GROUNDING AND CABLING: Safety and signal grounds, low and high frequency grounding methods, grounding of amplifiers and cable shields, isolation, neutralizing transformers, shield grounding at high frequencies, digital grounding, types of cables, mechanism of EMI emission coupling in cables. effectiveness of shielding, near and far fields / impedances, methods of analysis, total loss due to absorption and reflection effects, composite absorption and reflection losses for electric fields / magnetic fields, magnetic materials as a shield, shield discontinuities, slots and holes, seams and joints, conductive gaskets Electrical Bonding, Shape and Material for Bond straps, General Characteristics of good bonds. for emi/emc standards: Choice of capacitors, inductors, transformers and resistors, EMC design components National , military and civilian standards.

International EMC standards,

Reference Books:

1. Dr. V.P. Kodali, "Engineering Electromagnetic Compatibility", IEEE Publication, S. Chand & Co. Ltd., New Delhi, 2000.
2. "Electromagnetic Interference and Compatibility", IMPACT series, IIT-Delhi, Modules1-9.
3. C.R. Pal, "Introduction to Electromagnetic Compatibility", Ny, John Wiley, 1992.

<table>
<tr><td>Course Title</td><td colspan="3">Electrical Energy Conservation and Auditing</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach how to conserve the energy and different aspects of Audit</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: Explain the basics of Energy audit.
CO 2 To understand the Different equipment's used for energy Audit
CO 4 To understand the requirement of the various economic analysis.
CO 5 Computation of various economic aspect.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO1</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>CO2</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO3</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Unit - I

Basic Principles of Energy Audit and management Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Pie charts – Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems – Principles of energy management – Initiating, planning, controlling, promoting, monitoring, reporting – Energy manager, Bureau of Energy Efficiency: Energy conservation building code, Accredited energy auditor.</td></tr>
</table>

Unit - II

Power Factor and energy instruments Power factor – Methods of improvement – Location of capacitors – Power factor with non linear loads – Effect of harmonics on Power factor – Numerical problems. Energy Instruments – Watt–hour meter – Data loggers – Thermocouples – Pyrometers – Lux meters – Tong testers – Power analyzer.

Unit - III

Space Heating and Ventilation – Air–Conditioning (HVAC) and Water Heating: Introduction – Heating of buildings – Transfer of Heat–Space heating methods – Ventilation and air–conditioning – Insulation– Cooling load – Electric water heating systems – Energy conservation methods

Unit - IV

Economic Aspects and Analysis Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts). GREEN BUILDINGS: Barriers to green buildings, green building rating tools, material selection, operating energy, façade systems, ventilation systems, transportation, water treatment systems, water efficiency, building economics, Leed and IGBC codes

Unit - V

Computation of Economic Aspects Calculation of simple payback method – Net present worth method – Power factor correction – Lighting – Applications of life cycle costing analysis – Return on investment.

Reference Books :

1. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
2. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
3. Energy management hand book by W.C.Turner, John wiley and sons.
4. Energy management and conservation –k v Sharma and pvenkata seshaiah-I K International Publishing House pvt.ltd,2011.
5. http://www.energymanagertraining.com/download/Gazette_of_IndiaP artIISecI-37_25-08-2010.pdf
6. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012
7. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995

<table>
<tr><td>Course Title</td><td colspan="3">Electricity Industry Structure & Regulations</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System, Electrical Machines</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach how to conserve the energy and different aspects of Audit</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: Explain the basic allocation of generators to operate at the optimal point
CO 2: To teach the hydro thermal operation according to the optimal point
CO 3To teach different techniques to handle the nonlinear complex problem
CO 4. To understand the effect of various control techniques on power system operation</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
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<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
</table>

UNIT 1:

Structure of electrical Industry: Introduction to electricity Industry, overview, Electricity Demand and supply relation of different region, Different types power producers, transmission companies and their regulations, The distribution companies and regulation for the distribution companies

UNIT 2:

Global markets for crude oil, Markets for refined petroleum products, Basic economics of power generation, transmission and distribution ,Economic dispatch of power plants, Rate of return regulation for electric utilities, Long range planning in the power sector, Different models to reduce the losses in the industry,

UNIT 3: Regulation: Regulations of the Grid, the mechanics of rate of return regulation, Economic dispatch and operations of electric Utilities discounted cash flow models and metrics for evaluating energy projects, regulation for generation companies, Restructuring and deregulation in the electric power Industry.

UNIT 4: Different Models: Discounted cash flow models and metrics for evaluating energy products, corporate finance and discount rate, taxes, subsidies, economic challenges in the integration of renewables, incentives for renewable sources

Text Books:

1. Pratik Biswas, Sukanya Mandal, Indian Electricity Sector under Regulatory Regime Paperback – 1 February 2019

2. K. R Padhiyar, Understanding the structure of Electricity supply, B S publications Jan. 2014

<table>
<tr><td>Course Title</td><td colspan="3">Modern Digital and Embedded Controllers</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Digital Electronics and Micro processors</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach internal structure, operation and application of the various controllers</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: To explain the various micro controller available and study the structure.
CO 2 To understand the basic I/O of FPGA and DSP based controllers
CO 3: To understand the serial and parallel operation in DSP and FPGA controllers
CO 4 To understand the operation of the PLC controllers.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO1</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>CO2</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO3</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">UNIT 1: Microcontroller Basics-8-Bit and 16-bit Microcontroller Internal Block Diagram, CPU, ALU, address bus, data bus, control signals, Working Registers, SFRs, Clock and Reset circuits, Stack and use of Stack Pointer, Chip Peripheral Interfaces-Interfacing concept and design rule

UNIT 2: FPGA based controller: Architecture, logic for different operations, parallel operation, Set of inputs, FPGAs- Resource Sharing, Implementation technology – PLD's, Custom Chips, Standard Cell and Gate arrays – FPGA Architectures – SRAM based FPGAs – Permanently programmed FPGAs –FPGA logic cells, I/O block architecture: Input and Output cell characteristics, clock input, Timing. FPGA applications to power electronic systems, Gating Pulse generation for AC-AC converter, AC-DC converter, PWM generation for Buck Converter, SPWM generation</td></tr>
</table>

- Main design rules of an FPGA-based controller: Control algorithm refinement (design of a time continuous controller, internal delay issues, digital re-design, sampling issues, quantization issues). Architecture refinement (algorithm architecture matching, IP-modules reusability, Hardware-In-the-Loop (HIL) validation

UNIT 3: DSP based controllers: Architecture, logic for different operations, parallel operation, Set of inutps, Dspace based controller

UNIT 4: Atmel AVR ATMEGA 8 Micro-controller: Introduction, Major features, Architecture, Application and programming, PLC for various control application, ladder logic.

Reference Books:

1. The 8051 Microcontroller and Embedded systems-using assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinaly,PHI,2006/pearson,2006
2. Embedded Systems Design using the TI MSP430 series, Cris Nagy, Newnes, Elsevier.

<table>
<tr><td>Course Title</td><td colspan="3">Intelligent Control of Drives</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-V I)</td><td>Semester</td><td>3</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System, Electrical Machines</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach application of intelligent techniques to control the electric drives</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: Understand and implement the concept of Neural Networks in Electric Drives
CO2: Understand and implement the basic concept of Fuzzy logic in Electric Drives
CO3: Analyze the different control techniques used for modelling and control of the AC and DC drives
CO4: Develop Simulation model of controllers using the toolbox of ANN and Fuzzy logic for both A.C. and D.C. drives
CO5: Review and describe the structure of electric drive systems and their role in various applications such as flexible production systems, energy conservation, renewable energy, transportation etc.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO1</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>CO2</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO3</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>Medium</td><td>High</td></tr>
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</td></tr>
</table>

Unit1:

Introduction to neural networks: Introduction – biological neurons – Artificial neurons – activation function – learning rules – feed forward networks – supervised learning – perception networks – adaline – madaline – back propagation networks – learning factors – linear separability – Hopfield network – discrete Hopfield networks

Unit2:

Architecture – types: Recurrent auto association memory – bi-directional associative memory – temporal associative memory – Boltzmann machine Hamming networks – self – organizing feature maps – adaptive resonance theory network – Instar – Outsar model – counter propagation network – radial basis function networks

Unit 3:

Introduction to Fuzzy sets and Systems: Crisp set – vaguness – uncertainty and imprecision – fuzzy set – fuzzy operation- properties – crisp versus fuzzy relations – fuzzy relation – cardinality operations, properties – fuzzy Cartesian product and composition – non – interactive fuzzy sets – tolerance and equivalence relations – fuzzy ordering relations – fuzzy morphism – composition of fuzzy relations

Unit 4:

Fuzzy logic controller: Fuzzy to crisp conversion – Lambda cuts for fuzzy sets and relations – definition methods – structure of fuzzy logic controller – database – rule base – Inference engine

Application and Design: Applications of Neural network and Fuzzy system for single phase fully controlled converter, single phase ac voltage controller, DC Drive and AC Drive, designing of controllers using Simulation Software Fuzzy Logic Toolbox – Modelling of DC Machines using Simulation Software and Simulink Toolbox

Reference Books:

1. L. Fausatt, Fundamentals of neural networks, Prentice Hall of India, New Delhi, 1994.
2. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw Hill International Edition, USA, 1997.
3. B. Kosko, Neural Networks and Fuzzy Systems, Prentice Hall of India, New Delhi, 2011.
4. B. K Bose, Modern Power Electronics and AC Drives, Prentice Hall PTR, USA, 2002.

Course Title	**Energy Storage System**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-V I)	Semester	3
Prerequisite Knowledge	Power System, Electrical Machines		
Course Aim	To teach different techniques to store the electrical energy and their limitations		
Course Outcomes (COs)	**CO1:**Understand the concept of various energy storage system **CO2:** Understand the chemical effect behind the batteries **CO3:** Analyze the different batteries used in electric vehicles. **CO4:** Develop Simulation model battery storage system **CO5:** Review and describe the structure of battery management system		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	High	Medium	High	High	Medium	High
CO2	Medium	High	High	High	Medium	High
CO3	Low	High	High	High	Medium	Medium
CO4	Medium	High	Medium	High	Medium	Medium
CO5	High	High	High	High	High	High

L=Low, M=Medium, H=High

Unit1:

Introduction , world/India energy storage overview/Storage Strategy/ Indian Installations, energy storage technology overview, Types and applications

Unit2:

Introduction to electrochemistry/ electrochemical techniques for testing and standards, Electrochemical energy storage, basic of batteries and terminology, Lithium Ion batteries: components/working/raw materials/commercials systems, Advancement in battery technology, improvements in cycle life and energy density

UNIT3:

Batteries for Electrical Vehicle: standalone grid connected, sizing of batteries, redox flow batteries for

large scale storage applications, Beyond lithium ion batteries, Sodium Sulphate battery

UNIT 4:
Battery modelling , Introduction to battery management system, thermal management and pack Design, battery recycling and circular economy, Novel gravity based energy storage plants, components, details and sizing. Energy system Integration with renewable energy systems.

Reference Books:

1. Handbook of lithium-ion battery pack design chemistry, components, types and terminology by Warner, John T, Elsevier.
2. Fundamentals and Application of Lithium-ion Battery Management in Electric Drive Vehicles by San Ping Jiang, Wiley.
3. Lithium ion rechargeable batteries by edited by Kazunori Ozawa, Wiley.
4. E. Lipman, A. Z. Weber, Fuel Cells and Hydrogen Production, A Volume in the Encyclopedia of Sustainability Science and Technology, Second Edition, Springer reference.
5. Modern electric, hybrid electric, and fuel cell vehicles fundamentals, theory, and design by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, CRC press

Course Title	**Power Electronic Converters for Microgrids**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-V I)	Semester	3
Prerequisite Knowledge	Power electronics, Electrical Machines		
Course Aim	To teach the various power electronic converters for micro grid and their controlling techniques		
Course Outcomes (COs)	**CO1:**Understand and implement the concept different converters for micro grid **CO2:** Understand and implement the basic concept power control techniques **CO3:** Analyze the different control techniques used for modelling and control of the AC and DC converters **CO4:** to teach the techniques to improve the power quality		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	High	Medium	High	High	Medium	High
CO2	Medium	High	High	High	Medium	High
CO3	Low	High	High	High	Medium	Medium
CO4	Medium	High	Medium	High	Medium	Medium
CO5	High	High	High	High	High	High

L=Low, M=Medium, H=High

Module 1: Characteristic of Converters: Functional characteristics of power converters, Converter designs ,Indirect converter Electromagnetic compatibility (EMC) Protective measures during power conditioning, Grid Protection , Grid Effects 24/7 General compatibility and interference Output behavior of wind power plants

Module 2: Voltage response in grid supply Harmonics and subharmonics ,Voltage faults and the fault-ride-through (FRT) , Remedial Measures against Grid Effects and Grid Resonances ,Filters design , Function of harmonic absorber filters and compensation units, Grid Control and Protection ,Grid Connection Rules. Power conditioning and maximum power point tracking (MPPT) algorithms MPPT algorithms based on based on buck- and boost-converter topologies, Maximum power point tracking (MPPT) algorithms,

Module 3:

Inverter control topologies for stand-alone and grid-connected operation. Analysis of inverter at fundamental frequency and at switching frequency. Feasible operating region of inverter at different power factor values for grid-connected systems, Stand-alone PV systems. Consumer applications, residential systems, PV water pumping, PV powered lighting, rural electrification, etc.,

Module 4: Grid-connected (utility interactive) PV systems. Active power filtering with real power injection, Modeling and simulation of standalone and grid-connected PV systems. Control Concepts,

Text Book:

1. R. Messenger, J. Ventre, Photovoltaic Systems Engineering, 2nd ed., CRC Press, 2004.

2. S. Heier, "Grid Integration of wind energy conversion systems", Wiley, New York (USA).

3. A. Goetzberger, V. U. Hoffmann, Photovoltaic Solar Energy Generation, Springer-Verlag, 2005

3. L. Castaner, S. Silvestre, Modeling Photovoltaic Systems Using PSpice, John Wiley & Sons, 2002

<table>
<tr><td>Course Title</td><td colspan="3">Power Plant Operation & Controls</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-V I)</td><td>Semester</td><td>3</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the different operation principle and safety measures of different Power Plant</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: To teach the operation of different electrical energy generating plant
CO2: To understand the different operating constraints and their control actions
CO3: To evaluate the different the safety measures of the power plant
CO4: To evaluate the scope and feasibility of power generation from renewables</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
<tr><td>CO1</td><td>H</td><td>H</td><td>H</td><td>M</td><td>M</td><td>M</td></tr>
<tr><td>CO2</td><td>H</td><td>H</td><td>H</td><td>H</td><td>M</td><td>H</td></tr>
<tr><td>CO3</td><td>H</td><td>H</td><td>M</td><td>M</td><td>M</td><td>M</td></tr>
<tr><td>CO4</td><td>H</td><td>H</td><td>H</td><td>H</td><td>M</td><td>H</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">UNIT 1:

Conventional Sources of electrical energy: Steam, hydro, nuclear, diesel and gas, their scope and potentialities for energy conversion. Generation : Different factors connected with a generating station, load curve, load duration curve, energy load curve, base load and peak load plants.

UNIT 2:

Thermal stations : Selection of site, size and no. of units, general layout, major parts, auxiliaries, generation costs of steam stations. Hydro stations : Selection of site, mass curve, flow duration curve,</td></tr>
</table>

hydrograph, classification of hydro plants, types of hydro turbines, pumped storage plants.

Nuclear stations : Main parts, location, principle of nuclear energy, types of nuclear reactors, reactor control, nuclear waste disposal.

UNIT 3:

power plant process and of unit cycle principles, hazards and the appropriate precautions associated with the plant and process systems Effective communication techniques, instrumentation and control features including permissive conditions, interlocks, alarm and trip conditions, requirements for the competent, safe and reliable operation of plant, abnormal plant and process conditions and the associated incident response mechanisms

UNIT 4:
Power station control and interconnection: Excitation systems, excitation control, automatic voltage regulator action, advantage of interconnection.

UNIT 5:
Alternate energy sources: Solar, wind, geo-thermal, ocean-thermal, tidal wave, MHD and biomass. renewable sources of alternative power generation and their operational requirements

Reference Books:

1. Deshpande, M.V., Elements of Electrical Power Station Design, 5th ed.,PHI, 2013.
2. B. R . Gupta,, Generation of Electrical Energy, S. Chand, New Delhi, 2013.
3. Nag, P.K., Power Plant Engineering, 3rd ed., Tata Mc-Graw Hill Education, 2013.
4. Raja, A.K., Srivastava, A.P. and Dwivedi, M., Power Plant Engineering, New Age International Private Limited, New Delhi, 2006

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<table>
<tr><td>Course Title</td><td colspan="3">Reliability Engineering</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-V I)</td><td>Semester</td><td>3</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System, Electrical Machines</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach how to enhance the reliability of the system</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: Appreciate the basic reliability concepts like qualitative and quantitative assessment; indices, criteria, availability, evaluation techniques, improvements, economics, monitoring and growth.
CO2: Understand Basic Probability concepts like permutations & combinations, Venn diagrams, rules for combining probabilities, probability distributions, practical engineering concepts; Application of binomial distribution
CO3: Understand Network modeling and evaluation of systems like simple and complex, partially and standby redundant systems, cut-set method, tie set method, connection matrix technique, event trees, fault trees, multi failure modes.
CO4: Understand Probability distributions in reliability evaluation; Discrete Markov chains, Continuous Markov processes; System reliability evaluations-series/parallel systems, network reduction techniques, minimal cut set.
CO5: Understand failure modes approach, common mode failures in power equipment.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><td></td><td>PO 1</td><td>PO 2</td><td>PO 3</td><td>PO 4</td><td>PO 5</td><td>PO 6</td></tr>
<tr><td>CO1</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO2</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO3</td><td>Low</td><td>High</td><td>High</td><td>High</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO4</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO5</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Basic Reliability Concepts- Review; qualitative and quantitative assessment; Reliability- definitions, concepts, indices, criteria, availability, evaluation techniques, improvements, economics, monitoring and growth.</td></tr>
</table>

Basic Probability theory- Concepts, permutations & combinations, Venn diagrams, rules for combining probabilities, probability distributions, practical engineering concepts; Application of binomial distribution.

Network modeling and evaluation of systems- simple and complex, partially and standby redundant systems, cut-set method, tie set method, connection matrix technique, event trees, fault trees, multi failure modes.

Probability distributions in reliability evaluation; Discrete Markov chains, Continuous Markov processes; System reliability evaluations-series/parallel systems, network reduction techniques, minimal cut set/failure modes approach, common mode failures.

RLA of equipment in power system: Residual life assessment and management.

Reference Books:

1. Roy Billinton and Ronald N. Allan, Reliability Evaluation of Engineering Systems: Concepts and Techniques, Springer New York, 1992
2. B.S. Dhillon, Reliability, Quality, and Safety for Engineers, CRC Press, Florida, 2005.
3. K.K. Aggarwal, Reliability Engineering, Springer Netherlands, 1993.
4. E. Balagurusamy, Reliability Engineering, Mcgraw Hill Education, 2002.
5. D.Elmakias, New computational methods in power system reliability. Berlin: Springer, 2008.

Course Title	**Advanced Digital Control**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-VI)	Semester	3
Prerequisite Knowledge	1. Control System 2. Signals and Systems		
Course Aim	To discuss different advanced digital control schemes and controllers.		
Course Outcomes (COs)	After completion of the course students shall be able to: **CO1:** formulate the mathematical model of digital control systems. **CO2:** determine the stability of discrete time systems using different techniques. **CO3:** design various advanced digital controllers for sampled-data control systems. **CO4:** demonstrate the design and applications of industrial and embedded digital controllers in real-time testbeds.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Low	Medium	Low	Low	Low
CO 2	Low	Medium	Medium	Low	Low	Low
CO 3	Low	Low	Medium	Low	Low	Low
CO 4	High	Medium	Medium	Low	Low	Medium

Module 1: Digital Control System

Sampled-data Control System, Components of Digital Control System: A/D Converter, Quantizer, Encoder, Hold Circuits, Ideal LP filter.

Nyquist–Shannon sampling theorem, Aliasing, Anti-aliasing filter.

Module 2: Modelling and Stability analysis using conventional approach

Z-transform revisited, Modified Z-transform, Difference equation, Pulse transfer function, Closed-loop sampled-data system, Bi-linear transformation, Impulse invariance method, Jury Stability, Routh-Hurwitz with w-plane.

Module 3: Modelling and Stability analysis using State-space approach

State-space modelling, State transition matrix, Cayley–Hamilton theorem, Discretization of Continuous Time state-space model, Lyapunov stability.

Module 4: Design of Digital Controllers

Conventional approaches: Root locus, Frequency domain design, Compensators, Dead-beat responses.

State feedback controllers, Observer-aided digital controllers, Digital LQR, Model predictive controller (MPC), Quasi-sliding mode controller (QSMC).

Filters Design: IIR, FIR

Module 5: Industrial and Embedded Controllers

SCADA, DSP-based Controllers, The Texas Instruments TMS320 DSP's, Field programmable gate array (FPGA).

Reference Books:

1. Katsuhiko Ogata, Discrete-time control systems, 2nd Edt., PHI.
2. Kuo, Digital Control System, 2nd Edt., Oxford University Press.
3. M. Gopal, Digital Control System, New Age Pub.

Course Title	**Embedded Systems**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Control System		
Course Aim	To teach the basics of Embedded System and apply embedded system on practical application		

Introduction to an Embedded systems design: Introduction to Embedded system (ES), Embedded system project management, ESD and co-design issues in system development process, design cycle in the development phase for an embedded system, use of target system or its emulator and in-circuit emulator, use of software tools for development of an ES.

RTOS & its overview: Real time operating system: Task and task states, tasks and data, semaphores and shared data operating system, services, message queues, timer function, events, memory management, interrupt routines in an RTOS environment, basic design using RTOS.

Microcontroller: Role of processor selection in embedded system (Microprocessor vs Microcontroller), 8051 Microcontroller: architecture, basic assembly language programming concepts, instruction set, addressing modes, logical operation, arithmetic operations, subroutine, interrupt handling, timing subroutines, serial data transmission, serial data communication.

Embedded System Development: Embedded system evolution trends. Round - Robin, robin with interrupts, function-one-scheduling architecture, algorithms. Introduction to assembler compiler-cross compilers and Integrated Development Environment (IDE). object oriented interfacing, recursion, debugging strategies, simulators.

Networks for Embedded Systems: The I2C Bus, The CAN bus, SHARC link ports, Ethernet, Myrinet, Internet, Introduction to Bluetooth: specification, core protocol, cable replacement protocol. IEEE 1149.1 (JTAG) Testability: boundary scan architecture.

References:

1. Raj Kamal, Embedded Systems, TMH
2. K.J. Ayala, The 8051 Microcontroller, Penram International
3. J B Peatman, Design with PIC Microcontrollers, Prentice Hall
4. David E. Simon,An Embedded Software Primer, Pearson Education
5. John Catsoulis, Designing Embedded Hardware,O'reilly,

6. Frank Vahid, Tony Givargis, Embedded System Design, John Wiley & Sons, Inc
7. Karim Yaghmour,Building Embedded Linux Systems, O'reilly
8. Michael Barr, Programming Embedded Systems,O'reilly
9. Alan C. Shaw, Real-time systems & software, John Wiley & sons, Inc

Course Title	**Fuzzy Logic and Control**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Any Engineering Specialization		
Course Aim	To teach the students to learn fuzzy logic and implement the fuzzy logic for various real time applications		

Module 1: Type-I Fuzzy Logic
Introduction to fuzzy logic, Fuzzy & Crisp Sets, Fundamental elements of fuzzy logic controllers: MFs, Rule base, Fuzzy fication, Defuzzification, Mamdani/TSK fuzzy model, Fuzzy-aided control system design and analysis.

Module 2: Type-II Fuzzy Logic
Merits and demerits over Type-I fuzzy logic, Elements of Type-II fuzzy logic, Design and applications of Fuzzy logic-II controller

Module 3: Hybrid fuzzy controller, ANFIS design and analysis, Applications to dynamical systems/estimation.

References:

1) Mendel JM. Uncertain Rule-Based Fuzzy Logic Systems: Introduction and New Directions. Prentice Hall PTR, 2001.
2) Mendel JM. Uncertain Rule-based Fuzzy Systems: Introduction and New Directions. Second Edition, Springer 2017.
3) Zadeh LA. Fuzzy sets. Inform Control 1965; 8: 338-353.

<table>
<tr><td>Course Title</td><td colspan="3">Optimization Techniques</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective (PE III)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Linear algebra, Control System, Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the basic of optimization techniques</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO1: To introduce basic optimisation techniques.

CO2: To understand the linear optimisation techniques and their applications.

CO3: To understand the non-linear optimisation techniques and their applications.

CO4: To study evolutionary based algorithms for optimisation techniques</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 3</td><td>Medium</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>High</td><td>Medium</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
</table>

Classical optimization techniques: Single variable optimization, multivariable optimization with constraints and without constraints, necessary and sufficient conditions.

Linear programming (LP): Two variable problems-graphical solutions, formulation of LP problems in more than two variables, standard form, Simplex algorithm, special cases-2 phase's method, Big-M method, duality and dual LP problems. Application of LP in Transportation problem-balanced and unbalanced transportation problems. Use of North West corner rule, least cost method, Vogel approximation method. Assignment problems- Hungarian method.

Non-linear programming (NLP): Philosophy of numerical methods, search methods for one dimensional problems- Fibonacci and Golden section methods. Unconstrained and constrained optimization, univariate method , Pattern search method , Steepest descent method, cutting plane method , penalty function method, basic idea of dynamic programming.

Evolutionary algorithms (EA): Genetic algorithm, particle swarm optimization, Tabu search, simulated annealing and ant colony optimization, Multi objective optimization using EA, Pareto solutions.

References:

1. S.S. Rao, Engineering Optimization: Theory and Practice. New York: Wiley. 2009.
2. K. Deb, Multiobjective Optimization using Evolutionary Algorithms. New York; Wiley. 2002.
3. G.P. Liu, J.B. Yang and J.F. Whidborne, Multiobjective Optimization and Control. PHI. 2008.
4. A. D. Belegundu, and T. R. Chandrupatla, Optimization Concepts and Applications in Engineering, Pearson Education (Singapore). 2003.
5. R. L. Rardin, Optimization in Operation Research. Prentice-Hall. 1999.
6. A. Schirisieer, Theory of linear and integer programming, John Wiley and Sons, 1986.
7. D. Leunberger, Linear and Nonlinear programming, Add. Wesley, 1984.

Course Title	**Artificial Intelligence in Engineering**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Control System		
Course Aim	To teach the application of artificial intelligence in engineering		

Basic Principles: Introduction, Experimental Evaluation: Over-fitting, Cross-Validation. Sample complexity. VC-dimension, Regularization, Theory of generalization, Bias-Variance trade off, Reinforcement Learning.

Supervised Learning: Linear and Logistic Regression, Decision Tree Learning, k-NN classification, SVMs, Ensemble learning: boosting, bagging.

Neural Network: Artificial Neural Networks: Perceptron, Multilayer networks and back propagation. Radial Basis function NN , Applications in electrical engineering

Probabilistic Models: Maximum Likelihood Estimation, MAP (Maximum a-posteriori), Bayes Classifiers, Naive Bayes. Markov Networks, Bayesian Networks, Factor Graphs, Inference in Graphical Models. Applications of probabilistic models

Unsupervised Learning: K-means and Hierarchical Clustering, Gaussian Mixture Models, PAC learning. EM algorithm, Hidden Markov Models. Applications in electrical Domain

References:

1. Tom Mitchell, Machine Learning, McGraw Hill, 1997.

2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer 2006.

3. Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, John Wiley & Sons, 2006.

4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer 2009.

Course Title	**Expert Systems**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Power electronics, Electrical Machines		
Course Outcomes (COs)	At the end of the course, students will be able **CO1**: To use basic concepts of expert systems **CO2:** Implement a rule-based expert system and Evaluate Expert System tools **CO3:** Apply knowledge representation and Design a knowledge base **CO4:** To Use and apply fuzzy logic in various control applications		

Mapping of COs with POs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	High	Medium	High	High	Medium	High
CO 2	Medium	High	High	High	Medium	High
CO 3	Low	High	High	High	Medium	Medium
CO 4	Medium	High	Medium	High	Medium	Medium
CO5	High	High	High	High	High	High

L=Low, M=Medium, H=High

Introduction, Expertise and Heuristic knowledge, knowledge based systems, Structure of knowledge based systems, Logic and automated reasoning, Predicate logic, logical inference, Resolution, Truth maintenance systems, Rule based reasoning, Forward chaining , Backward chaining, Rule based architectures, conflict resolution schemes, Associative networks, Frames and Objects, uncertainty management, Baynesian approaches, Certainty factors, Dempeter-Shefer theory of Evidence, Fuzzy sets and Fuzzy logic, knowledge Acquisition search strategies and matching techniques. Inference based knowledge generation

References:

1) Peter Jackson, "Introduction to expert systems," Addison-Wesley, 3 edition, 1998.
2) Archino .J. Gonzalez Douglas D. Dankel and Douglas D. Dankel II, "The Engineering of knowledge based systems," Prentice Hall, 1993.
3) Dan W. Patterson, "An introduction to artificial intelligence and expert systems," Prentice Hall, 1990.
4) Sasikumar et aI., "Rule based expert systems," Narosa Publishing, 1996.
5) Janusz S. Kowalik; "Knowledge based problem solving," Prentice Half, I?86.
6) Frederick Hayes-Roth, Donald A. Waterman and Douglas B. Lenat, "Building expert systems," Addison-Wesley Longman Publishing Co., Inc. Boston, MA, USA, 1983

Course Title	**Robotics and Automation**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Control System		

UNIT 1:

Introduction: Past, Present & Future; Robot Terminology; Applications, Components and Subsystems; Classification of Robot etc. End Effectors, Different types of grippers and their design concepts etc. Motion Analysis: Homogeneous transformations as applicable to rotation and translation – problems.

UNIT 2:

Robot Kinematics: Specifications of matrices, D-H notation joint coordinates and world coordinates, Forward and inverse kinematics – problems. Differential transformation and manipulators, Jacobians – problems

Dynamics: Lagrange – Euler and Newton – Euler formations – Problems.

UNIT 3:

Trajectory Planning: Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion, straight line motion–Robot programming, languages and software packages. Robot actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors etc.

UNIT4:

Automation : Introduction, Types of systems - mechanical, electrical, electronics, fluidics; Hydraulics Systems and components; Pneumatic Systems Control; Applications of relays/switches; Measuring systems, Transducers; Programmable controllers; Automatic orientation and assembly; Design of components for assembly. Cost considerations and case studies. design and operation of automatic systems-Pneumatic Controls, Electropneumatic Controls, Programmable Logic Controller (PLC) etc.

References:

1. Robotics and Control by Mittal R.K Mittal and I.J. Nagrath,TMH

2. Introduction to Robotics, Analysis, Systems, Applications by Saeed B. Niku, PHI Publications.

3. CAM and Automation by M.P. Groover, PHI Learning

4. Robotics –Control, sensing, TMH

5. Robotics Fundamental concepts and analysis, Ghosal Ashitava, Oxford

6. Robotics Technology and Flexible Automation by S.R. Deb and S. Deb S., " Tata McGraw Hill Education Pvt. Ltd, 2010.

7. Introduction to Robotics by John J. Craig, Pearson

Course Title	**Research Methodology**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Any Engineering Specialization		
Course Aim	To teach the students how to perform the analysis and write technical papers		

Introduction: A quick glance on research, Conceptualizing a research design Reviewing the literature.

Formulating a Research Problem: Identifying variables, Constructing hypotheses, Establishing the validity and reliability, Constructing an instrument for data collection, Measurement and Scaling Techniques, Sampling Fundamentals, Methods of Data Collection, Defining the Research Problem.

Developing a research plan and writing and presenting a research proposal (Mid-sem Exam). Experimentation.

Processing data: Analysing Data, Analysis of Variance and Covariance, Testing of Hypotheses, Multivariate Analysis Techniques, Chisquare Test, Displaying data. Research methodology and practice evaluation.

Writing and presentation of a research report (End Sem Exam).

References books

1. Research Methodology: Methods and Techniques, C R Kothari.

<table>
<tr><td>Course Title</td><td colspan="3">Digital Signal Processing</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective (PE III)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Signal Systems</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the different signal processing techniques</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO1: To understand the different frequency domain analysis.
CO2: To understand the Signal detection, modulation techniques, frequency translation.
CO3: To learn the Issues involved in DSP processor design-speed
CO4: To study the applications using DSP Processor</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
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<tr><td>CO 4</td><td>High</td><td>Medium</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">DFT- Walsh- Hadamard transforms, discrete convolution and correlation, FFT algorithms, Digital filters-flow graph and Matrix representation, IIR and FIR filter design, Signal processing algorithm, waveform generation, Quadrature signal processing, Signal detection , modulation techniques, frequency translation, over ranging, Issues involved in DSP processor design-speed, cost, accuracy, pipelining, parallelism, quantization error, etc., Key DSP hardware elements - Multiplier, ALU, Shifter, Address Generator, etc., Software development tools-assembler, linker and simulator, Applications using DSP Processor - spectral analysis.

References:
1. V. Oppenheim and R. W. Schafer, Digital Signal Processing. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1975.
2. A. Bateman and W. Yates, Digital signal processing design, W H Freeman & Co, 1989.
3. A. Antoniou, Digital filters analysis and design, McGraw-Hill Science/Engineering/Math; Second Edition, USA, 2000.</td></tr>
</table>

Course Title	**Linear Algebra**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Any Engineering Specialization		

Algebraic Structures: Sets, functions, Group, homomorphism of groups, Ring, Field, Vector Space, Subspaces, direct sum, metric space, inner product space, Lp space, Banach Space, Hilbert Space. Linear independence, basis, dimension, orthonormal basis, finite dimensional vector spaces, isomorphic vector spaces, Examples of finite and infinite dimensional vector spaces, RN , CN .

Linear Transformations: Linear Transformations, four fundamental subspaces of linear transformation, inverse transformation, rank nullity theorem, Matrix representation of linear transformation, square matrices, unitary matrices, Inverse of a square matrix, Change of basis, coordinate transformation, system of liner equations, existence and uniqueness of solutions, projection, least square solution, pseudo inverse.

Matrix Methods and Transforms: Eigen values, Eigen vectors, Generalized Eigen vectors, Diagonalizability, orthogonal diagonalization, Symmetric, Hermitian and Unitary matrices (transformations), Jordan canonical form, Fourier basis, DFT as a linear transformation, Translation invariant linear transformation, wavelet basis, wavelet transforms.

References:

1. G. F. Simmons, Topology and Modern Analysis, McGraw Hill

2. Frazier, Michael W. An Introduction to Wavelets through Linear Algebra, Springer Publications.

3. Hoffman Kenneth and Kunze Ray, Linear Algebra, Prentice Hall of India.

Course Title	**Virtual Instrumentation**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	EMMI, Control System		
Course Aim	To teach the students about virtual instrumentation and its applications.		
Course Outcomes (COs)	At the end of the course, students will be able **CO 1:** Appreciate the difference between conventional and virtual instrumentation and the pros and cons of both. **CO 2:** To perform graphical programming with various programming constructs in LabVIEW and be able to make VIs and Sub-VIs for simple and complex operations. **CO 3:** Use various data structures and various numeric and logical operations on them to do complex data processing. **CO 4:** Be familiar with various display functions for displaying output and input variables. **CO 5:** Be able to use data acquisition methods and file I/O and be familiar with various DAQ hardware and Instrumentation buses.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	Medium	High	Medium	Medium	Medium	Medium
CO 2	High	High	High	High	High	High
CO 3	High	Medium	High	High	High	High
CO 4	High	Low	Medium	High	Medium	Medium
CO 5	High	Low	High	High	High	High

L=Low, M=Medium, H=High

Introduction, Virtual instrumentation (VI) advantages, Graphical programming techniques, Data flow programming, VI's and sub VI's, Structures, Arrays and Clusters, Data acquisition methods, File I/O, DAQ hardware, PC hardware: operating systems, Instrumentation buses, ISA, PCI, USB, PXI, Instrument control, Data communication standards, RS-232C, GPIB, Real time operating systems, Reconfigurable I/O, FPGA.

References:

1. Jovitha Jerome,*Virtual Instrumentation Using Lab VIEW*, PHI Learning Pvt. Ltd, New Delhi, 2009.
2. S. Gupta and J. John, *Virtual Instrumentation Using Lab VIEW, Tata McGraw-Hill,* New Delhi, 2005.
3. R.H. Bishop, *Lab VIEW 7 Express Student Edition,* Prentice Hall, 2003.
4. National Instruments, *Lab VIEW User Manual, USA, 2003.*
5. National Instruments, *Lab VIEW Real Time User Manual, USA, 2001.*

<table>
<tr><td>ourse Title</td><td colspan="3">Neural Network & Deep Learning</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective (PE III)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Coding Skills, Linear Algebra</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the students to obtain basic knowledge on Neural Network & Deep Learning</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO 1: To Model Neuron and Neural Network, and to analyze ANN learning, and its applications.
CO 2: To perform Pattern Recognition, Linear classification.
CO 3: To develop different single layer/multiple layer Perception learning algorithms
CO 4: To design of another class of layered networks using deep learning principles.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
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<tr><td>CO 1</td><td>L</td><td>L</td><td>L</td><td>L</td><td>M</td><td>H</td></tr>
<tr><td>CO 2</td><td>L</td><td>L</td><td>L</td><td>L</td><td>M</td><td>H</td></tr>
<tr><td>CO 3</td><td>L</td><td>L</td><td>L</td><td>L</td><td>M</td><td>H</td></tr>
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</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Introduction to Neural Networks: Neural Network, Human Brain, Models of Neuron, Neural networks viewed as directed graphs, Biological Neural Network, Artificial neuron, Artificial Neural Network architecture, ANN learning, analysis and applications, Historical notes.

Learning Processes: Introduction, Error correction learning, Memory-based learning, Hebbian learning, Competitive learning, Boltzmann learning, credit assignment problem, Learning with and without teacher, learning tasks, Memory and Adaptation.

Single layer Perception: Introduction, Pattern Recognition, Linear classifier, Simple perception, Perception learning algorithm, Modified Perception learning algorithm, Adaptive linear combiner, Continuous perception, Learning in continuous perception. Limitation of Perception.

Multi-Layer Perceptron Networks: Introduction, MLP with 2 hidden layers, Simple layer of a MLP, Delta learning rule of the output layer, Multilayer feed forward neural network with continuous perceptions, Generalized delta learning rule, Back propagation algorithm.</td></tr>
</table>

Introduction to Deep learning: Neuro architectures as necessary building blocks for the DL techniques, Deep Learning & Neocognitron, Deep Convolutional Neural Networks, Recurrent Neural Networks (RNN), feature extraction, Deep Belief Networks, Restricted Boltzman Machines, Autoencoders, Training of Deep neural Networks, Applications and examples(Google, image/speech recognition)

References:

1) Simon Haykins, "Neural Network- A Comprehensive Foundation", Pearson Prentice Hall, 2nd Edition, 1999. ISBN-13: 978-0-13-147139-9/ISBN-10: 0-13-147139-2
2) Zurada and Jacek M, "Introduction to Artificial Neural Systems", West Publishing Company, 1992, ISBN: 9780534954604
3) Vojislav Kecman,"Learning & Soft Computing", Pearson Education, 1st Edition, 2004, ISBN:0-262-11255-8.
4) M T Hagan, H B Demoth, M Beale, "Neural Networks Design", Thomson Learning, 2002. ISBN-10: 0-9717321-1-6/ ISBN-13: 978-0-9717321-1-7.
5) Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer Publisher; 1st ed. 2018 edition
6) François Chollet, "Deep Learning with Python", Manning Publisher; 1st edition, 2017

3

Course Structure & Curriculum

For

M. Tech. Programme

In

Electrical Engineering

With Specialization in

Power System

(Effective from Session 2022-23)

Regular & Part Time

Department of Electrical Engineering
Motilal Nehru National Institute of Technology Allahabad
Teliarganj, Allahabad-211004, Uttar Pradesh

MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY ALLAHABAD

VISION

To establish a unique identity for the institute amongst national and international academic and research organizations through knowledge creation, acquisition and dissemination for the benefit of society and humanity.

MISSION

- To generate high quality human and knowledge resources in our core areas of competence and emerging areas to make valuable contribution in technology for social and economic development of the nation. Focused efforts to be undertaken for identification, monitoring and control of objective attributes of quality and for continuous enhancement of academic processes, infrastructure and ambience.
- To efficaciously enhance and expand, even beyond national boundaries, its contribution to the betterment of technical education and offer international programmes of teaching, consultancy and research.

DEPARTMENT OF ELECTRICAL ENGINEERING

VISION

To produce globally competitive technical manpower with sound knowledge of theory and practice, with a commitment to serve the society and to foster cutting edge research in Electrical Engineering pertaining to the problems currently faced by the country and the world.

MISSION

1. Develop state of art lab facilities for research and consultancy
2. Develop infrastructure and procure cutting edge tools/equipment
3. Develop relevant content and capability for quality teaching
4. Improve symbiotic relationship with Industry for collaborative research and resource generation.

Program Outcomes of M. Tech in Power System

POs	
PO 1	Ability to apply knowledge of power systems for the design and development of power sector for diverse engineering applications, suitable for industries, academia and research requirements.
PO 2	An ability to independently carry out research /investigation and development work to solve practical problems in the field of Power Systems.
PO 3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.
PO 4	Ability to write and present a substantial technical report/document in order to communicate ideas and solutions of research problem through publication in journals and conference proceedings.
PO 5	Possess good leadership, communication skill and sound technical knowledge for effective team work.
PO 6	Motivation for continuous and self-learning for knowledge update and sustainability.

M. Tech. (Electrical Engineering) with specialization in Power System

Overall Credit Structure

Category	Program Core (PC)		Program Electives (PE)	Total
	Core Essentials	Thesis/ SOA/ minor project		
Credits	16	40	24	80

Program Core

Subject Code	Subject Name	L	T	P	Credits
EE21121	Power System Operation & Control	3	0	2	4
EE21122	Advanced Power System Protection	3	0	2	4
EE22121	Economic Operation of Power System	3	0	2	4
EE22122	Power System Dynamics	3	0	2	4
EE2X103	Term project	0	0	6	4
EE23603	Thesis -I	0	0	18	12
EE23653	State-of-the-art Seminar	0	0	6	4
EE24603	Thesis -II	0	0	30	20
Total credits					**56**

Program Electives (PE-I & II) – 1st Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Flexible AC Transmission Systems	3	1	0	4
EE 2XXXX	Advanced Energy Management System	3	1	0	4
EE 2XXXX	EHV Transmission Technologies	3	1	0	4
EE 2XXXX	Renewable Energy & Grid Integration	3	1	0	4
EE 2XXXX	Power Quality and Mitigation	3	1	0	4
EE 2XXXX	Power Systems Restructuring and Deregulation	3	1	0	4
EE 2XXXX	Electric Vehicle Technology	3	1	0	4
EE 2XXXX	Sustainable and Renewable Energy	3	1	0	4
EE 2XXXX	Electrical Machines Design	3	1	0	4
EE 2XXXX	Computer Aided Power System Analysis	3	1	0	4

Program Electives (PE-III) – 1st Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Embedded Systems	3	1	0	4
EE 2XXXX	Fuzzy logic and control	3	1	0	4
EE 2XXXX	Optimization Techniques	3	1	0	4
EE 2XXXX	Artificial Intelligence in Engineering	3	1	0	4
EE 2XXXX	Expert Systems	3	1	0	4
EE 2XXXX	Robotics and Automation	3	1	0	4
EE 2XXXX	Research Methodology	3	1	0	4
EE 2XXXX	Digital Signal Processing	3	1	0	4
EE 2XXXX	Linear Algebra	3	1	0	4
EE 2XXXX	Virtual Instrumentation	3	1	0	4
EE 2XXXX	Neural Network & Deep Learning	3	1	0	4

Program Electives (PE-IV & V) – 2nd Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Cyber Security	3	1	0	4
EE 2XXXX	Computer Aided Design of Electrical Systems	3	1	0	4
EE 2XXXX	Distribution Automation	3	1	0	4
EE 2XXXX	HVDC Transmission	3	1	0	4
EE 2XXXX	Electric Traction and Vehicles	3	1	0	4
EE 2XXXX	Power System Planning	3	1	0	4
EE 2XXXX	Distributed Generation Systems	3	1	0	4
EE 2XXXX	Electrical Safety	3	1	0	4
EE 2XXXX	Active Power Conditioning	3	1	0	4
EE 2XXXX	Electrical Energy Conservation & Auditing	3	1	0	4
EE 22XXX	Modern Digital and Embedded Controllers	3	1	0	4

Program Electives (PE–VI) – 3rd Semester

Subject Code	Subject Name	L	T	P	Credits
EE 2XXXX	Power System Communication	3	1	0	4
EE 2XXXX	Energy Storage Systems	3	1	0	4
EE 2XXXX	Power Plant Operation & Control	3	1	0	4
EE 2XXXX	Reliability Engineering	3	1	0	4
EE 2XXXX	Computer Relaying for Power System Protection	3	1	0	4
EE 2XXXX	Advanced Digital Control	3	1	0	4

Course Structure for M. Tech. (Regular)

Sem	Course Name, L-T-P					Lecture courses	Contact hours/ week				Credits
							L	T	P	Total	
I	Power System Operation & Control (3-0-2)	Advanced Power System Protection (3-0-2)	PE-I (3-1-0)	PE-II (3-1-0)	PE-III (3-1-0)	5	15	3	4	22	20
II	Economic Operation of Power System (3-0-2)	Power System Dynamics (3-0-2)	Term Project (0-0-6)	PE-IV (3-1-0)	PE-V (3-1-0)	4	12	2	10	28	20
III	Thesis –I (0-0-18)	State-of-the-art Seminar (0-0-6)		PE-VI / MOOC*/ Online* (3-1-0)		1	3	1	24	30	20
IV	Thesis –II (0-0-30)					0	0	0	30	30	20

*This course can be completed between the start of the month of May (2nd semester) and end of the odd semester (3rd semester), i.e., between the end of their 2nd and 3rd Semesters.

Course Structure for M. Tech. (Part Time)

Sem	Course Name, L-T-P			Lecture courses	Contact hours/ week				Credits
					L	T	P	Total	
I	Power System Operation & Control (3-0-2)	Advanced Power System Protection (3-0-2)		2	6	0	4	10	8
II	Economic Operation of Power System (3-0-2)	Power System Dynamics (3-0-2)		2	6	0	4	10	8
III	PE-I (3-1-0)	PE-II (3-1-0)	PE-III (3-1-0)	3	9	3	0	12	12
IV	PE-IV (3-1-0)	PE-V (3-1-0)	Term Project (0-0-6)	2	6	2	6	14	12
V	Thesis –I (0-0-18)	State-of-the-art Seminar (0-0-6)	PE-VI/ MOOC*/ Online* (3-1-0)	1	3	1	24	30	20
VI	Thesis –II (0-0-30)			0	0	0	30	30	20

*This course can be completed between the start of the month of May (2nd semester) and end of the odd semester (3rd semester), i.e., between the end of their 2nd and 3rd Semesters.

Course Title	**Power System Operation & Control**		
Course Code	EE-XXXX	Credit	4
Core/ Elective	Core	Semester	I
Prerequisite Knowledge	Power System, Control System, Electrical Machines at UG level		
Course Aim	To provide advanced idea about various operational and control aspects related to power system along with its optimal operation.		
Course Outcomes (COs)	At the end of the course, students will be able: **CO1:** To describe the fundamental characteristics of power system operation. **CO2:** To classify, discriminate and formulate power system stability problems and their effective solutions. **CO3:** To identify and illustrate power system control methods. **CO4:** To understand, categorized and formulate the oscillations problems in power systems.		

Mapping of COs with POs& PSOs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	M	M
CO2	H	H	H	H	M	H
CO3	H	H	M	M	M	M
CO4	H	H	H	H	M	H

L=Low, M=Medium, H=High

UNIT 1–FUNDAMENTALS OF POWER SYSTEM OPERATION: (11 Hours)

Fundamentals of synchronous machine model, Synchronous generator capability curve, Capabilities and constraint operation of generators, exciters, turbines, network elements (lines, transformers, etc), Constraints on energy supply, load characteristics, Introduction to angle, frequency and voltage instability.

UNIT 2–POWER SYSTEM STABILITY: (8 Hours)

Swing equation in single machine infinite bus (SMIB) system, multi-machine system, Fundamental concepts of stability in dynamic systems, Eigen properties of the state matrix, Small signal stability analysis in single-machine infinite bus (SMIB) and multi-machine systems, Transient stability analysis, Voltage Stability: Introduction, affecting factors, its analysis.

UNIT 3–CONTROL OF POWER SYSTEM: (11 Hours)

Reactive power and voltage control, Use of machine excitation system and AVR, Reactive power compensation devices, different FACTS devices and their characteristics, Active power and frequency control, Primary and secondary loop, static and dynamic characteristic of primary control in islanded and

2-generator system, role of speed droop, automatic generation control (AGC).

UNIT 4–OSCILLATIONS IN POWER SYSTEMS: **(10 Hours)**

Type of oscillations, Detection and controls of oscillations, Damping controllers: PSS operation, Power System Oscillation damping Controller, Operation of phasor measurement units (PMUs), Fundamentals of wide area monitoring system (WAMS).

Text / Reference books

1. P.M. Anderson, and AA. Fouad, "Power System Control and Stability," John Wiley & Sons, Inc, 2003.
2. P. Kundur, "Power System Stability and Control," Tata McGraw Hill Inc.,1st Edition, 2006.
3. E.W. Kimbark, "Power System Stability," Wiley-IEEE, 1995.
4. K.R. Padiyar, "Power System Dynamics: Stability and Control," John Wiley, 2nd Edition, 2002.
5. P.S.R. Murthy, "Operation and Control in Power Systems," BS Publications, 2nd Edition, 2011.
6. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis," McGraw-Hill, 2006.
7. A. J. Wood and B. F. Wollenberg, "Power Generation Operation and Control," John Wiley and Sons, 2nd Edition, 1996.

<table>
<tr><td>Course Title</td><td colspan="3">Advanced Power System Protection</td></tr>
<tr><td>Course Code</td><td>EE 2XX01</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Core</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To understand the basic concepts and recent trends in power system protection.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able:
CO1: To understand characteristics of current and potential transformer.
CO2: To implement over current protection for various electrical apparatus.
CO3:To implement distance protection for various electrical apparatus.
CO4:To implement differential protection for various electrical apparatus.
CO5:To understand the essential background of numerical protection.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
<tr><td>CO1</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO2</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO3</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO4</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO5</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Introduction to protective relays, Current and Potential Transformer: Theory, errors, types, issues; Introduction, block diagram of numerical relay, sampling theorem, correlation with a reference wave, DFT and least error squared (LES) technique for Phasor estimation, digital filtering, Anti-Aliasing Filters. Mimic Filters. Effect of CCVT transient of Phasor Estimation.

Transmission line protection: Over-current protection, over-current relay coordination, directional overcurrent relay, Drawback of over-current relay; Coordination of the relays. Issues of the coordination. Dual setting OCR.

Distance protection, Simple impedance relay, Reactance relay, mho relays comparison of distance relay, Distance protection of a three-phase line, Reasons for inaccuracy of distance relay reach, Three stepped distance protection, Classification of fault in transmission line. Distance relay for 3 phase line for all type of fault. Zero sequence compensation factor. Need for carrier aided protection, Various options for a carrier aided protection. Fault Location in Lines. Intelligent protection schemes

Transformer Protection: Differential protection, Percentage biased differential protection, Differential protection scheme for various types of three phase transformer, Magnetizing inrush current and harmonics</td></tr>
</table>

restraint method, Restricted earth fault protection, over-fluxing protection, Incipient fault protection. Digital implementation of the 3-phase differential protection of 3 phase transformer

Busbar protection: Differential protection of busbars, External and internal fault, Actual behaviors of a protective CT and circuit model of a saturated CT, Need for high impedance, Stability ratio of high impedance busbar differential scheme, Supervisory relay.

Multiagent based protection scheme, Special protection Scheme

References:

1. A.T. Johns and S.K. Salman,Digital Protection for Power Systems, Peter Peregrinus Ltd. on behalf of the IEE London U.K.,1995
2. Arun G. Phadke and J.S. Thorp, Computer Relaying for Power Systems, John Wiley and Sons Ltd. England and Research Studies Press Ltd,2009
3. Badri Ram and D.N. Vishvakarma, Power System Protection and Switchgear, TMH, New Delhi,2001.
4. Y.G. Paithankar, and S.R. Bhide, Fundamentals of Power System Protection,2nd Edition,PHI Pvt. Limited, New Delhi, 2013
5. Areva, Network Protection Application Guide,1966.
6. Lewis Blackburn, J., 'Protective Relaying – Principles and Applications', Marcel Dekkar, INC, New York, 2006
7. The Electricity Training Association, 'Power System Protection Vol1-4', The IEE, U.K.,2005.
8. P M Anderson, 'Power System Protection', IEE Press, 2012.

Course Title	**Economic Operation of Power System**		
Course Code	**EE 2XX04**	Credit	4
Core/ Elective	Elective	Semester	2
Prerequisite Knowledge	Power System		
Course Aim	To familiarize various aspects and tools used in operation and planning of power systems.		
Course Outcomes (COs)	At the end of the course students will be able to: **CO1**: Aware of the various aspects and tools used in operation and planning of power systems. **CO2**: Define automatic generation control scheme on a power system and analyze generation control on a power system. **CO3**: Apply the optimal power flow using various mathematical optimization techniques. **CO4**: Define real time monitoring requirements in a power system.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	High	High	High	Low	High
CO 2	High	High	Low	High	Medium
CO 3	High	High	Medium	High	High
CO 4	High	High	Low	High	Medium

Module 1: Introduction and linkages between various operational, control and planning problems in power systems.

Module 2: Economic Dispatch - Introduction, system constraints, economic dispatch neglecting losses, penalty factor, economic dispatch with losses, transmission loss equation, automatic load dispatching, LP application.

Module 3: Optimal power flow - LP application, Interior point application, second-order conic programming.

Module 4: Day Ahead Unit commitment - dynamic programming.

Module 5: Automatic generation and voltage control.

Module 6: Power system planning in the presence of renewable energy resources, RE based Economic operation.

References:

1. Leon K. Kirchmayer, *Economic Operation of Power Systems*, Wiley India, 2009.
2. Hadi Sadat, *Power System analysis*, McGraw-Hill, 2nd Edition, 2002.
3. John J. Grainger, William D. Stevenson, Gary W. Chang, *Power System analysis*, McGraw-Hill Education, 2016.
4. Jin Zhong, "Power System Economic and Market Operations," CRC Press, 2018, ISBN

9781482299045

<table>
<tr><td>Course Title</td><td colspan="3">Power System Dynamics</td></tr>
<tr><td>Course Code</td><td>EE 2XX05</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Core</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Electrical Machines, Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To train the students to develop dynamic model of the system and analyze the dynamic model with small and large disturbance.</td></tr>
<tr><td>Course Outcomes (Cos)</td><td colspan="3">At the end of the course, students will be able to
CO1: Understand the basics of power system dynamics and stability.
CO2: do the dynamic modelling of the electrical system components
CO3: Investigate the system response for small and large disturbance
CO4: Ability to interpret results coming from the simulation of differential – algebraic systems.
CO5: Develop essential measures to enhance the power system stability</td></tr>
<tr><td>Mapping of Cos with Pos</td><td colspan="3">
<table>
<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
<tr><td>CO1</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO2</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO3</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO4</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO5</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Modeling of Synchronous Machine Synchronous Machine, Park's Transformation, Analysis of Steady State Performance, P. U. Quantities, Equivalent Circuit of Synchronous Machine

Excitation systems & Prime Mover Controllers: Simplified Representation of Excitation Control, Excitation systems, Modeling, Std. Block Diagram, State Equations, Prime Mover Control System, Transmission Line & Load Modeling

Dynamics of Synchronous Generator Connected to Infinite Bus System Model, Synchronous Machine Model, System Simulation, Consideration of other Machine Models including SVC Model.</td></tr>
</table>

Transient Stability and Voltage Stability Evaluation and Simulation, application of energy functions for direct stability evaluation, TS controllers.

Multi-machine and multi-area based modelling. Integrated System Modelling with RES.

References:

1. K. R. Padiyar, Power System Dynamics - Stability & Control, BS Publications, 2002.

2. P. Sauer & M. A. Pai, Power System Dynamics & Stability, Prentice Hall, 1997.

3. Prabha Kundur, Power System Stability and Control, Tata McGraw Hill, 1994.

4.P.M Anderson, F. Fouad, Power System Control and Stability, Iowa StateUniversity Press

<table>
<tr><td>Course Title</td><td colspan="3">Flexible AC Transmission Systems</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Electronics, Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the student to learn the need of FACTS devices and application of various FACTS Devices in the transmission and distribution system.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able to
CO1: Understand the needs of FACTS devices
CO2:Investigate the issues with the control of voltage and current source converters
CO3:Analyze the operation and control of shunt compensation devices
CO4:Analyze the operation and control of series compensation devices
CO5: Develop and implement the combination of series and shunt compensation devices.</td></tr>
<tr><td>Mapping of Cos with Pos</td><td colspan="3">
<table>
<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
<tr><td>CO1</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>M</td></tr>
<tr><td>CO2</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>M</td></tr>
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<tr><td>CO4</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>M</td></tr>
<tr><td>CO5</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>M</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Introduction to FACTS, challenges and needs, Power Flow in AC transmission line, Power flow control, Description and definition of FACTS controllers, Static power converter structures, Voltage-sourced and current-sourced converters, Converter output and harmonic control, power converter control issues, Shunt Compensation: SVC, STATCOM, Operation and control, Configurations and applications, Series Compensation: TCSC, mitigation of sub-synchronous resonance, SSSC, Combination of shunt-series compensation: UPFC, Power flow studies with FACTS controllers, operational constraints, IPFC, UPQC, other FACTS Controllers: TCPAR, TCBR etc.</td></tr>
</table>

References:

1. N. G. Hingorani and L. Gyugyi, Understanding FACTS, IEEE Press, New York, 1999.

2. K.R. Padiyar, FACTS Controllers in Transmission & Distribution, New Age International (P) Limited, 1990.

3. V. K. Sood, HVDC and FACTS Controllers: Applications of Static Converters in Power Systems, Kluwer academic publishers, Canada, 2004.

4. Enrique Acha, C.R. Feurte-Esquivel and others, Modelling and Simulation in Power Networks, Wiley, 2004.

Course Title	**Advanced Energy Management System**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective	Semester	1
Prerequisite Knowledge	Power System		
Course Aim	To provide a general awareness on the importance of energy and its conservation, its impact on society, various energy sources, energy conversion processes, energy management, energy audit and energy conservation measures.		
Course Outcomes (COs)	At the end of the course students will be able to: **CO1**: Realize the present energy scenario in national and international context. **CO2**: Understand the concepts energy management, auditing and accounting. **CO3**: Design electricity tariff methods based on demand side management. **CO4**: Understand the methods of improving energy efficiency in different electrical systems.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	High	High	High	Low	High
CO 2	High	High	Low	High	Medium
CO 3	High	High	Medium	High	High
CO 4	High	High	Low	High	Medium

Module 1: Energy resources, Energy Mix, Energy Poverty, Barriers to Energy Poverty, Energy Literacy, Energy Security, Distributed Generation, Renewable Energy Sources, Energy Storage Systems, Hybrid System Configurations, Grid-integrated and Stand-alone Systems, Concept of Micro-Grid.

Module 2: Energy conservation and its importance, Classification of Energy Conservation Measures,

Government Schemes - Energy Conservation Act, Electricity Act, National Electricity Policy, National Tariff Policy;

Regulatory Authorities - Bureau of Energy Efficiency;

Energy Conservation in Buildings, Energy Conservation Building Codes,

Waste-To-Energy Technology.

Module 3: Demand Response, Demand Side Management (DSM) – Need, benefits and role in Power Systems, DSM Techniques, Smart Metering, Communication Systems, Factors affecting DSM, Standards and Labelling, Supervisory Control and Data Acquisition.

Module 4: Energy Accounting, Energy Audit, Types of Energy Audit, Methodology for Energy Audit, Phases of Auditing, Energy Audit Report Format, Energy Audit Instruments, Competence Requirements of an Energy Auditor.

Module 5: Energy Management, General Principles of Energy Management, Energy Flexibility, Dynamic Tariffs.

References:

1. Amlan Chakrabarti, *Energy Engineering and Management*, Prentice Hall India, 2011.
2. Anil Kumar, Om Prakash, Prashant Singh Chauhan, Samsher, "Energy Management-Conservation and Audits, CRC Press, 2020, ISBN: 9780429325458
3. Eastop T. D. and D. R. Croft, *Energy Efficiency for Engineers & Technologists*, Longman, 1990.
4. Rao S. and B. B. Parulekar, *Energy Technology*, Khanna Publishers, 2005.
5. Doty S. and W. C. Turner, *Energy Management Hand book*, 7/e, Fairmont Press, 2009.

<table>
<tr><td>Course Title</td><td colspan="3">EHV Transmission Technologies</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Systems, Power Electronics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To aware the students about the concepts, performance and application of Extra High Voltage A.C. & D.C. Transmission in power systems</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course students will be able to
CO1: Demonstrate the knowledge of EHV AC and HVDC transmission in terms of design, power handling capacity etc.
CO2: Formulate and solve mathematical problems related to the effect of Electrostatic and electromagnetic fields and corona in the EHVAC & HVDC lines
CO3: Analyze the various causes of over voltages in the EHV systems developed due to switching
CO4: Design the EHV lines based upon the steady state and transient limit.
CO5: Review the existing HVDC systems along with MTDC systems and their controls and recognize the need of EHV AC and HVDC transmission for sustainable development</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
<tr><td>CO1</td><td>H</td><td>M</td><td>H</td><td>M</td><td>L</td><td>M</td></tr>
<tr><td>CO2</td><td>M</td><td>M</td><td>H</td><td>M</td><td>L</td><td>M</td></tr>
<tr><td>CO3</td><td>H</td><td>M</td><td>H</td><td>M</td><td>L</td><td>M</td></tr>
<tr><td>CO4</td><td>H</td><td>M</td><td>H</td><td>M</td><td>L</td><td>M</td></tr>
<tr><td>CO5</td><td>H</td><td>L</td><td>M</td><td>M</td><td>L</td><td>H</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
</table>

UNIT 1 – Introduction to EHV AC Transmission: **(6 Hours)**

Necessity of EHV AC transmission, advantages and associated problems, various EHV voltage levels, power handling capacity and line losses, mechanical consideration in line performance, cost of transmission.

UNIT 2 – Calculation of line and ground parameters: **(8 hours)**

Resistance of conductors, temperature rise and current carrying capacity of conductors, calculation of inductance, capacitance of bundle conductors, calculation of sequence inductance and capacitance, surface voltage gradients on conductor and distribution of voltage gradients on subconductor of the bundle.

UNIT 3– Corona effect in EHV system and Audible noise: **(6 hours)**

Calculation of corona loss, charge-voltage diagram and corona loss, attenuation of travelling waves due to corona, Generation & characteristics of AN, Day Night AN level, radio interference.

UNIT 4 –Overvoltages in EHV system caused by switching: **(6 hours)**

Types of overvoltage, overvoltages due to low inductive and capacitive current, calculation of switching surges for lumped and distributed parameter lines.

UNIT 5 – Design of EHV AC lines: **(5 hours)**

Design of EHV lines based upon steady state limits, various design factors.

UNIT 6 – HVDC Transmission: **(4 hours)**

Layout/Arrangement of substation, Equipments; converter transformer arrangement, converters, filters, etc. LCC and VSC converters, Multiterminal HVDC system and its applications

References:

1. R. D. Begamudre, EHVAC Transmission Engineering, New Age International (P) Ltd.
2. K. R. Padiyar, HVDC Power Transmission System, Wiley Eastern Limited, New Delhi. Second Edition, 1990.
3. S. Rao, EHV-AC, HVDC Transmission & Distribution Engineering

<table>
<tr><td>Course Title</td><td colspan="3">Renewable Energy & Grid Integration</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Electronics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the students to generate power through renewable energy and integration of renewable energy to the grid.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course students will be able to
CO1: Demonstrate the concept of solar and wind energy conversion system and its characteristics.
CO2:Design of various MPPT methods for wind and solar energy conversion system.
CO3:Design of DC-DC converters and DC – AC converter for grid connected operation
CO4:Understand the role of energy storage components and its integration with the grids.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
<tr><td>CO1</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO2</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO3</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>H</td></tr>
<tr><td>CO4</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>H</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
</table>

Wind energy conversion systems, Wind turbines, Turbine characteristics, Various electrical generators, Induction generators, doubly-fed induction generator, Synchronous generator and permanent magnet synchronous generator (PMSG), Power conversion through power electronics converters, Maximum Power point tracking (MPPT), Controlled rectifiers and DC-DC converters for MPPT, Voltage source inverters, Modelling and control of WECS for grid interface, Standalone and grid interface application, Solar photovoltaic (PV) system, classifications, PV characteristics, MPPT methods, DC-DC converters and VSI, roof-top and domestic PV systems, Grid connected PV system, Fuel cells, classification and characteristics, power electronics interfaces, Hybrid systems, Other renewable sources of energy, Integration of renewable energy systems.

Components required for grid integration, Energy storage components and integration with the grids, Large energy storage technologies (MW), Grid integration issues and standards. Adequate converter topologies, tariff related to renewable energy interface. Microgrid structure and operation.

References:

1. M. R. Patel, Wind and Solar Power Systems, Tailor & Francis CRC Press, USA, 2006.

2. M. H. Rashid (ed), Power Electronics Handbook, Academic Press, Florida, 2001.

3. Bin Wu, Yongqiang Lang, Navid Zargari, Power Conversion and Control of Wind Energy Systems, Wiley, 2011.

4. Anaya-Lara, N. Jenkins et al, Wind Energy Generation Modeling and Control, Wiley, 2011.

5. B. Fox et al, Wind Power Integration Connection and system operational aspects, IET, London, 2007.

6. A. Ghosh and G. Ledwich, Power Quality Enhancement using Custom Power Devices, Kluwer Academic, 2002.

7. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, 2nd Edition, Wiley-IEEE Press, 2016.

<table>
<tr><td>Course Title</td><td colspan="4">Power Quality and Mitigation</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td colspan="2">4</td></tr>
<tr><td>Core/ Elective</td><td>Elective</td><td>Semester</td><td colspan="2">1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="4">Fundamentals of Power Systems and Power Electronics</td></tr>
<tr><td>Course Aim</td><td colspan="4">To understand various sources and effects of power quality disturbances in power systems.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="4">At the end of the course students will be able to:
CO1: Identify the sources of various power quality problems.
CO2: Estimate the impact of various power quality problems on appliances.
CO3: Use equipment that are required to measure the quality of power.
CO4: Decide the compensators and filters to keep the power quality indices within the standards.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="4"><table>
<tr><td></td><td>PO 1</td><td>PO 2</td><td>PO 3</td><td>PO 4</td><td>PO 5</td></tr>
<tr><td>CO 1</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 3</td><td>High</td><td>High</td><td>Medium</td><td>High</td><td>High</td></tr>
<tr><td>CO 4</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>Medium</td></tr>
</table></td></tr>
<tr><td colspan="5">Module 1: Overview and definition of power quality (PQ), Sources of pollution and regulations, Power quality problems, Rapid voltage fluctuations voltage unbalance, Voltage dips and voltage swells, Short-duration outages.
Module 2: Definitions Voltage sag analysis and mitigation, Sag caused by motor starting, Sag caused by utility fault clearing, Sag mitigation, Sag magnitude and duration calculations, RMS voltage, Calculation in 1-phase systems, Equipment performance in presence of sag, Computers, AC and DC drives.</td></tr>
</table>

Module 3: Harmonic distortion and its effects within the power system, Harmonic sources, Harmonic analysis, Detection of harmonics, Harmonic elimination, Transformer magnetization and non-linearities, Rotating machines, Arc furnaces, Fluorescent lighting, Total harmonic distortion, RMS and average value calculations.

Module 4: PQ measuring equipment, PQ improvement/ mitigation, Electric power conditioning, Active and passive filters, Unified Power Quality Compensators.

Module 5: IEEE, IEC, ANSI standards, Power acceptability curves, Current trends.

References:

1. C. Sankaran, "Power Quality," CRC Press, 2017, ISBN: 9781420041026
2. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques, Wiley, February 2015, ISBN: 9781118922057
3. Bollen, M.H.J., Power Quality Problems: Voltage Sag and Interruptions, IEEE Press, 1999, ISBN: 0780347137
4. Beaty, H. and Santoso, S., Electrical Power System Quality, McGraw Hill (2002).
5. Kennedy, B., Power Quality Primer, McGraw Hill, 2000.

<table>
<tr><td>Course Title</td><td colspan="3">Power Systems Restructuring and Deregulation</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System, Power System Operation and Control, at UG level</td></tr>
<tr><td>Course Aim</td><td colspan="3">This course is intended to provides a comprehensive understanding of the power sector restructuring and deregulation, power markets operations including power system economics, market models, and market design etc.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course students will be able to:
CO1: Familiarize the needs, concepts, challenges and structures of deregulated power systems.
CO2: Distinguish the components of restructured power system and conventional power system and their applications.
CO3: Describe the development and latest trends in electricity market design and analyze its connection to operation and planning of power systems.
CO4: Analyze and reflect upon different models and methods for electricity market design, planning and operation.
CO5: Impart the knowledge of power market developments in India and across the world.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
<tr><td>CO1</td><td>M</td><td>L</td><td>M</td><td>L</td><td>L</td><td>H</td></tr>
<tr><td>CO2</td><td>H</td><td>M</td><td>H</td><td>M</td><td>L</td><td>H</td></tr>
<tr><td>CO3</td><td>H</td><td>H</td><td>H</td><td>M</td><td>L</td><td>H</td></tr>
<tr><td>CO4</td><td>H</td><td>H</td><td>H</td><td>H</td><td>L</td><td>H</td></tr>
<tr><td>CO5</td><td>M</td><td>L</td><td>M</td><td>H</td><td>L</td><td>H</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
</table>

UNIT 1 – INTRODUCTION TO POWER SYSTEMS RESTRUCTURING AND DEREGULATION: (7 Hours)

Traditional Power Industry Structure, Motivations & need for restructuring & deregulation, Fundamentals of restructured & deregulated power system, Components of restructured & Deregulated power systems, Technical, economic & regulatory issues involved in deregulation of power industry, Privatization, Competition in the electricity sector.

UNIT 2 – COMPONENTS OF RESTRUCTURED SYSTEMS: (9 Hours)

Centralized and de-centralized dispatch philosophies, Functions of monopoly model, purchasing agency model, wholesale competition model, retail competition model, Functions and responsibilities of key market entities- ISO, TSO, GENCO, TRANSCO, DISCO, RETAILCO, Trading arrangements: Pool, bilateral & multilateral, Open Access Transmission & Distribution Systems.

UNIT 3 – OPERATION OF RESTRUCTURED POWER MARKETS: (9 Hours)

Transmission congestion management, Locational Marginal Prices (LMP), Ancillary Services, Operation and control of Day-ahead and Real-time Energy Markets, Financial Transmission Rights and Hedging, Market Power.

UNIT 4 – TRANSMISSION PRICING METHODS AND LOSS ALLOCATION: (7 Hours)

Models of transmission pricing, Different transmission services, Network cost evaluation methods, Cost allocation methods, loss allocation algorithms.

UNIT 5 – POWER SECTOR REFORMS IN INDIA AND WORLD: (8 Hours)

Introduction to Indian electricity markets, Introduction to various institutions in Indian Power sector: e.g. Ministry of Power, Planning Commission, CEA, central and state utilities, PGCIL, Power Finance Corporation Limited (PFC), REC, CERC & SERCs, traders, LDCs, Power Exchanges, and their roles, Experience of world's electricity reforms.

Text / Reference books

1. Loi Lei Lai, "Power System Restructuring and Deregulation", John Wiley & Sons Ltd, England, 2001.
2. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured Electric Power Systems: Operation, Trading and Volatility", Marcel Dekker, Inc., 2001.
3. D. Kirschen, G. Strbac, "Fundamentals of Power System Economics", 2nd Edition, John Wiley, 2018
4. Sioshansi, "Competitive Electricity Markets: Design, Implementation, Performance", Elsevier, 2008
5. Geoffrey Rothwell, Tomas Gomez (Eds.), "Electricity Economics Regulation and Deregulation", IEEE Press Power Engineering Series, John Wiley & Sons, 2003.
6. Steven Stoft, "Power System Economics: designing markets for electricity", Wiley Interscience, 2002.
7. Richard J. Gilbert, Edward P. Khan, "International Comparisons of Electricity Regulation", Cambridge University Press, 2002.
8. A. R. Abhyankar, S. A. Khaparde, NPTEL Web Course: Restructured Power System, Available: https://nptel.ac.in/courses/108/101/108101005/
9. Lorrin Philipson, H. Lee Willis, "Understanding Electric Utilities and Deregulation", Taylor & Francis, New York, 2nd Edition, 2006.

<table>
<tr><td>Course Title</td><td colspan="3">Electric Vehicle Technology</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Electronics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the Electrical vehicles and their operation</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course students, will be able to
CO1:To understand the electric vehicle design, architecture and types of EV.
CO2:To competent in designing the power electronic converters for electric vehicle charging applications
CO3:Analyze the energy storage systems for EVs and carry research on the same
CO4:Be Proficient in design and control of electric motors for EVs
CO5:To understand and create the solutions for the impact of EV on grid</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>L</td></tr>
<tr><td>CO 2</td><td>H</td><td>H</td><td>L</td><td>H</td><td>H</td><td>L</td></tr>
<tr><td>CO 3</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>CO 4</td><td>H</td><td>H</td><td>L</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>CO 5</td><td>L</td><td>L</td><td>H</td><td>H</td><td>H</td><td>H</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">General Introduction, History of Electric Vehicles (EV), Evolution of Batteries, E-Mobility – advantages, Preference for EV over ICE Vehicles, EV types - Battery EV, Fuel Cell EV, Hybrid EV, Plug-In EV; Policies and Regulations for Faster EV Adoption.

Energy Storage Options for EV Applications-battery types, Li-ion Batteries- Characteristics and Parameters, Modeling and Estimation; Battery Management System; Safety strategies (passive/active) of Li-ion batteries; Alternate energy storage technology.

Electric Motors for EV Applications, Performance requirements, Types of motors, Magnetic materials, Thermal issues and management, Electromagnetic Analysis and Design, Sizing of propulsion motor.

Power Electronic Converters for EV Applications: Si-based devices, Wide-band gap devices, Power losses, Reliability assessment, Role of Power Electronic Converters, Battery charging topologies, Traction drives, Voltage source inverters, Modulation techniques, Sizing of power electronics converters.</td></tr>
</table>

Drive-trains: Hybrid Electric and Electric Drive-trains, Energy Management Strategies.

Modeling and Sizing of Batteries used in EVs, EV Battery Management Systems, Critical battery states (State of Charge, State of Energy, State of Health, State of Power, State of Temperature); Safety technologies.

EV Charging Methods(CC/CV), Charging Infrastructures, Standards, Location of Charging Stations, Integration of EV load in Power System - Impact of EV charging on grid, EV charging strategies, Mitigation Techniques.

EVs in Grid Support: Flexibility Services, Vehicle to Everything (V2X), Barriers in V2X Infrastructure, Ancillary services, Dynamic Tariff with EVs.

Communication systems, Integrated Vehicle Health Monitoring

Reference Books :

1. Sandeep Dhameja, Electric Vehicle Battery Systems, Elsevier, First Edition, 2002
2. John Fenton & Ron Hodkinson, *Lightweight Electric/Hybrid Vehicle Design*, Elsevier Oxford, 2000.
3. Seth Leitman, Bob Brant, *Build Your Own Electric Vehicle*, McGraw Hill, Third Edition, 2013.
4. Iqbal Husain, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, Second Edition, 2010.
5. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, Second Edition 2009.

Various IEEE/Science direct journals

<table>
<tr><td>Course Title</td><td colspan="3">Sustainable and Renewable Energy</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power electronics, Power System and Electrical machines</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the renewable energy technologies and their control techniques</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course students, will be able
CO1: To develop the new renewable energy technologies to meet the power demand of the nation.
CO2:To Competent in designing the power electronic converters for solar, wind and fuel cell sources
CO3: To design and control the novel electrical generators for renewable energies
CO4: To understand the concepts of energy storage systems for renewable energy systems</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>H</td><td>H</td><td>H</td><td>L</td><td>H</td><td>L</td></tr>
<tr><td>CO 2</td><td>H</td><td>H</td><td>L</td><td>H</td><td>H</td><td>L</td></tr>
<tr><td>CO 3</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>CO 4</td><td>H</td><td>L</td><td>H</td><td>L</td><td>H</td><td>H</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Unit 1: Sustainable and Renewable energy
Difference between sustainable and renewable energy sources (RES), types of RES and brief introduction about working of each, status of RES in the world and previous three years IRENA renewable capacity highlights. Role of electrical engineering in RES- role of power electronics, role of electric generators, role of storage systems, role of control schemes, role of transmission and distribution lines and role of FACTs devices.
Unit 2: Power electronics for RES</td></tr>
</table>

Power converters and control for PV system: Design of dc/dc converter, single phase and three phase inverter with PV as a source, Different MPPT algorithms, Grid interfacing-with isolation, without isolation, PV-Inverters with D.C. to D.C. converters-on low frequency side and high frequency side with isolation, without isolation. Voltage step-up using D.C.-D.C. converter- with and without battery storage, Voltage controller for Fuel cell using D.C. – D.C. converter, Inverter interaction with fuel cell for A.C. loads, A.C. Voltage build-up and controller for fuel cells- using power converters and transformers (isolation). Three phase AC voltage controllers-AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, matrix converters- Standalone operation of fixed and variable speed wind energy conversion systems.

Unit 3: Electrical generators for RES

Electric generators for wind energy conversion systems- state of art challenges, control techniques, solutions.

Electric generators for hydro power plants- state of art challenges, control techniques, solutions.

Electric generators for biomass, geothermal RES.

Unit-4: Energy storage systems for EV

Various types of energy storage systems, electrical domain, chemical domain, electrochemical domain, Batteries, Super capacitors, Superconducting Magnetic Energy Storage (SMES), charging methodologies, SoC, SoH estimation techniques. Hydrogen production and storage, fuel cells. Applications of Energy storage in distributed generation. Sodium Sulphate battery

Reference Books :

1. Sudipta Chakraborty, Marcelo G. Simões, and William E. Kramer, Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration, Springer.
2. S. N. Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.
3. B.H.Khan Non-conventional Energy sources Tata McGraw-hill Publishing Company, New Delhi, 2009.
4. Rashid .M. H "power electronics Hand book", Academic press, 2001.
5. Rai. G.D, "Non-conventional energy sources", Khanna publishes, 1993.
6. Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995.
7. R. Pendse, "Energy Storage Science and Technology", SBS Publishers & Distributors Pvt. Ltd., New Delhi, (ISBN – 13:9789380090122), 2011.
8. Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, "The Role of Energy Storage with Renewable Electricity Generation", National Renewable Energy Laboratory (NREL) – A National Laboratory of the U.S. Department of Energy – Technical Report NREL/ TP6A2-47187, January 2010.

<table>
<tr><td>Course Title</td><td colspan="3">Electrical Machines Design</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Electric Machine</td></tr>
<tr><td>Course Aim</td><td colspan="3">To analyze the Design Aspects of Various Machines</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course students, will be able
CO1:To know the basic considerations of machine design, heat dissipation, cooling and calculation of various quantities
CO2: To learn the design of core, yoke, winding, dimensions of transformer and its cooling
CO3: To know the design of various aspect of rotating machine as specific electric and magnetic loadings, selection of frame size, Core and armature design
CO4: To understand the rotor design of induction machine and field design of dc and synchronous machine
CO5: To know about computer aided design and various software package available for verifying the various aspects of machine design</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
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<tr><td>CO 2</td><td>H</td><td>H</td><td>L</td><td>H</td><td>H</td><td>L</td></tr>
<tr><td>CO 3</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td></tr>
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</table>
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</td></tr>
</table>

UNIT 1 –BASIC CONSIDERATIONS:

Basic concept of design, limitation in design, standardization, modern trends in design and manufacturing techniques, Classification of insulating materials. Modes of heat dissipation & temperature rise time curves. Methods of cooling ventilation (induced & forced, radial & axial), direct cooling & quantity of cooling medium. Calculation of total MMF and magnetizing current. Specific permeance and leakage reactance

UNIT 2 –TRANSFORMER DESIGN:

Output equation design of core, yoke and windings, overall dimensions, Computation of no load current to voltage regulation, efficiency and cooling system designs.

UNIT 3 –DESIGN OF ROTATING MACHINES – I:

Output equations of rotating machines, specific electric and magnetic loadings, factors affecting size of rotating machines, separation of main dimensions, selection of frame size, Core and armature design of dc and 3-phase ac machines

UNIT 4 –DESIGN OF ROTATING MACHINES – II:

Rotor design of three phase induction motors. Design of field system of DC machine and synchronous machines, Estimation of performance from design data

UNIT 5 –COMPUTER AIDED DESIGN:

Philosophy of computer aided design, advantages and limitations. Computer aided design approaches analysis, synthesis and hybrid methods. Concept of optimization and its general procedure. Flow charts and 'c' based computer programs for the design of transformer, dc machine; three phase induction and synchronous machines.

UNIR 6: Various commercial Software packages for electrical machine design

Text/ Reference Books:

1. A. K. Sawhney, "A Course in Electrical Machine Design," Dhanpat Rai&Sons., 6thEdition, 2014.
2. K.G. Upadhyay, "Conventional and Computer Aided Design of Electrical Machines", Galgotia Publications Pvt. Ltd., 1stEdition, 2004.
3. M.G. Say, "The Performance and Design of AC Machines," Pitman & Sons, 1985.
4. S.K. Sen, "Principle of Electrical Machine Design with Computer Programming," Oxford and IBM Publications.

<table>
<tr><td>Course Title</td><td colspan="3">Computer Aided Power System Analysis</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System and Electrical machine</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the Algorithms of power flow and fault Calculations for large systems using Computer Methods</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO 1. To study the Algebraic Techniques for computer Simulation.
CO 2. To study Power Flow Analysis of Bigger System.
CO 3. To study Fault Analysis of Bigger System.
CO 4. To study the state Estimation and Optimal Power Flow.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3"><table><tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr><tr><td>CO1</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>M</td></tr><tr><td>CO2</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>M</td></tr><tr><td>CO3</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>M</td></tr><tr><td>CO4</td><td>H</td><td>H</td><td>H</td><td>L</td><td>M</td><td>M</td></tr></table>L=Low, M=Medium, H=High</td></tr>
<tr><td colspan="4">Network Modelling and Power Flow I: System graph, loop, cutest and incidence matrices, y- bus formation, sparsity and optimal ordering, power flow analysis, Newton Rap son method.

Network Modelling and Power Flow II: Decoupled and fast decoupled method, formulation of three phase load flow, dc load flow, formulation of AC-DC load flow, sequential solution technique.

Analysis of three phase symmetrical and unsymmetrical faults: in phase and sequence domain, Phase shift in sequence quantities due to transformer, open circuit faults.

Stability Studies: Transient stability analysis, swing equation, stability of multimachine system using modified Euler method and Runge-Kutta method

Power System Security: Factors affecting security, State transition diagram, contingency analysis using network sensitivity method.

AC power flow method, introduction to state estimation.

Power System analysis with large integration of Renewable sources.</td></tr>
</table>

References:

1. D. P. Kothari and I. J. Nagrath, Modern Power System Analysis, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.

2. HadiSaadat, Power System Analysis, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2002.

3. George L. Kusic, Computer Aided Power System Analysis, Prentice Hall of India (P) Ltd., New Delhi, 1989.

4. J. Arrilaga, C. P. Arnold, B. J. Harker, Computer Modelling of Electric Power System, John Wiley &Sons.K, 1988

5. Mahailnaos, D. P. Kothari, S. I. Ahson, Computer Aided Power System Analysis & Control, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1988.

6. G. T. Heydt, Computer Analysis Methods for Power Systems, Macmillan Publishing Company, New York, 1992.

7. L. P. Singh Advanced Power System Analysis and Dynamics, New Age International Publishers, New Delhi, 2006.

<table>
<tr><td>Course Title</td><td colspan="3">Cyber Security</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power system, Distribution Automation</td></tr>
<tr><td>Course Aim</td><td colspan="3">To understand the different Cyber-attacks and their prevention techniques</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course students, will be able to

CO1:Understand the core principles behind CPS
CO2: Identify safety specifications and critical properties
CO3: Understand abstraction in system design
CO4: Learn techniques for attack detection and attack mitigation.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO1</td><td>L</td><td>H</td><td>H</td><td>L</td><td>H</td><td>H</td></tr>
<tr><td>CO2</td><td>L</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>CO3</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>CO4</td><td>H</td><td>H</td><td>H</td><td>L</td><td>H</td><td>H</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Unit 1: Dynamical Systems Modeling
i. Cyber-Physical Systems (CPS) in the real world
ii. Dynamical Systems : stability and performance
iii. Different notions of stability
iv. Controller Design techniques
v. Sensors and Actuators for Physical Processes
Unit 2: CPS Compute/Scheduling
i. Real time scheduling theory
ii. CAN bus scheduling
iii. Packet drops and their effects on stability/performance
iv. Delay/Deadline-miss aware control design
Unit 3: Secure CPS
i. Distributed CPS
ii. Attack Models
iii. Attack detection techniques in CPS
iv. Attack mitigation in CPS</td></tr>
</table>

Unit4:

Smart Grid Security and Privacy : Automated Generation Control attack mitigation

References:

1. E. A. Lee and S. A. Seshia , Introduction to Embedded Systems - A Cyber-Physical Systems Approach, 2014.
2. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
3. J. J. E. Slotine, Applied nonlinear control, Prentice-Hall,1991
4. Brown, P., Sensors and Actuators: Technology and Applications, Library Press, 2016.

Course Title	**Computer Aided Design of Electrical Systems**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Program Elective (PE-IV and PE-V)	Semester	2
Prerequisite Knowledge	Power system		
Course Aim	To learn various standard and various components in power system		
Course Outcomes (COs)	At the end of the course students, will be able **CO1:**To develop the analysis electrical circuits if software **CO2:** To understand how the circuits will behave during the transient **CO3**: To understand the various utilization of the Circuit **CO4**: To implement a real time circuit in software.		

Mpping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	H	H	H	L	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	L	H	H

L=Low, M=Medium, H=High

UNIT 1: Use of International Standards, Electrical Codes & Standards - BS, NEC, IEE, IEEE, NFPA, IEC Design Basis, std. practices/procedure and specifications, Understanding, Basic Electrical Formulae, Basic Design requirement based on the type of various plants, Intra-discipline co-ordination with civil, process, mechanical, piping, telecom HVAC etc.

UNIT 2: Wiring Accessories & Cable Management Systems, Cable Selection and Sizing and cable laying methods, Selection and sizing of electrical equipment used in various projects, Preparation of equipment specifications, High Voltage system requirements including substation design.

UNIT 3: Lighting systems, Lighting Fixtures (Types & Applications), Lighting Design- Illumination Lux Levels, Emergency & Exit Lighting System, Specialized Engineering like Heat Tracing systems and cathodic protection design, Design of Earthlings system, Lightning system and lightning protection system, Method of Lightening protection, Basic Consideration for Protection (Rfer Std IS 2309,NFC 72-102),Low current systems- Fire alarm & detection system, CCTV system etc.

UNIT 4: Generation, Transmission & Distribution of Electricity, Design of power distribution, Earthing in Power Stations and Substations, Earthing Associated with Overhead Power Lines and lighting protection systems, Equipment vendor drawing review and approval.

UNIT 5: Electrical System Drafting (CAD)- Preparation of lighting layouts, Preparation of Power Layouts, Preparation of Single Line Diagrams (SLD) or Riser Diagrams, Preparation of Electrical General Installation Details & Sections, Preparation of LV or Electrical Room Details, Procurement Requirements and installation standards., Inspection of Equipment/system.

Text/ Reference Books:

1. S. Marran, "Electrical System Design and Specification Handbook for Industrial Facilities," Prentice Hall PTR, 1 Edition, 1998.
2. T. R. Bosela, "Electrical System Design," Prentice Hall, 1stEdition, 2002.
3. A. Thumannt and H. Franz, "Efficient Electrical Systems Design Handbook," Fairmont Press, 1stEdition, 2009.
4. K.B. Raina, "Electrical Design Estimating and Costing," New Age International, 2007.

<table>
<tr><td>Course Title</td><td colspan="3">Distribution Automation</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System, Power system Protection, Electrical Machines.</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the automation in the Power System</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO 1. To study Automation of Distribution System.
CO 2. To study different Control Techniques.
CO 3. To understand the issues with Automated System.
CO 4. To understand the Cost benefit Analysis.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
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<tr><td>CO 2</td><td>H</td><td>H</td><td>M</td><td>H</td><td>M</td><td>M</td></tr>
<tr><td>CO 3</td><td>H</td><td>M</td><td>H</td><td>H</td><td>M</td><td>M</td></tr>
<tr><td>CO 4</td><td>H</td><td>H</td><td>H</td><td>H</td><td>M</td><td>M</td></tr>
</table>
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</td></tr>
</table>

SUBSTATION AUTOMATION: Tools for distribution system planning and design. Substation Automation – Data acquisition from field devices and supervisory control of field devices, Substation Automation-Data acquisition from field devices and supervisory control of field devices, Different techniques of service restoration, substation reactive power control, Procedure to determine the best capacitor location, Asset Management.

FEEDER AUTOMATION: Feeder level Automation-Modern devices at Feeder level, Data acquisition from Field devices at feeder level, supervisory control of field devices, Fault location, Fault isolation, Feeder reconfiguration, feeder reactive power control. Coordinated Control of ALL devices.

CUSTOMER LEVEL AUTOMATION: Customer level Automation-automatic meter reading, Remote programming of time-of-use (TOU) meters, Remote service connect / disconnect, Automated customer claims analysis. Demand Side management, Energy Audit for energy conservation. Remote LOAD control. Home management system, Home area network

DIFFERENT CONTROL UNITS AND THEIR ISSUES: Automatic meter reading, Remote programming of time-of-use (TOU) meters, Remote service connect / disconnect Control hierarchy and

control center architecture-RTU's, IEDs, PLCs, Use of GPS and GIS systems for Asset/Facilities management. Cyber Security Issues with Automation. Resiliency improvement using Automation.

DSO role and its functions.

COST BENEFIT ANALYSIS: Cost benefit analysis of Distribution Automation Schemes-Review of distribution automation roadmaps of prominent utilities in Europe and US, Review of distribution automation in Indian utilities.

Text/ Reference Books:

1. M. S. Nardone, "Direct Digital Control Systems: Application Commissioning," Kluwer, Springer US, 1 Edition, 1999.

2. K. Peter Brand and others Substation Automation Handbook

3. M.K. Khedkar, G.M. Dhole, "Electric Power Distribution Automation," University Science Press,2010.

4. A.S.Pabla, "Electric Power Distribution,"TMH,5th Edition, 2004

<table>
<tr><td>Course Title</td><td colspan="3">HVDC Transmission</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Systems, Power Electronics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To aware the students about the concepts of High Voltage Direct Current Transmission and analyze their performance</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course students will be able to
CO1: Develop the knowledge of HVDC transmission and HVDC converters and the applicability and advantage of HVDC transmission over conventional AC transmission.
CO2: Formulate and solve mathematical problems related to rectifier and inverter control methods and learn about different control schemes as well as starting and stopping of DC links.
CO3: Develop harmonic models and use the knowledge of circuit theory to develop filters and assess the requirement and type of protection for the filters.
CO4: Study and understand the nature of faults happening on both the AC and DC sides of the converters and formulate protection schemes for the same.
CO5: Review the existing HVDC systems along with MTDC systems and their controls and recognize the need of HVDC transmission for sustainable development.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
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<tr><td>CO2</td><td>M</td><td>M</td><td>H</td><td>M</td><td>L</td><td>M</td></tr>
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<tr><td>CO4</td><td>H</td><td>M</td><td>H</td><td>M</td><td>L</td><td>M</td></tr>
<tr><td>CO5</td><td>H</td><td>L</td><td>M</td><td>M</td><td>L</td><td>H</td></tr>
</table>
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</table>

UNIT 1 – Introduction to HVDC Transmission: **(5 hours)**

Growth and developments, Comparison of AC and DC transmission, Application of DC transmission, HVDC terminals and types; Description of DC transmission system, Substation layout, Planning for HVDC transmission, Modern trends in DC transmission

UNIT 2 – HVDC converter and control characteristics: **(10 hours)**

Analysis and waveforms of HVDC converters as rectifier and inverter, delay angle, overlap angle, Number of pulses, Choice of converter configuration, Simplified analysis of Graetz circuit, 6-pulse, 12-pulse groups and their voltage waveform, Power factor of converter, VSC-HVDC principle, Power flow in HVDC link, equivalent circuit, Compound converter control characteristics; constant extinction angle, constant current, constant ignition angle, positive current margin, negative current margin, Current margin control methods, Current control at rectifier, extinction angle control at inverter, Control hierarchy; bipole controller, pole controller, valve group controller.

UNIT 3– Harmonics and filters: **(6 hours)**

Introduction, Generation of harmonics, Characteristic (2n±1) and non-characteristic (2n) harmonics, Harmonic cancellation via transformer connection, Design of AC filters, DC filters and their characteristics, AC harmonics filter calculations; impedance circle and polygon methods.

UNIT 4 –Multi-terminal HVDC (MTDC) systems: **(5 hours)**

Configurations and applications, Future MTDC using VSC for wind-farm integration, Control methods in MTDC; slave and master, VSC-HVDC protection schemes, hand shaking method in MTDC.

UNIT 4 –Fault and protection schemes in HVDC systems: **(4 hours)**

Nature and types of faults, faults on AC side of the converter stations, converter faults, fault on DC side of the systems, protection against over currents and over voltages, protection of filter units.

References:

1. K. R. Padiyar, *HVDC Power Transmission System,* Wiley Eastern Limited, New Delhi. Second Edition, 1990.
2. Edward Wilson Kimbark, *Direct Current Transmission*, Vol.-I, Wiley Interscience, New York, London, Sydney, 1971
3. Colin Adamson and Hingorani N G, *High Voltage Direct Current Power Transmission*, Garraway Limited, London, 1960.

<table>
<tr><td>Course Title</td><td colspan="3">Electric Traction and Vehicles</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Electrical Machines, Power Electronics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the students to understand and develop the electric traction system and electric vehicles</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO1: To distinguish different traction systems and to differentiate services of traction system based on speed time curve.
CO2: To control different types of traction motors
CO3: To design electric vehicle & HEV for various EV applications
CO4: To select appropriate motor and converter for EV applications
CO5: To develop various energy storage components for EV applications</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
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<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
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<tr><td>CO2</td><td>M</td><td>M</td><td>M</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO3</td><td>M</td><td>M</td><td>M</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO4</td><td>M</td><td>M</td><td>M</td><td>L</td><td>M</td><td>L</td></tr>
<tr><td>CO5</td><td>M</td><td>M</td><td>M</td><td>L</td><td>M</td><td>L</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Electric Traction Services, Nature of Traction Loads, Conventional and Modern Traction Drives, Traction Motors, Tractions Drives, Braking Systems, Semiconductor Converter Controlled drives, Induction and Synchronous motor drives, VSI/CSI drives, Polyphase ac motors for traction Drives, Diesel Electric traction, Energy Conservation, Interlocking and sequencing operations and protection.

Introduction to Alternative Vehicles, Electric Vehicles, Hybrid Electric Vehicles, Electric and Hybrid, Vehicle Components, Vehicle Mass and Performance, Electric Motor and Engine Ratings, Well-to-Wheel Analysis, EV/ICEV Comparison, Electric Vehicle Market, Vehicle Mechanics, Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion Power Velocity and Acceleration, Tire–Road Force Mechanics, Propulsion System Design

Plug-In Hybrid Electric Vehicle, Power train Component Sizing, Mass Analysis and Packaging, Vehicle Simulation, Battery Energy Storage, Batteries in Electric and Hybrid Vehicles, Battery Modeling, Traction Batteries, Battery Pack Management, Alternative Energy Storage, Fuel Cells, Ultra</td></tr>
</table>

capacitors, Compressed Air Storage, Flywheels Control of AC Machines.

Power train Components and Brakes, Cooling Systems, Vehicle Supervisory Controller, Mode Selection Strategy, Modal Control Strategies

References:

1. Sandeep Dhameja,Electric Vehicle Battery Systems, Elsevier,First Edition, 2002
2. John Fenton & Ron Hodkinson, Lightweight Electric/Hybrid Vehicle Design,Elsevier Oxford, 2000.
3. Seth Leitman, Bob Brant, Build Your Own Electric Vehicle, McGraw Hill, Third Edition, 2013.
4. Iqbal Husain,Electric and Hybrid Vehicles: Design Fundamentals, CRC Press,Second Edition, 2010.
5. MehrdadEhsani, YiminGao, and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, Second Edition 2009.

<table>
<tr><td>Course Title</td><td colspan="3">Power System Planning</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To perform power system planning with load forecasting and uncertainties.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able to
CO1:Understand and analyze the need of power system planning in a detailed manner.
CO2:Learn and develop various optimization techniques for power system planning
CO3:Understand the concepts of load forecasting and apply load forecasting in power system planning.
CO4:Perform expansion planning, reactive power planning and plan the system with uncertainties</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
<tr><td>CO1</td><td>H</td><td>H</td><td>H</td><td>L</td><td>L</td><td>L</td></tr>
<tr><td>CO2</td><td>M</td><td>M</td><td>M</td><td>L</td><td>L</td><td>M</td></tr>
<tr><td>CO3</td><td>H</td><td>H</td><td>H</td><td>L</td><td>L</td><td>H</td></tr>
<tr><td>CO4</td><td>H</td><td>H</td><td>H</td><td>L</td><td>L</td><td>M</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Introduction: Basic principles, power system elements, structures, power system study in the perspective of various time horizon, various planning issues, role of renewable energy plants. Interconnected Systems, Research trends in PSP

Economic aspects and Optimization methods: Definition and various related terms, deregulation and constant tariff scheme, cash flow concept, economic analysis by present worth method, annual cost method, rate of return method. Importance of optimization, defining an optimization problem, problem modelling, constraints and limitations, conventional approaches: LP, dynamic programming, Newton's method, Gauss method, other conventional methods, heuristic approaches: nature inspired techniques, viz., SA, ACO, GA, PSO, etc.

Load forecasting: Relevance, various load characteristics, factors affecting the load, ISOs, Demand side management, spatial load forecasting, econometric models, time-series models, and heuristic models,</td></tr>
</table>

Expansion planning (basic and advanced approaches for generation, sub-station and network expansion): Basic definition, problem description, mathematical development, constraints, required data, solution algorithm for single and multi-bus generation planning.

Reactive power planning: Introduction, voltage profile, voltage stability, parameters affecting voltage profile, resources for static and dynamic reactive power. Problem description: static resource allocation and sizing, dynamic resource allocation and sizing, mathematical solution approaches.

Uncertainties and deregulated electricity market: Introduction, uncertainties due to regulated and deregulated environment, practical issues under deregulated environment, methods to deal uncertainties PSP: expected cost criterion, min-max regret criterion, Laplace criterion, VNM criterion, Hurwicz criterion.

Power System substation planning with large scale RE penetration

References:

1. Hossein Seifi, Mohammad SadeghSepasian, *Electric power system planning: Issues, Algorithms and solutions*, Springer-Verlag Berlin Heidelberg2011
2. James Momoh and LamineMili, *Economic Market Design and Planning for Electric Power Systems*, IEEE Press series on power engineering, M E Hawary (Ed.), A John Wiley & Sons, Inc., Publication,2010
3. FawwazElkarmi and Nazih Abu-Shikhah, *Power System Planning Technologies and Applications: Concepts, Solutions,and Management,* Engineering Science Reference, IGI Global, 2010
4. Sullivan, R.L., *Power System Planning*, Heber Hill,1987.

<table>
<tr><td>Course Title</td><td colspan="3">Distributed Generation Systems</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Systems, Power Electronics</td></tr>
<tr><td>Course Aim</td><td colspan="3">To aware the students about the status and perspectives of the distributed generation (DG) in modern power systems</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able to
CO1: Perform preliminary evaluation of technical and economic potential of utilisation of renewable energy sources
CO2: Understand the basic operation, control and modelling of distributed energy sources
CO3: Understand and describe the impacts of distributed energy resources on the control and operation of electrical networks
CO4: Understand the operation and application of energy storage devices in renewable energy applications
CO5: Analyse the environmental and legal aspects of distributed energy sources for sustainable development</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
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<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
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</table>

UNIT 1 – Introduction to DG systems: **(6 Hours)**

Overview of DG based power systems, DG definition, distributed generation advantages and needs, basic models of DG systems, economic and financial Aspects of distributed generation, the regulatory environment and standards.

UNIT 2 – Generation resources: **(8 hours)**

Photovoltaic systems, Solar-thermal power generation, Wind power generation, Other renewables like geothermal, tidal, wave, etc.

UNIT 3– Effects of DG on the grid: **(6 hours)**

Stability, Supply guarantee and power quality, Issues related to bidirectional power flow on network; voltage control, system protection.

UNIT 4 –Energy storage systems: **(6 hours)**

Capacity evaluation storage for given distribution System Battery, Ultra capacitors, Flywheel, Compressed air, fuel cell. etc.

UNIT 5 – Distributed Generation Protection: **(5 hours)**

Islanding- Definition, detection approach, Protection approach, Protection schemes in DG based systems

UNIT 6 – Smart grid: **(4 hours)**

Concepts, Application of Information & Communication Technologies (ICT) in smart grid.

References:

1. A.J. Pansini, *Guide to Electrical Power Distribution Systems*, 2005, The Fairmont Press Inc.
2. Ann-Marie Borbely, Jan F. Kreider, *Distributed Generation*, 2001, CRC Press.
3. Felix A. Farret and M. Godoy Simoes, *Integration of Alternative Sources of Energy,* John Wiley and Sons, 2006.
4. Bollen, Hassan, Integration of Distributed Generation in the Power System, Wiley- IEEE Press, 2011.
5. H. Lee Willis, Walter G. Scott, *Distributed Power Generation, Planning & Evaluation*, CRC Press Taylor & Francis Group, 2000.

<table>
<tr><td>Course Title</td><td colspan="3">Electrical Safety</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Electronics, Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the basic of Automation of Distribution Systems</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able to
CO1: Summarize the basic rules of electrical safety.
CO2: Gain skills in identifying the presence of electrical hazards and implementing measures to minimize risks
CO3: Assess and provide solutions to practical problems faced by the industries.
CO4: Employ Safe Work Practices when working with and around electricity</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
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<tr><td>CO 4</td><td>M</td><td>H</td><td>M</td><td>M</td><td>M</td><td>M</td></tr>
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</td></tr>
</table>

Unit 1:

Contents: Review of electrical concept, Working principle of major electrical equipment, Typical supply situation, Standards and statutory requirements, Indian electricity acts and rules, Indian boiler acts and regulations statutory requirements from electrical inspectorate.

Unit 2:

International standards of electrical safety, Different Indian standards of electrical safety, First aid-cardiopulmonary resuscitation (CPR). Electrical hazards, Effect of electrical shock of human being, Effect of lightening current on installation and buildings, Energy leakage, Clearance and insulation, Excess energy, Current, Surges,

Unit 3:

Electrical causes of fire and explosion, Introduction To Earthing And Its Types, Advantages Of Different Types Of Earthings And Earthing For Different Systems Like Transformer, Alternators, DC Machines, Etc Importance of earthing in installation.

Unit 4:

Safety of transmission lines, substations, Transformer, circuit breakers and power control drives. National electrical safety code. General safety rules, Principles, Maintenance, Inspections.

Reference Books:

1. Krishnan, N.V., Safety Management in Industry, Jaico Publishing House, 1997.

2. Cooper W.F., Electrical Safety Engineering,3rd ed., Newnes, 2002.

3. Cadick, J., et. al., Electrical Safety Handbook, 4thed, McGraw Hill, 2013.

4. Bureau of Indian Standards, National Electrical Code 2011, Bureau of Indian Standards, New Delhi, 2011.

5. Manchanda, S.C., Manchanda"s the Indian Boilers Regulations, 1950 and the Indian Boilers Act, 1923 (Act No. V of 1923), 2nd ed., Delhi Law House, Delhi, 2009.

<table>
<tr><td>Course Title</td><td colspan="3">Active Power Conditioning</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power Electronics, Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the basics of power condition devices to improve the power quality</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able to
CO1: To introduce the wide application of power electronics in power system.
CO2: To convey the importance of power quality aspects in the distribution system and their characterization.
CO3: To discuss the conventional passive compensation methods including reactive power compensation and harmonics filter design.
CO4: To consider the various power system analytical methods useful for compensation and characterization, such as sequence components, reference frames and transformations, PQ theory etc.
CO5: To introduce the concept of power electronics based active power compensation in distribution system and design of power electronics converters.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>H</td><td>M</td><td>H</td><td>H</td><td>M</td><td>H</td></tr>
<tr><td>CO 2</td><td>M</td><td>H</td><td>M</td><td>M</td><td>M</td><td>H</td></tr>
<tr><td>CO 3</td><td>L</td><td>H</td><td>H</td><td>M</td><td>M</td><td>M</td></tr>
<tr><td>CO 4</td><td>M</td><td>H</td><td>M</td><td>M</td><td>M</td><td>M</td></tr>
<tr><td>CO5</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td><td>H</td></tr>
</table>
L=Low, M=Medium, H=High</td></tr>
<tr><td colspan="4">Introduction: Distribution and Transmission system, Power Quality issues, Application of Power Electronics in Power Systems, Custom Power (CP) and FACTS devices.

Power Quality Characterization and Analysis: Load power factor, Harmonic distortion indices, Transients, Unbalancing and symmetrical components, Voltage sag/swell and flicker indices, Power acceptability curves, Harmonic distortions limits: IEEE 519, IEC standards

Conventional Methods of Compensation: Load balancing, Capacitor banks design, higher pulse converter, Transformer connections, Harmonic filter design, Resonance effect

Reference Current Generation: Instantaneous PQ theory, Instantaneous symmetrical components, Moving average, Low pass and High pass filters, phase-locked loop (PLL)</td></tr>
</table>

Active Power Filters: Hybrid and Active Power Filters: Shunt, Series and Shunt-series active power filters, structure &control of APFs, Combination of active and passive hybrid power filters.

Custom Power Devices: Distribution static compensator (DSTATCOM), Dynamic voltage restorer (DVR), Unified power quality conditioner (UPQC):Structure, Modelling and Control

Reference Books:

1. A. Ghosh and G. Ledwich, Power Quality Enhancement using Custom Power Devices, Kluwer Academic Publisher, Boston, MA, 2002.
2. Bhim Singh, Ambrish Chandra, and Kamal Al-Haddad, Power Quality: Problems and Mitigation Techniques, Wiley, 2015.
3. G. J. Walkileh, Power Systems Harmonics, Springer Verlag, New York, 2001.
4. IEEE Standard 519-1992, IEEE recommended practices and requirements for harmonic control in electrical power systems, 1992.
5. R. C Dugan , S. Santoso, M. F. McGranaghan and H. W. Beaty, Electric Power System Quality, McGraw-Hill, New York, 2003. Page 27 of 29.
6. M. H. Rashid, Power Electronics Handbook, Elsevier, Third Edition, 2011.

Course Title	**Electrical Energy Conservation & Auditing**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Program Elective (PE-IV and PE-V)	Semester	2
Prerequisite Knowledge	Power System		
Course Aim	To teach how to conserve the energy and different aspects of Audit		
Course Outcomes (COs)	At the end of the course, students will be able to **CO1:** Explain the basics of Energy audit. **CO2:** To understand the Different equipment's used for energy Audit **CO3:** To understand the requirement of the various economic analysis. **CO4:** Computation of various economic aspect.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	H	M	H	H	M	H
CO 2	M	H	H	H	M	H
CO 3	L	H	H	H	M	M
CO 4	M	H	M	H	M	M

L=Low, M=Medium, H=High

Unit - I

Basic Principles of Energy Audit and management Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Pie charts – Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems – Principles of energy management – Initiating, planning, controlling, promoting, monitoring, reporting – Energy manager. Bureau of Energy Efficiency: Energy conservation building code, Accredited energy auditor.

Unit - II

Power Factor and energy instruments Power factor – Methods of improvement – Location of capacitors – Power factor with non linear loads – Effect of harmonics on Power factor – Numerical problems. Energy Instruments – Watt–hour meter – Data loggers – Thermocouples – Pyrometers – Lux meters – Tong testers – Power analyzer.

Unit - III

Space Heating and Ventilation – Air–Conditioning (HVAC) and Water Heating: Introduction – Heating of buildings – Transfer of Heat–Space heating methods – Ventilation and air–conditioning – Insulation–

Cooling load – Electric water heating systems – Energy conservation methods

Unit - IV

Economic Aspects and Analysis Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts). GREEN BUILDINGS: Barriers to green buildings, green building rating tools, material selection, operating energy, façade systems, ventilation systems, transportation, water treatment systems, water efficiency, building economics, Leed and IGBC codes

Unit - V

Computation of Economic Aspects Calculation of simple payback method – Net present worth method – Power factor correction – Lighting – Applications of life cycle costing analysis – Return on investment.

Reference Books :

1. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
2. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
3. Energy management hand book by W.C.Turner, John wiley and sons.
4. Energy management and conservation –k v Sharma and pvenkata seshaiah-I K International Publishing House pvt.ltd,2011.
5. http://www.energymanagertraining.com/download/Gazette_of_IndiaP artIISecI-37_25-08-2010.pdf
6. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012
7. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995

<table>
<tr><td>Course Title</td><td colspan="3">Modern Digital and Embedded Controllers</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-IV and PE-V)</td><td>Semester</td><td>2</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Digital Electronics and Micro processors</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach internal structure, operation and application of the various controllers</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO1: To explain the various micro controller available and study the structure.
CO2: To understand the basic I/O of FPGA and DSP based controllers
CO3: To understand the serial and parallel operation in DSP and FPGA controllers
CO4: To understand the operation of the PLC controllers.</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO1</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
<tr><td>CO2</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO3</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
<tr><td>CO4</td><td>High</td><td>High</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">UNIT 1: Microcontroller Basics-8-Bit and 16-bit Microcontroller Internal Block Diagram, CPU, ALU, address bus, data bus, control signals, Working Registers, SFRs, Clock and Reset circuits, Stack and use of Stack Pointer, Chip Peripheral Interfaces-Interfacing concept and design rule

UNIT 2: FPGA based controller: Architecture, logic for different operations, parallel operation, Set of inputs, FPGAs- Resource Sharing, Implementation technology – PLD's, Custom Chips, Standard Cell and Gate arrays – FPGA Architectures – SRAM based FPGAs – Permanently programmed FPGAs –FPGA logic cells, I/O block architecture: Input and Output cell characteristics, clock input, Timing. FPGA applications to power electronic systems, Gating Pulse generation for AC-AC converter, AC-DC converter, PWM generation for Buck Converter, SPWM generation
- Main design rules of an FPGA-based controller: Control algorithm refinement (design of a time continuous controller, internal delay issues, digital re-design, sampling issues, quantization issues). Architecture refinement (algorithm architecture matching, IP-modules reusability, Hardware-In-the-Loop (HIL) validation

UNIT 3: DSP based controllers: Architecture, logic for different operations, parallel operation, Set of</td></tr>
</table>

inutps, Dspace based controller

UNIT 4: Atmel AVR ATMEGA 8 Micro-controller: Introduction, Major features, Architecture, Application and programming, PLC for various control application, ladder logic.

Reference Books:

1. The 8051 Microcontroller and Embedded systems-using assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinaly,PHI,2006/pearson,2006
2. Embedded Systems Design using the TI MSP430 series, Cris Nagy, Newnes, Elsevier.

<table>
<tr><td>Course Title</td><td colspan="3">Power System Communication</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE VI)</td><td>Semester</td><td>3</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Communication Signals</td></tr>
<tr><td>Course Aim</td><td colspan="3">To learn the communication networks and protocols for power system application.</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO1:To understand the need for communication in monitoring, control and protection in transmission and distribution systems
CO2: To learn the concepts of various analog and digital modulation techniques
CO3: To understand the components of SCADA systems
CO4: To comprehend various communication protocols for the smart grid</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>H</td><td>M</td><td>M</td><td>L</td><td>L</td><td>M</td></tr>
<tr><td>CO 2</td><td>H</td><td>M</td><td>M</td><td>L</td><td>L</td><td>M</td></tr>
<tr><td>CO 3</td><td>H</td><td>M</td><td>M</td><td>L</td><td>L</td><td>M</td></tr>
<tr><td>CO 4</td><td>H</td><td>M</td><td>M</td><td>L</td><td>L</td><td>M</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
</table>

Introduction: Need of communications for the protection, control and monitoring of the transmission and distribution systems, examples include state estimation and load flow, generator dispatch, voltage and var control, outage management, and demand response.

Fundamentals of Communication Engineering: Basics of modulation and sampling; analog and digital modulation techniques; multiple access schemes; spread spectrum echniques.

SCADA: Introduction, SCADA Functional requirements and Components, General features, Functions and Applications, Benefits, Configurations of SCADA, RTU (Remote Terminal Units) Connections, Power Systems SCADA and SCADA in Power System Automation, SCADA Communication requirements, SCADA Communication protocols: Past Present and Future, Structure of a SCADA Communications Protocol, Theory of operation, installation and testing of substation LANs.

Communication Protocols for the Smart Grid: Communication data protocols such as Modbus, DNP3.0, and IEC 61850 including GOOSE and GSSE relay-to-relay messaging, Specifications, theory of operation and capabilities of RS232, RS485, 10/100 Base T and 10/100 Base F Ethernet LANs, protocols for home/building automation networks (OpenHAN, BACnet, LonWorks, and ZigBee); protocols for communication between control centers (TASE.2/ICCP); time synchronization protocols

(NTP, IRIG-B,PTP).

Data communication criterion for assessment of communication bandwith

Note: The course shall have demonstration either in the laboratory or visit to nearby power substation.

References:

1. William Stallings, *Data and Computer Communication*, PHI,1994.
2. John Gowar, *Optical Communications Systems*, PHI,1993.
3. Theodore S. Rappaport, *Wireless Communication*, Principles and Practice, IEEE Press; PH PTR,1996
4. K. Feher, *Wireless Digital Communications*, PHI,1995.
5. Wood, A. J and Wollenberg, B. F, *Power Generation Operation and Control*, 2nd Edition John Wiley and Sons,2003.
6. Green, J. N, Wilson, R, *Control and Automation of Electric Power Distribution Systems*, Taylor and Francis,2007.
7. E. Hossain, Z. Han and H.V. Poor, *Smart Grid Communications and Networking*, Cambridge University Press,2012.
8. John D Mc Donald, *Electric Power Substation Engineering*, CRC press,2001.
9. A.S. Tanenbaum, *Computer Network*,1980.
10. *Related IEEE/IEE Publications.*

Course Title	**Energy Storage Systems**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Program Elective (PE VI)	Semester	3
Prerequisite Knowledge	Power System, Electrical Machines		
Course Aim	To teach different techniques to store the electrical energy and their limitations		
Course Outcomes (COs)	At the end of the course, students will be able to **CO1:** Understand the concept of various energy storage system **CO2:** Understand the chemical effect behind the batteries **CO3:** Analyze the different batteries used in electric vehicles. **CO4:** Develop Simulation model battery storage system **CO5:** Review and describe the structure of battery management system		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	H	M	H	H	M	H
CO 2	M	H	H	H	M	H
CO 3	L	H	H	H	M	M
CO 4	M	H	M	H	M	M
CO5	H	H	H	H	H	H

L=Low, M=Medium, H=High

UNIT1:

Introduction , world/India energy storage overview/Storage Strategy/ Indian Installations, energy storage technology overview, Types and applications

UNIT2:

Introduction to electrochemistry/ electrochemical techniques for testing and standards, Electrochemical energy storage, basic of batteries and terminology, Lithium Ion batteries: components/working/raw materials/commercials systems, Advancement in battery technology, improvements in cycle life and energy density

UNIT3:

Batteries for Electrical Vehicle: standalone grid connected, sizing of batteries, redox flow batteries for large scale storage applications, Beyond lithium ion batteries Sodium Sulphate battery

UNIT 4:

Battery modelling, Introduction to battery management system, thermal management and pack Design,

battery recycling and circular economy, Novel gravity based energy storage plants, components, details and sizing. Energy system Integration with renewable energy systems.

Reference Books:

1. Handbook of lithium-ion battery pack design chemistry, components, types and terminology by Warner, John T, Elsevier.
2. Fundamentals and Application of Lithium-ion Battery Management in Electric Drive Vehicles by San Ping Jiang, Wiley.
3. Lithium ion rechargeable batteries by edited by Kazunori Ozawa, Wiley.
4. E. Lipman, A. Z. Weber, Fuel Cells and Hydrogen Production, A Volume in the Encyclopedia of Sustainability Science and Technology, Second Edition, Springer reference.
5. Modern electric, hybrid electric, and fuel cell vehicles fundamentals, theory, and design by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, CRC press

<table>
<tr><td>Course Title</td><td colspan="3">Power Plant Operation & Controls</td></tr>
<tr><td>Course Code</td><td>EE 2XXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Program Elective (PE-V I)</td><td>Semester</td><td>3</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power System</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the different operation principle and safety measures of different Power Plant</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">CO1: To teach the operation of different electrical energy generating plant
CO2: To understand the different operating constraints and their control actions
CO3: To evaluate the different the safety measures of the power plant
CO4: To evaluate the scope and feasibility of power generation from renewables</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th></tr>
<tr><td>CO1</td><td>H</td><td>H</td><td>H</td><td>M</td><td>M</td><td>M</td></tr>
<tr><td>CO2</td><td>H</td><td>H</td><td>H</td><td>H</td><td>M</td><td>H</td></tr>
<tr><td>CO3</td><td>H</td><td>H</td><td>M</td><td>M</td><td>M</td><td>M</td></tr>
<tr><td>CO4</td><td>H</td><td>H</td><td>H</td><td>H</td><td>M</td><td>H</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
</table>

UNIT 1:

Conventional Sources of electrical energy: Steam, hydro, nuclear, diesel and gas, their scope and potentialities for energy conversion. Generation : Different factors connected with a generating station, load curve, load duration curve, energy load curve, base load and peak load plants.

UNIT 2:

Thermal stations : Selection of site, size and no. of units, general layout, major parts, auxiliaries, generation costs of steam stations. Hydro stations : Selection of site, mass curve, flow duration curve, hydrograph, classification of hydro plants, types of hydro turbines, pumped storage plants.

Nuclear stations : Main parts, location, principle of nuclear energy, types of nuclear reactors, reactor control, nuclear waste disposal.

UNIT 3:

power plant process and of unit cycle principles, hazards and the appropriate precautions associated with the plant and process systems Effective communication techniques, instrumentation and control features including permissive conditions, interlocks, alarm and trip conditions, requirements for the competent, safe and reliable operation of plant, abnormal plant and process conditions and the associated incident response mechanisms

UNIT 4:

Power station control and interconnection: Excitation systems, excitation control, automatic voltage regulator action, advantage of interconnection.

UNIT 5:

Alternate energy sources: Solar, wind, geo-thermal, ocean-thermal, tidal wave, MHD and biomass. renewable sources of alternative power generation and their operational requirements

Reference Books:

1. Deshpande, M.V., Elements of Electrical Power Station Design, 5th ed.,PHI, 2013.
2. B. R . Gupta,, Generation of Electrical Energy, S. Chand, New Delhi, 2013.
3. Nag, P.K., Power Plant Engineering, 3rd ed., Tata Mc-Graw Hill Education, 2013.
4. Raja, A.K., Srivastava, A.P. and Dwivedi, M., Power Plant Engineering, New Age International Private Limited, New Delhi, 2006

Course Title	**Reliability Engineering**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Program Elective (PE VI)	Semester	3
Prerequisite Knowledge	Not available		

Basic Reliability Concepts: Review; qualitative and quantitative assessment; Reliability- definitions, concepts, indices, criteria, availability, evaluation techniques, improvements, economics, monitoring and growth.

Basic Probability theory: Concepts, permutations & combinations, Venn diagrams, rules for combining probabilities, probability distributions, practical engineering concepts; Application of binomial distribution.

Network modeling and evaluation of systems: simple and complex, partially and standby redundant systems, cut-set method, tie set method, connection matrix technique, event trees, fault trees, multi failure modes.

Probability distributions in reliability evaluation; Discrete Markov chains, Continuous Markov processes; System reliability evaluations-series/parallel systems, network reduction techniques, minimal cut set/failure modes approach, common mode failures.

RLA of equipment in power system: Residual life assessment and management.

References:

1. Roy Billinton and Ronald N. Allan, Reliability Evaluation of Engineering Systems: Concepts and Techniques, Springer New York, 1992
2. B.S. Dhillon, Reliability, Quality, and Safety for Engineers, CRC Press, Florida, 2005.
3. K.K. Aggarwal, Reliability Engineering, Springer Netherlands, 1993.
4. E. Balagurusamy, Reliability Engineering, Mcgraw Hill Education, 2002.
5. D.Elmakias, New computational methods in power system reliability. Berlin: Springer, 2008.

Course Title	**Computer Relaying for Power System Protection**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Program Elective (PE-VI)	Semester	3
Prerequisite Knowledge	Power System, Power System Protection		
Course Aim	To teach the students to implement the various digital protection schemes in power system		
Course Outcomes (COs)	At the end of the course, students will be able **CO1:**To analyze and implement various protection algorithm for computer relaying **CO2:**To understand and design Phasor Measurement Units and wide area measurement systems application in computer relaying **CO3:**To analyze and implement various transformation-based protection algorithm for computer relaying **CO4:**To implement the digital protection schemes and fault location identification schemes in microgrids and transmission system		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	H	H	H	L	M	H
CO 2	H	H	H	L	M	H
CO 3	H	H	H	L	M	H
CO 4	H	H	H	L	M	H
CO5	H	H	H	L	M	H

L=Low, M=Medium, H=High

Mathematical background to protection algorithms: Finite difference techniques, Interpolation formulas: forward, backward and central difference interpolation. Numerical differentiation, Curve fitting and smoothing.

Protection algorithms: Sinusoidal wave-based algorithms: Sample and first derivative, first and second derivative, two and three sample techniques, Fourier and Walsh based algorithms: Fourier algorithm: Full cycle window algorithm, fractional cycle window algorithm. Walsh function-based algorithm. Other algorithms: Least squares-based algorithms. Differential equation-based Travelling wave-based techniques. algorithms.

Over Current relays for Distribution system. Issues with DGs, Relay Blinding, sympathetic tripping, Dual setting of OCR, Optimization techniques for relay coordination. Adaptive OCR.

Phasor Measurement Units: Introduction to Phasor measurement units (PMUS), global positioning system (GPS), Functional requirements of PMUs and PDCs, phasor estimation of nominal frequency inputs

PMU Applications: Wide Area Measurement Systems (WAMS), WAMS Applications in Smart Grid,

WAMS Based Protection Concepts, Adaptive Relaying, State estimation. System Integrated protection schemes (SIPS)

Recent advances in digital protection of power systems. New technology in microgrids. Communication protocols applied in the protection. Effect of RE penetration on protection scheme and Modification of protective scheme with RE

Signal processing techniques for protection. Intelligent protection techniques for security enhancement.

Fault location: transmission system fault location, Distribution system fault locator, Different techniques.

References:

1. A.T. Johns and S.K. Salman, Digital Protection for Power Systems, Peter Peregrinus Ltd. on behalf of the IEE London U.K.,1995
2. Arun G. Phadke and J.S. Thorp, Computer Relaying for Power Systems, John Wiley and Sons Ltd. England and Research Studies Press Ltd,2009
3. *A.G. Phadke, J.S. Thorp, 'Synchronized Phasor Measurements and Their Applications', Springer Publications, 2008*
4. Badri Ram and D.N. Vishvakarma, Power System Protection and Switchgear, TMH, New Delhi,2001.
5. Y.G. Paithankar, and S.R. Bhide, Fundamentals of Power System Protection, 2nd Edition, PHI Pvt. Limited, New Delhi, 2013
6. Areva, Network Protection Application Guide,1966.

Course Title	**Advanced Digital Control**		
Course Code	**EE 2XXXX**	Credit	4
Core/ Elective	Program Elective (PE-VI)	Semester	3
Prerequisite Knowledge	1. Control System 2. Signals and Systems		
Course Aim	To discuss different advanced digital control schemes and controllers.		
Course Outcomes (COs)	After completion of the course students shall be able to: **CO1:** formulate the mathematical model of digital control systems. **CO2:** determine the stability of discrete time systems using different techniques. **CO3:** design various advanced digital controllers for sampled-data control systems. **CO4:** demonstrate the design and applications of industrial and embedded digital controllers in real-time testbeds.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Low	Medium	Low	Low	Low
CO 2	Low	Medium	Medium	Low	Low	Low
CO 3	Low	Low	Medium	Low	Low	Low
CO 4	High	Medium	Medium	Low	Low	Medium

Module 1: Digital Control System

Sampled-data Control System, Components of Digital Control System: A/D Converter, Quantizer, Encoder, Hold Circuits, Ideal LP filter.

Nyquist–Shannon sampling theorem, Aliasing, Anti-aliasing filter.

Module 2: Modelling and Stability analysis using conventional approach

Z-transform revisited, Modified Z-transform, Difference equation, Pulse transfer function, Closed-loop sampled-data system, Bi-linear transformation, Impulse invariance method, Jury Stability, Routh-Hurwitz with w-plane.

Module 3: Modelling and Stability analysis using State-space approach

State-space modelling, State transition matrix, Cayley–Hamilton theorem, Discretization of Continuous Time state-space model, Lyapunov stability.

Module 4: Design of Digital Controllers

Conventional approaches: Root locus, Frequency domain design, Compensators, Dead-beat responses.

State feedback controllers, Observer-aided digital controllers, Digital LQR, Model predictive controller (MPC), Quasi-sliding mode controller (QSMC).

Filters Design: IIR, FIR

Module 5: Industrial and Embedded Controllers

SCADA, DSP-based Controllers, The Texas Instruments TMS320 DSP's, Field programmable gate array (FPGA).

Reference Books:

1. Katsuhiko Ogata, Discrete-time control systems, 2nd Edt., PHI.
2. Kuo, Digital Control System, 2nd Edt., Oxford University Press.
3. M. Gopal, Digital Control System, New Age Pub.

Course Title	**Embedded Systems**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Control System		
Course Aim	To teach the basics of Embedded System and apply embedded system on practical application		

Introduction to an Embedded systems design: Introduction to Embedded system (ES), Embedded system project management, ESD and co-design issues in system development process, design cycle in the development phase for an embedded system, use of target system or its emulator and in-circuit emulator, use of software tools for development of an ES.

RTOS & its overview: Real time operating system: Task and task states, tasks and data, semaphores and shared data operating system, services, message queues, timer function, events, memory management, interrupt routines in an RTOS environment, basic design using RTOS.

Microcontroller: Role of processor selection in embedded system (Microprocessor vs Microcontroller), 8051 Microcontroller: architecture, basic assembly language programming concepts, instruction set, addressing modes, logical operation, arithmetic operations, subroutine, interrupt handling, timing subroutines, serial data transmission, serial data communication.

Embedded System Development: Embedded system evolution trends. Round - Robin, robin with interrupts, function-one-scheduling architecture, algorithms. Introduction to assembler compiler-cross compilers and Integrated Development Environment (IDE). object oriented interfacing, recursion, debugging strategies, simulators.

Networks for Embedded Systems: The I2C Bus, The CAN bus, SHARC link ports, Ethernet, Myrinet, Internet, Introduction to Bluetooth: specification, core protocol, cable replacement protocol. IEEE 1149.1 (JTAG) Testability: boundary scan architecture.

References:

1. Raj Kamal, Embedded Systems, TMH
2. K.J. Ayala, The 8051 Microcontroller, Penram International
3. J B Peatman, Design with PIC Microcontrollers, Prentice Hall
4. David E. Simon,An Embedded Software Primer, Pearson Education
5. John Catsoulis, Designing Embedded Hardware,O'reilly,
6. Frank Vahid, Tony Givargis, Embedded System Design, John Wiley & Sons, Inc
7. Karim Yaghmour,Building Embedded Linux Systems, O'reilly
8. Michael Barr, Programming Embedded Systems,O'reilly
9. Alan C. Shaw, Real-time systems & software, John Wiley & sons, Inc

Course Title	**Fuzzy Logic and Control**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Any Engineering Specialization		
Course Aim	To teach the students to learn fuzzy logic and implement the fuzzy logic for various real time applications		

Module 1: Type-I Fuzzy Logic
Introduction to fuzzy logic, Fuzzy & Crisp Sets, Fundamental elements of fuzzy logic controllers: MFs, Rule base, Fuzzy fication, Defuzzification, Mamdani/TSK fuzzy model, Fuzzy-aided control system design and analysis.

Module 2: Type-II Fuzzy Logic
Merits and demerits over Type-I fuzzy logic, Elements of Type-II fuzzy logic, Design and applications of Fuzzy logic-II controller

Module 3: Hybrid fuzzy controller, ANFIS design and analysis, Applications to dynamical systems/estimation.

References:

1) Mendel JM. Uncertain Rule-Based Fuzzy Logic Systems: Introduction and New Directions. Prentice Hall PTR, 2001.
2) Mendel JM. Uncertain Rule-based Fuzzy Systems: Introduction and New Directions. Second Edition, Springer 2017.
3) Zadeh LA. Fuzzy sets. Inform Control 1965; 8: 338-353.

Course Title	**Optimization Techniques**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Linear algebra, Control System, Power System		
Course Aim	To teach the basic of optimization techniques		
Course Outcomes (COs)	At the end of the course, students will be able **CO1:** To introduce basic optimisation techniques. **CO2:** To understand the linear optimisation techniques and their applications. **CO3:** To understand the non-linear optimisation techniques and their applications. **CO4:** To study evolutionary based algorithms for optimisation techniques		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	High	Medium	High	High	High	Medium
CO 2	High	High	Medium	High	Medium	High
CO 3	Medium	Medium	High	High	High	Medium
CO 4	High	Medium	Medium	High	High	Medium

L=Low, M=Medium, H=High

Classical optimization techniques: Single variable optimization, multivariable optimization with constraints and without constraints, necessary and sufficient conditions.

Linear programming (LP): Two variable problems-graphical solutions, formulation of LP problems in more than two variables, standard form, Simplex algorithm, special cases-2 phase's method, Big-M method, duality and dual LP problems. Application of LP in Transportation problem-balanced and unbalanced transportation problems. Use of North West corner rule, least cost method, Vogel approximation method. Assignment problems- Hungarian method.

Non-linear programming (NLP): Philosophy of numerical methods, search methods for one dimensional problems- Fibonacci and Golden section methods. Unconstrained and constrained optimization, univariate method , Pattern search method , Steepest descent method, cutting plane method , penalty function method, basic idea of dynamic programming.

Evolutionary algorithms (EA): Genetic algorithm, particle swarm optimization, Tabu search, simulated annealing and ant colony optimization, Multi objective optimization using EA, Pareto solutions.

References:

1. S.S. Rao, Engineering Optimization: Theory and Practice. New York: Wiley. 2009.
2. K. Deb, Multiobjective Optimization using Evolutionary Algorithms. New York; Wiley. 2002.
3. G.P. Liu, J.B. Yang and J.F. Whidborne, Multiobjective Optimization and Control. PHI. 2008.
4. A. D. Belegundu, and T. R. Chandrupatla, Optimization Concepts and Applications in Engineering, Pearson Education (Singapore). 2003.
5. R. L. Rardin, Optimization in Operation Research. Prentice-Hall. 1999.
6. A. Schirisieer, Theory of linear and integer programming, John Wiley and Sons, 1986.
7. D. Leunberger, Linear and Nonlinear programming, Add. Wesley, 1984.

Course Title	**Artificial Intelligence in Engineering**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Control System		
Course Aim	To teach the application of artificial intelligence in engineering		

Basic Principles: Introduction, Experimental Evaluation: Over-fitting, Cross-Validation. Sample complexity. VC-dimension, Regularization, Theory of generalization, Bias-Variance trade off, Reinforcement Learning.

Supervised Learning: Linear and Logistic Regression, Decision Tree Learning, k-NN classification, SVMs, Ensemble learning: boosting, bagging.

Neural Network: Artificial Neural Networks: Perceptron, Multilayer networks and back propagation. Radial Basis function NN , Applications in electrical engineering

Probabilistic Models: Maximum Likelihood Estimation, MAP (Maximum a-posteriori), Bayes Classifiers, Naive Bayes. Markov Networks, Bayesian Networks, Factor Graphs, Inference in Graphical Models. Applications of probabilistic models

Unsupervised Learning: K-means and Hierarchical Clustering, Gaussian Mixture Models, PAC learning. EM algorithm, Hidden Markov Models. Applications in electrical Domain

References:

1. Tom Mitchell, Machine Learning, McGraw Hill, 1997.

2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer 2006.

3. Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, John Wiley & Sons, 2006.

4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer 2009.

<table>
<tr><td>Course Title</td><td colspan="3">Expert Systems</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective (PE III)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Power electronics, Electrical Machines</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO1: To use basic concepts of expert systems
CO2: Implement a rule-based expert system and Evaluate Expert System tools
CO3: Apply knowledge representation and Design a knowledge base
CO4: To Use and apply fuzzy logic in various control applications</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 2</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 3</td><td>Low</td><td>High</td><td>High</td><td>High</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>Medium</td></tr>
<tr><td>CO5</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td><td>High</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">Introduction, Expertise and Heuristic knowledge, knowledge based systems, Structure of knowledge based systems, Logic and automated reasoning, Predicate logic, logical inference, Resolution, Truth maintenance systems, Rule based reasoning, Forward chaining , Backward chaining, Rule based architectures, conflict resolution schemes, Associative networks, Frames and Objects, uncertainty management, Baynesian approaches, Certainty factors, Dempeter-Shefer theory of Evidence, Fuzzy sets and Fuzzy logic, knowledge Acquisition search strategies and matching techniques. Inference based knowledge generation.

References:
1) Peter Jackson, "Introduction to expert systems," Addison-Wesley, 3 edition, 1998.
2) Archino .J. Gonzalez Douglas D. Dankel and Douglas D. Dankel II, "The Engineering of knowledge based systems," Prentice Hall, 1993.
3) Dan W. Patterson, "An introduction to artificial intelligence and expert systems," Prentice Hall, 1990.
4) Sasikumar et aL., "Rule based expert systems," Narosa Publishing, 1996.
5) Janusz S. Kowal ik; "Knowledge based problem solving," Prentice Half, I?86.
6) Frederick Hayes-Roth, Donald A. Waterman and Douglas B. Lenat, "Building expert systems," Addison-Wesley Longman Publishing Co., Inc. Boston, MA, USA, 1983</td></tr>
</table>

Course Title	**Robotics and Automation**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Control System		

UNIT 1:

Introduction: Past, Present & Future; Robot Terminology; Applications, Components and Subsystems; Classification of Robot etc. End Effectors, Different types of grippers and their design concepts etc. Motion Analysis: Homogeneous transformations as applicable to rotation and translation – problems.

UNIT 2:

Robot Kinematics: Specifications of matrices, D-H notation joint coordinates and world coordinates, Forward and inverse kinematics – problems. Differential transformation and manipulators, Jacobians – problems

Dynamics: Lagrange – Euler and Newton – Euler formations – Problems.

UNIT 3:

Trajectory Planning: Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion, straight line motion–Robot programming, languages and software packages. Robot actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors etc.

UNIT4:

Automation : Introduction, Types of systems - mechanical, electrical, electronics, fluidics; Hydraulics Systems and components; Pneumatic Systems Control; Applications of relays/switches; Measuring systems, Transducers; Programmable controllers; Automatic orientation and assembly; Design of components for assembly. Cost considerations and case studies. design and operation of automatic systems-Pneumatic Controls, Electropneumatic Controls, Programmable Logic Controller (PLC) etc.

References:

1. Robotics and Control by Mittal R.K Mittal and I.J. Nagrath,TMH

2. Introduction to Robotics, Analysis, Systems, Applications by Saeed B. Niku, PHI Publications.

3. CAM and Automation by M.P. Groover, PHI Learning

4. Robotics –Control, sensing, TMH

5. Robotics Fundamental concepts and analysis, Ghosal Ashitava, Oxford

6. Robotics Technology and Flexible Automation by S.R. Deb and S. Deb S., " Tata McGraw Hill Education Pvt. Ltd, 2010.

7. Introduction to Robotics by John J. Craig, Pearson

Course Title	**Research Methodology**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Any Engineering Specialization		
Course Aim	To teach the students how to perform the analysis and write technical papers		

Introduction: A quick glance on research, Conceptualizing a research design Reviewing the literature.

Formulating a Research Problem: Identifying variables, Constructing hypotheses, Establishing the validity and reliability, Constructing an instrument for data collection, Measurement and Scaling Techniques, Sampling Fundamentals, Methods of Data Collection, Defining the Research Problem.

Developing a research plan and writing and presenting a research proposal (Mid-sem Exam). Experimentation.

Processing data: Analysing Data, Analysis of Variance and Covariance, Testing of Hypotheses, Multivariate Analysis Techniques, Chisquare Test, Displaying data. Research methodology and practice evaluation.

Writing and presentation of a research report (End Sem Exam).

References books

1. Research Methodology: Methods and Techniques, C R Kothari.

<table>
<tr><td>Course Title</td><td colspan="3">Digital Signal Processing</td></tr>
<tr><td>Course Code</td><td>EE XXXXX</td><td>Credit</td><td>4</td></tr>
<tr><td>Core/ Elective</td><td>Elective (PE III)</td><td>Semester</td><td>1</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="3">Signal Systems</td></tr>
<tr><td>Course Aim</td><td colspan="3">To teach the different signal processing techniques</td></tr>
<tr><td>Course Outcomes (COs)</td><td colspan="3">At the end of the course, students will be able
CO1: To understand the different frequency domain analysis.
CO2: To understand the Signal detection, modulation techniques, frequency translation.
CO3: To learn the Issues involved in DSP processor design-speed
CO4: To study the applications using DSP Processor</td></tr>
<tr><td>Mapping of COs with POs</td><td colspan="3">
<table>
<tr><th></th><th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th></tr>
<tr><td>CO 1</td><td>High</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 2</td><td>High</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>High</td></tr>
<tr><td>CO 3</td><td>Medium</td><td>Medium</td><td>High</td><td>High</td><td>High</td><td>Medium</td></tr>
<tr><td>CO 4</td><td>High</td><td>Medium</td><td>Medium</td><td>High</td><td>High</td><td>Medium</td></tr>
</table>
L=Low, M=Medium, H=High
</td></tr>
<tr><td colspan="4">DFT- Walsh- Hadamard transforms, discrete convolution and correlation, FFT algorithms, Digital filters-flow graph and Matrix representation, IIR and FIR filter design, Signal processing algorithm, waveform generation, Quadrature signal processing, Signal detection , modulation techniques, frequency translation, over ranging, Issues involved in DSP processor design-speed, cost, accuracy, pipelining, parallelism, quantization error, etc., Key DSP hardware elements - Multiplier, ALU, Shifter, Address Generator, etc., Software development tools-assembler, linker and simulator, Applications using DSP Processor - spectral analysis.

References:
1. V. Oppenheim and R. W. Schafer, Digital Signal Processing. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1975.
2. A. Bateman and W. Yates, Digital signal processing design, W H Freeman & Co, 1989.
3. A. Antoniou, Digital filters analysis and design, McGraw-Hill Science/Engineering/Math; Second Edition, USA, 2000.</td></tr>
</table>

Course Title	**Linear Algebra**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Any Engineering Specialization		

Algebraic Structures: Sets, functions, Group, homomorphism of groups, Ring, Field, Vector Space, Subspaces, direct sum, metric space, inner product space, Lp space, Banach Space, Hilbert Space. Linear independence, basis, dimension, orthonormal basis, finite dimensional vector spaces, isomorphic vector spaces, Examples of finite and infinite dimensional vector spaces, RN , CN .

Linear Transformations: Linear Transformations, four fundamental subspaces of linear transformation, inverse transformation, rank nullity theorem, Matrix representation of linear transformation, square matrices, unitary matrices, Inverse of a square matrix, Change of basis, coordinate transformation, system of liner equations, existence and uniqueness of solutions, projection, least square solution, pseudo inverse.

Matrix Methods and Transforms: Eigen values, Eigen vectors, Generalized Eigen vectors, Diagonalizability, orthogonal diagonalization, Symmetric, Hermitian and Unitary matrices (transformations), Jordan canonical form, Fourier basis, DFT as a linear transformation, Translation invariant linear transformation, wavelet basis, wavelet transforms.

References:

1. G. F. Simmons, Topology and Modern Analysis, McGraw Hill

2. Frazier, Michael W. An Introduction to Wavelets through Linear Algebra, Springer Publications.

3. Hoffman Kenneth and Kunze Ray, Linear Algebra, Prentice Hall of India.

Course Title	**Virtual Instrumentation**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	EMMI, Control System		
Course Aim	To teach the students about virtual instrumentation and its applications.		
Course Outcomes (COs)	At the end of the course, students will be able **CO 1:** Appreciate the difference between conventional and virtual instrumentation and the pros and cons of both. **CO 2:** To perform graphical programming with various programming constructs in LabVIEW and be able to make VIs and Sub-VIs for simple and complex operations. **CO 3:** Use various data structures and various numeric and logical operations on them to do complex data processing. **CO 4:** Be familiar with various display functions for displaying output and input variables. **CO 5:** Be able to use data acquisition methods and file I/O and be familiar with various DAQ hardware and Instrumentation buses.		

Mapping of COs with POs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	Medium	High	Medium	Medium	Medium	Medium
CO 2	High	High	High	High	High	High
CO 3	High	Medium	High	High	High	High
CO 4	High	Low	Medium	High	Medium	Medium
CO 5	High	Low	High	High	High	High

L=Low, M=Medium, H=High

Introduction, Virtual instrumentation (VI) advantages, Graphical programming techniques, Data flow programming, VI's and sub VI's, Structures, Arrays and Clusters, Data acquisition methods, File I/O, DAQ hardware, PC hardware: operating systems, Instrumentation buses, ISA, PCI, USB, PXI, Instrument control, Data communication standards, RS-232C, GPIB, Real time operating systems, Reconfigurable I/O, FPGA.

References:

1. Jovitha Jerome, *Virtual Instrumentation Using Lab VIEW*, PHI Learning Pvt. Ltd, New Delhi, 2009.
2. S. Gupta and J. John, *Virtual Instrumentation Using Lab VIEW, Tata McGraw-Hill,* New Delhi, 2005.
3. R.H. Bishop, *Lab VIEW 7 Express Student Edition,* Prentice Hall, 2003.
4. National Instruments, *Lab VIEW User Manual, USA, 2003.*
5. National Instruments, *Lab VIEW Real Time User Manual, USA, 2001.*

ourse Title	**Neural Network & Deep Learning**		
Course Code	**EE XXXXX**	Credit	4
Core/ Elective	Elective (PE III)	Semester	1
Prerequisite Knowledge	Coding Skills, Linear Algebra		
Course Aim	To teach the students to obtain basic knowledge on Neural Network & Deep Learning		
Course Outcomes (COs)	At the end of the course, students will be able **CO 1:** To Model Neuron and Neural Network, and to analyze ANN learning, and its applications. **CO 2:** To perform Pattern Recognition, Linear classification. **CO 3:** To develop different single layer/multiple layer Perception learning algorithms **CO 4:** To design of another class of layered networks using deep learning principles.		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	L	L	L	L	M	H
CO 2	L	L	L	L	M	H
CO 3	L	L	L	L	M	H
CO 4	L	L	L	L	M	H

L=Low, M=Medium, H=High

Introduction to Neural Networks: Neural Network, Human Brain, Models of Neuron, Neural networks viewed as directed graphs, Biological Neural Network, Artificial neuron, Artificial Neural Network architecture, ANN learning, analysis and applications, Historical notes.

Learning Processes: Introduction, Error correction learning, Memory-based learning, Hebbian learning, Competitive learning, Boltzmann learning, credit assignment problem, Learning with and without teacher, learning tasks, Memory and Adaptation.

Single layer Perception: Introduction, Pattern Recognition, Linear classifier, Simple perception, Perception learning algorithm, Modified Perception learning algorithm, Adaptive linear combiner, Continuous perception, Learning in continuous perception. Limitation of Perception.

Multi-Layer Perceptron Networks: Introduction, MLP with 2 hidden layers, Simple layer of a MLP, Delta learning rule of the output layer, Multilayer feed forward neural network with continuous perceptions, Generalized delta learning rule, Back propagation algorithm.

Introduction to Deep learning: Neuro architectures as necessary building blocks for the DL techniques, Deep Learning & Neocognitron, Deep Convolutional Neural Networks, Recurrent Neural Networks

(RNN), feature extraction, Deep Belief Networks, Restricted Boltzman Machines, Autoencoders, Training of Deep neural Networks, Applications and examples(Google, image/speech recognition)

References:

1) Simon Haykins, "Neural Network- A Comprehensive Foundation", Pearson Prentice Hall, 2nd Edition, 1999. ISBN-13: 978-0-13-147139-9/ISBN-10: 0-13-147139-2
2) Zurada and Jacek M, "Introduction to Artificial Neural Systems", West Publishing Company, 1992, ISBN: 9780534954604
3) Vojislav Kecman,"Learning & Soft Computing", Pearson Education, 1st Edition, 2004, ISBN:0-262-11255-8.
4) M T Hagan, H B Demoth, M Beale, "Neural Networks Design", Thomson Learning, 2002. ISBN-10: 0-9717321-1-6/ ISBN-13: 978-0-9717321-1-7.
5) Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer Publisher; 1st ed. 2018 edition
6) François Chollet, "Deep Learning with Python", Manning Publisher; 1st edition, 2017

ANNEXURE-III

प्रयुक्त यांत्रिकी विभाग
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
प्रयागराज–211004 (उ0प्र0), भारत
Department of Applied Mechanics
Motilal Nehru National Institute of Technology Allahabad
Prayagraj-211004 (U.P.) India

Letter No. /AMD/F- 2022 Dated: 05/04/2022

चेयरमैन (एस.एम.पी.सी.) / Chairman (SMPC)

डी. एम. पी. सी. बैठक 05/04/2022 के कार्यवृत्त / Minutes of DMPC Meeting Dated 05/04/2022

डी. एम. पी. सी. की बैठक 05/04/2022 को 12:45 PM माइक्रोसॉफ्ट टीम्स ऑनलाइन प्लेटफार्म पर बुलाई गई जिसमे निम्नलिखित सदस्यों ने भाग लिया। / Online meeting of the DMPC was convened on 05/04/2022 at 12:45 PM using MS Teams Platform. Following members were present in the meeting.

1. Dr. A.R. Paul (Head, AMD oftg. And Chairman Ex-officio)
2. Prof. Ravi Prakash (External Member, MED)
3. Dr. Ramesh Pandey (Member)
4. Dr. Anindya Bhar (Member)
5. Dr. V.K. Patel (Member & Convener - DUGC)
6. Dr. A.K. Upadhyay (Convener)
7. Mr. Abhimanyu Singh Mertiya (Student Representative)
8. Ms. Khritika (Student Representative)

The agenda discussed and recommended by the members, are as follows.

Agenda 1: To discuss the application of Mr. Himanshu Chandra (2021EM23)

Case: Mr. Himanshu Chandra (2021EM23), M. Tech., Engineering Mechanics and Design student was not regular in the online classes in his 1st semester and could not appear in the final semester examinations due as well due to family issues. Consequently, he was ACD (Zero SPI/CPI) in the 1st semester. Further, he had paid online fees for second semester but did not inform the department or the teachers. He came to the institute in March last week as per the notification of the Dean (Academic) and requested to attend the classes for second semester.

Recommendation: The Committee deliberated on the following points of the new ordinances for Masters' programme:

Clause 9.2 says that "*A student who secures SPI less than 5.5 in the first semester shall be called ACD.* ***Such student shall be allowed to register*** *for second semester without stipend/fellowship*". Further, as per **Clause 10.2:** "*A student who has not been able to clear academic deficiency* ***at the end of second semester (as per clause 9) shall be terminated*** *from the programme*". Thus, there is no requirement of programme termination on the basis of 1st semester results. However, the student shall not be able to clear the ACD in the supplementary examination because he can take maximum three theory courses as per **Clause 8.2.4 (II)** "*A student can appear for a maximum of three Theory Courses and two Practical/laboratory Courses every year in the Supplementary Examination*".

Considering all above facts and that the registration of the student in the second semester (Even 2021-22) will not help the student to clear the academic deficiency, and in accordance with the **Clause 9.4 (i)** "*The Head of The Department and the DMPC convener shall advise the students regarding remedial actions to be undertaken to remove the academic deficiencies such as repeating a course/ replacing a course/ appearing in*

05/4/22 Abhar 05/04/2022 05/04/22 05/4/22

subsequent supplementary examination ***or repeating a semester where applicable"***, the committee recommends that:

* "The registration of Mr. Himanshu Chandra (2021EM23), M. Tech., Engineering Mechanics and Design, in the second semester (Even 2021-22) is not accepted and he will be on semester leave in the said semester as per the request made by him. Further, Mr. Himanshu Chandra (2021EM23), will register fresh in the 1st semester in the academic session 2022-23.

The meeting was concluded with a vote of thanks to the chair, as no other agenda was discussed.

Ravi 05/04/2022
(Ravi Prakash)
External Member, MED

Bawdey 05/04/22
(Ramesh Pandey)
Member

Bhar 05/04/2022
(Anindya Bhar)
Member

V.Patel 5/4/22
(V.K. Patel)
Member and Convener - DUGC

Ashutosh. 05/4/22
(A.K. Upadhyay)
Convener

Akshay Ranjan Paul 05/04/22
(A.R. Paul)
Head, oftg. and Chairman, Ex- officio

* Mr. Himanshu Chandra (2021EM23) M.Tech Engineering Mechanics and Design is recommended for semester leave in the even semester 2021-22. Chairman Senate may kindly approve the same. Further, he is recommended to register fresh in the IST semester of session 2022-23.

18-04-2022
(R.A. Mishra)
Chairman, SMPC

Chairman, Senate

chairman, senate may kindly approve the semester leave of Mr. Himanshu Chandra (2021EM23), and also permit him to register fresh in the IST semester of session 2022-23.

18-04-2022
(R.A. Mishra)
Chairman, SMPC

approved 25/4/22

Head/Convenor DMPC AMD for necessary action please.

25-4-2022

19.4.22
10.00
159

विद्या परिषद मास्टर कार्यक्रम समिति
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
प्रयागराज २११००४, उ0प्र0, भारत

Senate Master Programme Committee
Motilal Nehru National Institute of Technology Allahabad
Prayagraj – 211004 [UP] India

Minutes of the meeting of SMPC

A meeting of the Senate Master Programme Committee [SMPC] was held on 07 April, 2022 at 11.30 AM in the Conference Room of the Dean (Academic) office. Following members were present:

1. Dr. Ashutosh Kumar Upadhyay -- Convener, DMPC, AMD
2. Dr. Manish Gupta -- Convener, DMPC, MED
3. Dr. Jyotsna Sinha -- Convener, DMPC, H.S.S
4. Dr. Shashank Srivastava -- Convener, DMPC,CSED
5. Dr. Ambak Kumar Rai -- Convener, DMPC, Biotechnology
6. Dr. Manohar Yadav -- Convener, DMPC, GIS Cell
7. Dr. Dipesh Shikchand Patle -- Convener, DMPC, Chemical
8. Dr. Goutam Ghosh -- Convener, DMPC, CED
9. Prof. G.P. Sahu -- Convener, DMPC, SMS
10. Prof. Richa Negi -- Convener, DMPC, EED
11. Prof.Anjana Pandey -- Senate Nominee
12. Prof. P.K.Dutta -- Senate Nominee
13. Prof. Vijaya Bhadauria -- Chairperson, SDPC
14. Prof. R.K.Nagaria -- Outgoing Chairman, SMPC
15. Prof. R.A.Mishra -- Chairman, SMPC

Following were the resolutions of the meeting

1. The SMPC committee discussed the resolution of DMPC of Computer Science & Engineering Department about the request of Mr. Nishant Kumar (Reg No 2020CS13) for conversion of his M.Tech. Programme from full time to part time. Mr. Nishant Kumar (Reg No 2020CS13) is currently registered in M. Tech 4th Semester (Final Year). He has been selected in National Informatics Centre for the post of Scientist B. He is requesting to continue his M.Tech. Programme in Part-time mode along with the job. As per the resolution of minutes of Standing Committee held on January 03, 2022, the benefit of conversion of M.Tech. Students from full time to part time is extended to all those M.Tech. Students who have completed two semesters.

18-04-2022

In the light of above observations, the committee considers the request of the Student and recommends him to do rest of the thesis work (rest of the 4th Semester) in part time mode. Further, he has to submit a No Objection Certificate from the employer.

2. The SMPC committee discussed the resolution of DMPC of Mechanical Engineering Department about the *Application of Mr. Krishna Kumar Varma (2020PR08) for conversion of his M.Tech (full time) to M.Tech. (Part time) as he has to join Vikram Sarabhai Space Centre, Thiruvananthpuram.* Student has completed three semesters successfully and current he is in mid of the final semester. As per the resolution of minutes of Standing Committee held on January 03, 2022, the benefit of conversion of M.Tech. Students from full time to part time is extended to all those M.Tech. Students who have completed two semesters.

In the light of above observations, the committee considers the request of the student and recommends him to do rest of the thesis work (rest of the 4th Semester) in part time mode. Further, he has to submit a No Objection Certificate from the employer.

3. The SMPC committee discussed the resolution of DMPC of Applied Mechanics Department about the request of Mr. Akshansh Yadav (2020BM06), a M. Tech., Biomedical Engineering, 4th semester student who is pursuing internship with Dr. Abhishek, Associate Professor, Aerospace Engineering Department, IIT Kanpur. The student was allowed as non-degree student to work for at least one semester (15 weeks) under the mentorship of Dr. Abhishek at IIT Kanpur in compliance with modalities prescribed for proceeding as non-Degree student mentioned in the ordinance of Master's programme of the Institute. He has completed the 15 week and wishes to extend the internship for another 11 weeks for successful completion. His supervisor Dr. Abhishek Kumar Tiwari, MNNIT Allahabad is satisfied with the thesis progress of the student.

SMPC Committee recommends that the student may be allowed for extension of 11-week internship as non-degree student without fellowship. Terms and conditions regarding thesis work and other modalities will remain same as was in the previous approval.

4. The SMPC committee discussed the resolution of DMPC of Applied Mechanics Department about the request Mr. Pradeep Singh (2020EM14). The student is currently detected with Glaucoma in his right eye and has deteriorated right eye vision. Doctor has prescribed operation and 25 days post operation rest. Doctor has also warned him for loss of vision if operation is not done soon. For this purpose, the student has requested permission for work from home for this month (till 31st march, 2022). His thesis supervisor Dr. Satish Kumar informed that the progress of the student is satisfactory even after the health issues.

   As per the PG ordinances, maximum 15 days leave is possible in a year but the student has requested for 30 days leave.

   The SMPC committee recommends the leave with fellowship till 31st March, 2022 subject to submission of weekly progress report. Further, all the leaves of the student will exhaust and any leave after joining the institute will cause deduction in the fellowship as per the institute rules.

18-04-2022

5. The SMPC committee discussed the resolution of DMPC of Civil Engineering Department about application of Mr. Ankit Kumar Srivastava(Reg. No. 2020TR04) . The student has requested for "Work from Home". The student had undergone two pancreatic attack within last one year and he is not in a position to join the Institute as his liver parameters are not under the required level and he is advised to continue non-spicy, non-oily food etc. which is not possible in the hostel. In the application, Mr.Srivastava has attached his latest liver diagnosis report dated 16th March, 2022 along with all the previous medical documents.

As per the latest notification of Dean (Academic) (Notice No. 959/Acad./2021-22 dated 21.02.2022), there is no provision for grant of "Work from Home". So, the SMPC Committee recommends for Semester Leave for the Even Semester 2021-22 based on His serious health condition as per "Clause No. 5.2 of Ordinances for Masters' Programmes".

6. The SMPC committee discussed the resolution of DMPC of Civil Engineering Department about the case related to Mr. Somit Pratap Singh (Reg. No. 2021 TR17) seeking permission for leave on medical grounds. The student is suffering from jaundice and fever and requested for 2 week medical leave from 22 March, 2022.

The SMPC committee considered the case of Mr.Somit Pratap Singh and recommended to allow two week medical leave from 22 March, 2022 In accordance with "Clause No. 5.3 of Ordinances for Masters' Programmes".

The meeting ended with vote of thanks to the Chair.

18-04-2022

(R.A.Mishra)
Chairman, SMPC

Chairman Senate

As per the recommendation of SMPC dated 07-04-2022, the points 1, 2, (3) 4, 5 and 6 may please be approved.

Not approved

18-04-2022
(R.A.Mishra)

Rest are approved

Dean 19/4

Head/Convenor DMPC CSED, MED, AMD, CED, FI(Admission)
for necessary action please.

19-04-2022

विद्या परिषदमास्टर कार्यक्रम समिति
मोतीलालनेहरू राष्ट्रीयप्रौद्योगिकीसंस्थानइलाहाबाद
प्रयागराज २११००४, उ0प्र0, भारत
Senate Master Programme Committee
Motilal Nehru National Institute of Technology Allahabad
Prayagraj – 211004 [UP] India

10.6.22
5.25
745

Minutes of the meeting of SMPC

A meeting of the Senate Master Programme Committee [SMPC] was held on 30May, 2022 at 11.30AM in the Conference Room of the Dean (Academic) office. Following members were present:

1.	Dr. Ashutosh Kumar Upadhyay	--	Convener, DMPC, AMD
2.	Dr. Bireswar Paul	--	Convener, DMPC, MED
3.	Dr. Rajesh Kumar Shastri	--	Convener, DMPC, H.S.S
4.	Mr.Rajesh Tripathi	--	Convener, DMPC, CSED
5.	Dr. Ambak Kumar Rai	--	Convener, DMPC, Biotechnology
6.	Dr. Manohar Yadav	--	Convener, DMPC, GIS Cell
7.	Dr. Shalinee Shukla	--	Convener, DMPC, CED
8.	Prof. G.P. Sahu	--	Convener, DMPC, SMS
9.	Dr. Nitin Singh	--	Convener, DMPC, EED
10.	Dr. Santosh Kumar Gupta	--	Convener, DMPC, ECED
11.	Prof.Anjana Pandey	--	Senate Nominee
12.	Prof. P.K.Dutta	--	Senate Nominee
13.	Prof. Vijaya Bhadauria	--	Chairperson, SDPC
14.	Prof. R.A.Mishra	--	Chairman, SMPC

Following were the resolutions of the meeting

1. The SMPC committee discussed the resolution of DMPC of Computer Science & Engineering Department about the case of **Mr. Jogendra Prasad (Reg. No. 2021CS09)** who is currently registered in M. Tech 2nd Semester. He has been absent since March 22nd 2022 without sanctioned leave. The student has been absent for a long time without sanctioned leave. As per the new ordinance clause 5.4, long absence without sanctioned leave (as per 5.1) may result in the termination of the student's Programme on the recommendation of the DMPC and SMPC and approval of the Chairperson Senate. In light of the above observations, **the committee recommends the termination of the student from M.Tech. Programme.**

2. The SMPC committee discussed the resolution of DMPC of Electronics & Communication Engg. about the case of **Mr. Vinayak Bhor (2021SP21).** Mr. Vinayak Bhor (2021SP21) has been continuously absent without any intimation from the department since the notification of Dean (Academic) for mandatory physical presence

10-06-2022

from 22nd March 2022 onwards. Regarding his absentia, two warning letters have been sent to him through email, and registered post to his home address. He also did not appear in the 2nd semester end semester examinations and have ACD in the current semester thereof. As per clause 5.4 & clause 10.3 of Masters' Programme Ordinance (applicable to M.Tech. students 2021-2022 onwards), long absentia without sanctioned leave may lead to termination of M.Tech. programme. Also, as per clause 10.2, a student who has not been able to clear academic deficiency at the end of second semester, shall be terminated from the programme. **The Committee considered his case and recommends for the termination of M.Tech. programme of Mr. Vinayak Bhor (2021SP21) as per clause 5.4 & clause 10.2 &10.3 of Masters' Programme Ordinance.**

3. The SMPC committee discussed the resolution of DMPC of Applied Mechanics Department about the request of **Mr. Akshansh Yadav (2020BM06)**, M. Tech., Biomedical Engineering, 4th semester. The student is pursuing internship with Dr. Abhishek, Associate Professor, Aerospace Engineering Department, IIT Kanpur. The student was allowed as non-degree student to work for one semester (15 weeks) under the mentorship of Dr. Abhishek at IIT Kanpur in compliance with modalities prescribed for proceeding as non-Degree student mentioned in the ordinance of Master's programme of the Institute (Clause 6) without any waiver in academic requirements at MNNIT Allahabad. After completion of 15 weeks' duration, the student again requested for extension and was not approved. The student did not join the department but was requesting for granting for leave only and later on sent an email requesting semester leave. The committee discussed the residence requirement in such cases. The minimum residence requirement in such cases is 3 semesters as per clause 6.4 of the ordinances for Master's programme. Based on the request of the student and recommendation of the supervisor, **the committee recommends the semester leave (Even 2021-22) to Mr. Akshansh Yadav (2020BM06)** as per clause 5.2 of the ordinances.

4. The SMPC committee discussed the resolution of DMPC of Mechanical Engineering Department about the application of **Mr. Manjula Viswateja (2020PR10)** for further extension of two months' special leave for pursuing experimental analysis at ISRO Thiruvananthapuram. Candidate has already been allowed for two months' special leave (from 15 March till 15 May, 2022) for carrying out his experimental work at ISRO through Chairman, Senate as per clause 5.1.3 of M.Tech. ordinances which states that- "The students going for prescribed training, or any academic work related to the Thesis work up to maximum of 15 days, assigned by the Supervisor, recommended by Convener DMPC and approved by the HoD shall be treated as On-duty. Any such assignment for more than this period shall require prior approval of the Chairman Senate through Chairman SMPC". **The committee recommends for the extension of special leave till 30th June, 2022**. However, fellowship for the leave period may be released after joining of the student in the Institute and successful completion certification from the supervisor at ISRO.

5. The SMPC committee discussed the resolution of DMPC of Mechanical Engineering Department about the application of **Mr. Shashwat Chandra (2021TH19)**. This student has been selected for summer internship at Mercedes-Benz Research and Development Bangalore during May 30th to July 29th, 2022.The student will also get stipend from Mercedes-Benz Research and Development Bangalore during this period. **The committee recommends for doing internship at Mercedes-Benz Research and Development Bangalore. Since the candidate is getting stipend by Mercedes-Benz Research**

10-06-2022

and Development Bangalore, therefore his stipend from May 30th to July 29th, 2022 may be stopped.

6. The SMPC committee discussed the resolution of DMPC of Civil Engineering Department about the application of **Mr. Aishwary Singh (Reg. No. 2021TR20).** It was found that the student did not join the institute in physical mode from 22.03.2022 to till date. He intimated about his illness on 07.04.2022 to O.C. (M. Tech.), Transportation Engg. Subsequently, on the same day, he was informed about the leave options available to him as per the Ordinances for Master's Programme. After that, on 25.04.2022, the student applied for leave along with the medical documents in which it was found that the student had consulted the doctor on 04.04.2022 and 21.04.2022. However, there were no supporting documents of illness from 22.03.2022 to 03.04.2022. Also, for the following periods no medical proofs have been enclosed. As per the Ordinances for Master's Programme (2021-22), the student is entitled to (i) 7 days' maximum leave in a semester as per Clause No. 5.1.2 and (ii) 15 days' maximum medical leave in a academic year as per Clause No. 5.3. Therefore, **the committee recommends for Semester Leave as per Clause No. 5.2 of the Ordinances for Master's Programme.**

7. The SMPC committee discussed the resolution of DMPC of Civil Engineering Department about the case of **Mr. Rahul Kumar (Reg. No. 2021EN10), Mr. Ravikant Choudhary (Reg. No. 2021EN12) and Mr.Pavan Kumar Jaurwar (Reg. No. 2021EN23)** who were absent from the Institute from 22.03.2022 to till date. The students were intimated through email by O.C. (Environmental Engineering) regarding the same on 08.05.2022 to respond and represent their case; otherwise, as per Ordinances of M.Tech. programme (Clause 5.1 & 5.4), they will be liable to loss of financial assistantship and even face termination from the programme. Subsequently, the students were again intimated by Convener, DMPC on 11.05.2022 to represent their case. But they did not join the institute.

   The committee discussed the above cases and recommended that as per Clause Nos. 5.4 and 10 (3) of the Ordinances for Masters' Programmes, Mr. Rahul Kumar (2021EN10), Mr. Ravikant Choudhary (2021EN12) and Mr. Pavan Kumar Jaurwar (2021EN23) may be terminated from the M. Tech. Programme because of "long absence without sanctioned leave".

8. The SMPC committee discussed the resolution of DMPC of Electrical Engineering about the termination of M.Tech. programme of **Ms Shivani Kataria (2021PS17) and Ms. Alka Yadav (2021PE04).** These students are found to be absent from the department without any sanctioned leave. They were issued warning letters on 04 April, 2022 to join the department, but they did not come. Therefore, **SMPC committee recommends the termination of M.Tech. programme of Ms Shivani Kataria (2021PS17) and Ms. Alka Yadav (2021PE04) as per clause no. 5.4and 10(3) of ordinance of Master's programme.**

9. The SMPC committee discussed the resolution of DMPC of Biotechnology Department about the cases of **Adrita Saha (2021BT01), Senthamizh. R (2021BT02), Shraddha Shukla (2021BT13), Shweta Rai (2021BT14), Swati (2021BT17), Jairam Selvam (2021BT19), Victoria J (2021BT21) and Apurva Dwivedi (2021BT26)** who want to do summer training at other premier institute as a part of special study for two months.

10-06-2022

The committee found that students have spent two semesters in our institute and are eligible to proceed for training elsewhere as per clause no.6.1 of Ordinances for Master's Programmes. They have submitted acceptance letter/consents from respective host institutes to the department. Since these students are stipendiary, they shall be submitting a certificate of not receiving financial assistance from elsewhere duly signed by concerned supervisor at host institute as per clause no.6.5 of Ordinances for Master's Programmes.
Thus, the committee resolved that such training will be in the interest of students and will help in their capacity building. This will also help them to perform well in their thesis work at our institute. Hence, they may be permitted for their respective training with fellowship.

10. The SMPC committee discussed the resolution of DMPC of Mechanical Engineering Department about the application of **Mr. Vinayak Singh (2020PR23)** for conversion of his M.Tech. programme from full time to part time due to his job in BEL Bangalore. The student has completed three semesters successfully and currently he is in the final semester. **The SMPC committee considered his case and recommended the conversion of his M.Tech. programme from Full-time to Part-time as per the approval of minutes of Standing Committee Meeting held on January 03, 2022.**

11. The SMPC committee discussed the resolution of DMPC of Civil Engineering Department about the application of **Mr. Aswani Singh (2021TR06)** for withdrawal from M.Tech. programme due to selection in Border Road Organization. The committee resolved that as per clause no.14.1(3) of Ordinances for Master's Programmes, if the student is leaving the institute on his own accord without completing the programme of study, **the student may be required to refund the amount of stipend received during the Academic session in which he leaves the programme. So, for withdrawal purpose, the process of refund may be initiated.**

12. The SMPC committee discussed the resolution of DMPC of Civil Engineering Department about the case related to **Mr. Somit Pratap Singh (Reg. No. 2021TR17)** seeking permission for leave on medical grounds. The student is suffering from jaundice and fever and requested for 2-week medical leave with effect from 08 April, 2022. It was found that the student was already granted 2-week medical leave from 22 March, 2022 and as per Clause no.5.3, Ordinance for Master's programme", maximum of two weeks' medical leave can be possible in an academic year. Therefore, **the committee recommends that further extension of leave is not permitted.**

13. The SMPC committee discussed the resolution of DMPC of Civil Engineering Department about the application of **Mr. Sridhar (Reg.No.2020ST18)** regarding leave under medical ground from 22.03.2022 to 03.04.2022. The student was injured due to an accident and was under treatment during the said period. He has submitted the medical document in support of his claim. **The SMPC committee recommends that the student may be permitted for leave on medical ground from 22-03-2022 to 03-04-2022.**

The meeting ended with vote of thanks to the Chair.

Chairman Senate

As per the recommendation of SMPC dated 30-05-2022, the points 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 may please be approved.

10-06-2022
(R.A. Mishra)
Chairman, SMPC

Approved 14/06/22

10-06-2022
(R.A. Mishra)

Circulate to FI (Admission) and Concerned department for necesary action. 14/6/2022

विद्या परिषदमास्टर कार्यक्रम समिति
मोतीलालनेहरू राष्ट्रीयप्रौद्योगिकीसंस्थानइलाहाबाद
प्रयागराज २११००४, उ0प्र0, भारत
Senate Master Programme Committee
Motilal Nehru National Institute of Technology Allahabad
Prayagraj – 211004 [UP] India

12.7.22 18.7.22 330 530 1055

Minutes of the meeting of SMPC

A meeting of the Senate Master Programme Committee [SMPC] was held on 05 July, 2022 at 11.30AM in the Conference Room of the Dean (Academic) office. Following members were present:

1. Dr. Ashutosh Kumar Upadhyay	--	Convener, DMPC, AMD
2. Dr. Manish Gupta	--	Convener, DMPC, MED
3. Dr. Soni Joseph	--	Convener, DMPC, H.S.S
4. Dr. Shashank Srivastava	--	Convener, DMPC, CSED
5. Dr. Goutam Ghosh	--	Convener, DMPC, CED
6. Dr. Sahadeo Padhye	--	Convener, DMPC, Mathematics
7. Dr. Richa Negi	--	Convener, DMPC, EED
8. Dr. Santosh Kumar Gupta	--	Convener, DMPC, ECED
9. Prof.Anjana Pandey	--	Senate Nominee
10. Prof. Vijaya Bhadauria	--	Chairperson, SDPC
11. Prof. R.K.Nagaria	--	Outgoing Chairman, SMPC
12. Dr. Naresh Kumar	--	Head, Physics (Special Invitee)
13. Prof. R.A.Mishra	--	Chairman, SMPC

Following were the resolutions of the meeting

1. The SMPC committee discussed the resolution of DMPC of Computer Science & Engineering Department about the case of Ms. Shweta Baliram Rangari (2021IS37) who is a student of M.Tech (Information Security). She is currently registered in the second semester of M.Tech. According to the student's application and supporting documents, she underwent medical treatment from 04/06/2022 to 13/06/2022at Radiant Super specialty Hospital Amravati, Maharashtra (Her home town). She joined the institute on 14/06/2022 and got verified the medical documents from MNNIT Health Center. As per ordinance clause 5.3, medical leave up to a maximum of 15 days may be sanctioned for valid reasons.

   In the light of the above observations, the committee recommends the student for medical leave from 04/06/2022 to 13/06/2022.

12-07-2022
अध्यक्ष, एसएमपीसी/Chairperson, SMPC
मोतीलालनेहरूप्रौसं इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

2. The SMPC committee discussed the resolution of DMPC of Applied Mechanics Department about the request of *Ms. Sanghamitra M.S. (2021FE35)*, a M. Tech. student of Applied Mechanics Department. She has been offered a six-month internship in the M.G. Motors India Private Limited, Gujarat. Her application is recommended and forwarded by her supervisor. **The Committee recommends her to join the internship without scholarship subject to fulfil all academic requirements as per ordinance of Masters Programme of the Institute. The committee also, advised her to present the work done during internship as a special study if permitted from M.G. Motors.**

3. The SMPC committee discussed the resolution of DMPC of Applied Mechanics Department about the request of *Mr. Ankit Gupta (2021EM05)*, a M. Tech. student of Applied Mechanics Department. He has been offered a forty-four weeks' internship in the Fabheads Automation Private Limited, Chennai. **The Committee recommends and advises to identify one supervisor of Fabheads Automation Private Limited, Chennai for the joint thesis supervision. No scholarship will be provided during internship period and the student has to fulfil all academic requirements as per ordinance of Masters Programme of the Institute.**

4. The SMPC committee discussed the resolution of DMPC of Civil Engineering Department about the application of Mr. Amit Sahu (Reg. No. 2020TR02), regarding conversion of M. Tech. Programme from Full-time to Part-time. Mr. Amit Sahu has been selected for the post of Assistant Engineer (AE) in Rural Works Department (RWD).The student has completed the minimum residence period of two semesters required for conversion from full time to part time as per the approval of minutes of Standing Committee Meeting held on January 03, 2022. **Hence, the committee recommended that the student may be permitted to convert his M.Tech. programme from Full-time to Part-time. Further, he has to submit a No Objection Certificate from the employer.**

5. The SMPC committee discussed the resolution of DMPC of Mathematics Department to include B.Sc. in Mathematics and Computing as a qualifying degree for admission in M.Sc. in Mathematics and Scientific Computing. **The committee recommends to add B.Sc. in Mathematics and Computing as one of the qualifying degree for admission in M.Sc. in Mathematics and Scientific Computing at MNNIT Allahabad in addition to already existing qualifications.**

12-07-2022

अध्यक्ष, एस०एम०पी०सी०/Chairperson, SMPC
मो०नै०रा०प्रौ०सं० इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

6. The SMPC committee discussed the resolution of Department of Physics for running two year (four-semester) Master of Science (M.Sc.) in Physics programme. The Department has also passed the programme by the Board of Academics. **Hence, the SMPC committee recommends to run this programme and refers to Senate for consideration.**

The meeting ended with vote of thanks to the Chair.

12-07-2022

(R.A.Mishra)
Chairman, SMPC

Chairman Senate

As per the recommendation of SMPC dated 05-07-2022, the points 1, 2, 3, 4 and 5 may please be approved.

12-07-2022

Point number 6 is referred to Senate for consideration.

12-07-02022

अध्यक्ष, एस०एम०पी०सी०/Chairperson, SMPC
मो०ने०रा०प्रौ०सं० इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

निदेशक
मो. ने. रा. प्रौ. सं. इलाहाबाद
इलाहाबाद

विद्या परिषदमास्टर कार्यक्रम समिति
मोतीलालनेहरू राष्ट्रीयप्रौद्योगिकीसंस्थानइलाहाबाद
प्रयागराज २११००४, उ0प्र0, भारत
Senate Master Programme Committee
Motilal Nehru National Institute of Technology Allahabad
Prayagraj – 211004 [UP] India

18.7.22
12.30 pm
1093

Minutes of the meeting of SMPC

A meeting of the Senate Master Programme Committee [SMPC] was held on 14 July, 2022 at 11.30AM in the Conference Room of the Dean (Academic) office. Following members were present:

1.	Dr. Manish Gupta	--	Convener, DMPC, MED
2.	Dr. Shashank Srivastava	--	Convener, DMPC, CSED
3.	Dr. Goutam Ghosh	--	Convener, DMPC, CED
4.	Dr. Dipesh Shikchand Patle	--	Convener, DMPC, Chemical
5.	Dr. Manohar Yadav	--	Convener, DMPC, GIS Cell
6.	Dr. Sahadeo Padhye	--	Convener, DMPC, Mathematics
7.	Dr. Richa Negi	--	Convener, DMPC, EED
8.	Dr. Santosh Kumar Gupta	--	Convener, DMPC, ECED
9.	Prof. G.P.Sahu	--	Convener, DMPC, SMS
10.	Prof. Vijaya Bhadauria	--	Chairperson, SDPC
11.	Prof. R.K.Nagaria	--	Outgoing Chairman, SMPC
12.	Prof. R.A.Mishra	--	Chairman, SMPC

Following were the resolutions of the meeting

1. The SMPC committee discussed the resolution of DMPC of Applied Mechanics Department about the request of Mr. Rushikethu (2021EM17) a M. Tech. student of Applied Mechanics Department. He has been offered a six-month internship (starting from July 2022) in the Allegion India Private Limited, Bengaluru. His application is recommended and forwarded by supervisors (Dr. Abhishek Kumar and Dr. Satish Kumar).

   The Committee recommends him to join the internship without scholarship subject to fulfil all academic requirements as per Ordinances for Masters' Programme of the Institute. The committee also advises him to present the work done during internship as a special study if permitted from Allegion India Private Limited.

2. The SMPC committee discussed the resolution of DMPC of Civil Engineering Department about the application of Mr.Kumar Kamal Kishor (Reg. No. 2021TR09), regarding leave on medical ground for two

18-07-2022

weeks with effect from 06.06.2022. It is mentioned that the student has suffered from Typhoid and Malaria and the doctor has advised for two weeks bed rest. **The committee considered the case and recommended that the student may be permitted for medical leave for two weeks with effect from 06.06.2022, as per "Clause No. 5.3, Ordinance for Masters' Programmes".**

3. The SMPC committee discussed the resolution of DMPC of Civil Engineering Department about the application of Mr.Himanshu (Reg. No. 2020GE06), regarding mercy appeal for completion of thesis work. It was found that the student is in the IVth semester of his M.Tech. programme. As per O.C. (Geotechnical Engineering) and one of his thesis supervisor, the student was continuously absent from 02.03.2022 to till date. The student has mentioned that he was suffering from injury in special disc and because of that he was unable to come to the institute. However, in his medical document, it was only mentioned that the student had mild disc bulge on 29.04.2022 and there was no updated medical document.

   The committee recommends for "Semester Leave" for "Even Semester 2021-22" as per "Clause No. 5.2 of Ordinances for Masters' Programmes". Further, the student may be permitted for registration in the "Odd Semester 2022-23" for continuation of his M.Tech. thesis.

4. The SMPC committee discussed the resolution of DMPC of Civil Engineering Department about the application of Mr. Utkarsh Verma (Reg. No. 2019ST05), regarding submission of his M.Tech. thesis. The student was supposed to submit his M.Tech. thesis in December, 2021 but he did not submit. Further, he has not done registration in the even semester 2021-22.
   Considering all these points, the committee recommends him to register in this semester (even semester 2021-22) for the purpose of submission of his M. Tech. Thesis.
5. The SMPC committee discussed the resolution of Department of Electrical Engineering to revise the course structure and curriculum of M.Tech. programme (Regular) and Part time with specialization in Control and Instrumentation, Power Electronics and Drives, and Power System. The Department has also passed the programme by the Board of Academics.

   Hence, the SMPC committee recommends to revise the course structure and curriculum of all three M.Tech. programme (Regular) and Part time and refers to Senate for consideration.

The meeting ended with vote of thanks to the Chair.

18-07-2022
(R.A.Mishra)
Chairman, SMPC

Chairman Senate

As per the recommendation of SMPC dated 14-07-2022, the points 1, 2, 3, 4 may please be approved.

18-07-2022

pg. 2 The point '5' is referred to Senate for Consideration.

18-07-2022

निदेशक
मो. ने. रा. प्रौ. सं.
इलाहाबाद

अध्यक्ष, एस०एम०पी०सी०/Chairperson, SMPC
मो०ने०रा०प्रौ०सं० इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

ANNEXURE-IV

Dis
ID
Date 22.4.22 22.4.22
Time 9.30 12.00
No 200

विद्यापरिषद् डॉक्टरल कार्यक्रम समिति
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
प्रयागराज 211004, उ0प्र0, भारत
Senate Doctoral Programme Committee
Motilal Nehru National Institute of Technology Allahabad
Prayagraj – 211004 [UP] India

Minutes of the meeting of SDPC

A meeting of the Senate Doctoral Programme Committee [SDPC] was held on April 8, 2022 at 11.30 AM in the meeting room of Dean Academic office. Following members were present:

1. Dr AjayaBharti -- Convener, DDPC, AMD
2. Dr. Manisha Sachan -- Convener, DDPC, Biotechnology
3. Dr. Rakesh Kumar -- Convener, DDPC, CED
4. Prof. D. K. Yadav -- Convener, DDPC, CSED
5. Prof. S. S. Narvi -- Convener, DDPC, Chemistry
6. Dr Nitin Singh -- Convener, DDPC, EED
7. Dr. Arun Prakash -- Convener, DDPC, ECED
8. Dr. Ramji Dwivedi -- Convener, DDPC, GIS Cell
9. Dr. Mantu Mondal -- Convener, DDPC,HSS
10. Dr. Pramod Kumar Yadav -- Convener, DDPC, Maths
11. Prof. R A Mishra -- Chairman, SMPC
12. Prof. A. K. Sachan, CED -- Outgoing Chairman SDPC
13. Prof. V. K. Srivastava, ECED -- Nominee of the Senate
14. Prof. Vijaya Bhadauria -- Chairperson, SDPC

Following member could not attend the meeting due to ?

1. Dr. Suantak Kamsonlian -- Convener, DDPC, Chemical Engineering
2. Dr. D K Shukla -- Convener, DDPC, MED
3. Dr.Animesh Ojha -- Convener, DDPC, Physics
4. Dr. Tanuj Nandan -- Convener, DDPC, SMS (off)
5. Prof. Neeraj Tyagi -- Nominee of the Senate

Following are the resolutions of the meeting

Following recommendations are approved by **SDPC**

1. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Mr Shreyansh Kumar (2019 RCE06) regarding conversion of his Ph. D. program from regular to part time. He has completed the course work,

Vijaya Bhadauria 20/4/22 — 20-4-22 — 20.4.22 — 20.4.22 — 20/4/22

passed comprehensive examination, given state of art which is adjudged as satisfactory and completed residential requirement as per clause 7.1 of Doctoral Programme ordinance.

The committee approved the same as per clause 4.5 of Doctoral Programme ordinance.

2. The Committee discussed the recommendation of the DDPC of Department of Electrical Engineering on the request of Mr Anurag Sharma (2017REE04) and Mr. Chandrashekhr S regarding conversion of their Ph. D. program from regular to part time. They have completed the course work, passed comprehensive examination, given state of art which is adjudged as satisfactory and completed residential requirement as per clause 7.1 of Doctoral Programme ordinance.

   The committee approved the same as per clause 4.5 of Doctoral Programme ordinance.

3. The Committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering on the request of Mr Shailendra Puskin (2014RCS54), Ms. Nisha Pal (2016RCS05) and Mr. Sharad Nigam (2017RCS11) regarding conversion of their Ph. D. program from regular to part time. They have completed the course work, passed comprehensive examination, given state of art which is adjudged as satisfactory and completed residential requirement as per clause 7.1 of Doctoral Programme ordinance.

   The committee approved the same as per clause 4.5 of Doctoral Programme ordinance.

4. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Ms Namrata Kulsheshtha (2015RCE05), regarding three month extension for her thesis submission which is due on April 24, 2022.

   The committee approved the same as per clause no. 13.1 of Doctoral Programme ordinance.

5. The Committee discussed the recommendation of the DDPC of Department of Electronics and Communication Engineering on the request of Mr Amit Kumar Singh (2015REL02), regarding three month extension for his thesis submission which was due on March 18, 2022.

   The committee approved the same as per clause no. 13.1 of Doctoral Programme ordinance.

6. The Committee discussed the recommendation of the DDPC of GIS Cell on the request of Mr. Dinesh Kumar Azad (2014RGI01) and Mrs. Rati Shukla (2014RGI02) regarding three month extension for their thesis submission which is due on April 13, 2022 and April 14, 2022 respectively.

   The committee approved the same as per clause no. 13.1 of Doctoral Programme ordinance.

7. The Committee discussed the recommendation of the DDPC of Department of Electronics and Communication Engineering on the request of Mr. Akash Jasper (2020REL01), regarding extension of six month for delivering State of Art seminar.

   The committee approved the one time extension of maximum six months as per clause no. 10 of Doctoral Programme ordinance.

8. The SDPC deliberated on the recommendation of the DDPC of Department of Civil Engineering regarding the request of Mr. Santosh Kumar Gupta (2021RCE57) and Mr. Rajrsh Kumar Srivastava (2021RCE55) and resolved to accept the same. There is no reduction in course work.

9. The SDPC deliberated on the recommendation of the DDPC of Department of Mechanical Engineering regarding the request of Dr. Rabindra Kumar Patel, MED and Dr. Binayak Nahak, MED and resolved to accept the same.

10. The Committee discussed the item number 2 of the minutes of the DDPC of Department of Humanities and Social Sciences on the request of Ms. Kajal Srivastava (2020RHU02). In the absence of clear recommendation of DDPC the matter is reverted to the department for detailed review and clear-cut recommendation in this case.

11. The committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering on the case of Ms. Naziya Aslam (20189RCS52) regarding Course Category Change. The committee resolved that there is no provision of change in category. The department may consider her request for financial assistant for other perspective.

12. The Committee discussed the recommendation of the DDPC of Department of Electrical Engineering on the request of Mr. Ashish Kumar Sankhwar (2019REE06), regarding addition of supervisor Dr Navneet Kumar Singh, Electrical Engineering Department.

    The matter deferred for next meeting due to insufficient documents.

<u>Following recommendations are submitted to Chairman Senate for approval:</u>

13. The Committee discussed the recommendation of the DDPC of Department of Electronics and Communication Engineering on the request of Mr. Akash Jasper (2020REL01), regarding addition of external co-supervisor, Dr Sara Paiva, Assistant Professor Instituto Politecnico de Viana do Castelo, Purtgal.

    The committee considered the case and resolved to recommend the same as per clause 12.1 point no. 4 of Doctoral Programme ordinance.

14. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Ms. Savita Verma (2020RCE11), regarding addition of supervisor Dr Anubhav Rawat, Applied Mechanics Department.

The committee considered the case and resolved to recommend the same as per clause 12.1 point no. 5 of Doctoral Programme ordinance.

15. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Mr. Alok Ranjan (2021RCE02), regarding addition of supervisor Dr N. R. Rawal, Department of Civil Engineering.

    The committee considered the case and resolved to recommend the same as per clause 12.1 point no. 5 of Doctoral Programme ordinance.

16. The Committee discussed the recommendation of the DDPC of Department of Mechanical Engineering on the request of Mr. Aman Kumar Agrahari (2021RME04), regarding addition of supervisor Dr Ajay Bharti, Applied Mechanics Department.

    The committee considered the case and resolved to recommend the same as per clause 12.1 point no. 5 of Doctoral Programme ordinance.

17. The Committee discussed the recommendation of the DDPC of Department of Applied Mechanics on the request of Mr. Amiy Chandraul (2021RAM52), regarding addition of supervisor Dr Satish Kumar, Applied Mechanics Department.

    The committee considered the case and resolved to recommend the same as per clause 12.1 point no. 5 of Doctoral Programme ordinance.

18. The Committee discussed the recommendation of the DDPC of GIS Cell on the request of Mr. Sudheer Kumar Tiwari (2021RGI05), regarding addition of supervisor Dr Sonam Agarwal, GIS Cell.

    The committee considered the case and resolved to recommend the same as per clause 12.1 point no. 5 of Doctoral Programme ordinance.

19. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Mr. Ram Raj Meena (2020RCE10), regarding addition of supervisor Dr Sushil Kumar, Chemical Engineering Department.

    The committee considered the case and resolved to recommend the same as per clause 12.1 point no. 5 of Doctoral Programme ordinance.

20. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Ms. Shashi Shekhar Singh (2021RCE13), regarding addition of supervisor Dr Gautam Ghose, Civil Engineering Department.

    The committee considered the case and resolved to recommend the same as per clause 12.1 point no. 5 of Doctoral Programme ordinance.

21. The committee discussed the recommendation of the DDPC of Department of Civil Engineering on the case of Mr Mayank Singh (2019RCE52), regarding semester leave for even semester of 2021-22 on medical ground.

The committee resolved to recommend the same under clause 5.2 of Doctoral Programme ordinance.

22. The Committee discussed the recommendation of the DDPC of Department of Humanities and Social Sciences on the case of Ms. Suruchi Singhal (2021RHU05), regarding semester leave for even semester of 2021-22 to look after her mother who is suffering from cancer.

    The committee resolved to recommend the same under clause 5.2 of Doctoral Programme ordinance.

23. The committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering on the case of Ms Anuska Gupta (2021RCS04), regarding semester leave for even semester of 2021-22 on personal ground.

    The committee resolved to recommend the same under clause 5.2 of Doctoral Programme ordinance.

24. The Committee discussed the recommendation of the DDPC of Department of Electrical Engineering on the request of Mr Chhabindra Nath Singh (2015REE02), regarding extension of his Ph.D. program by one year starting from July 2021. The committee noted that the student has requested for extension of the odd 2021-22 also which is already over and the request is to be considered post facto.

    The committee considered it as special case on the basis of the recommendation of the supervisor and the DDPC of EED and resolved to recommend the extension of odd semester 2021-22 with retrospective effect and even semester 2021-22 as per clause 7.3 of Doctoral Programme ordinance.

25. The case of Mrs. Ankita Shukla (2015RGI02) is very unique in nature as the student did not register during the session 2021-22 (neither in odd semester nor in even semester). Further she has completed the maximum duration of six year in June 2021.

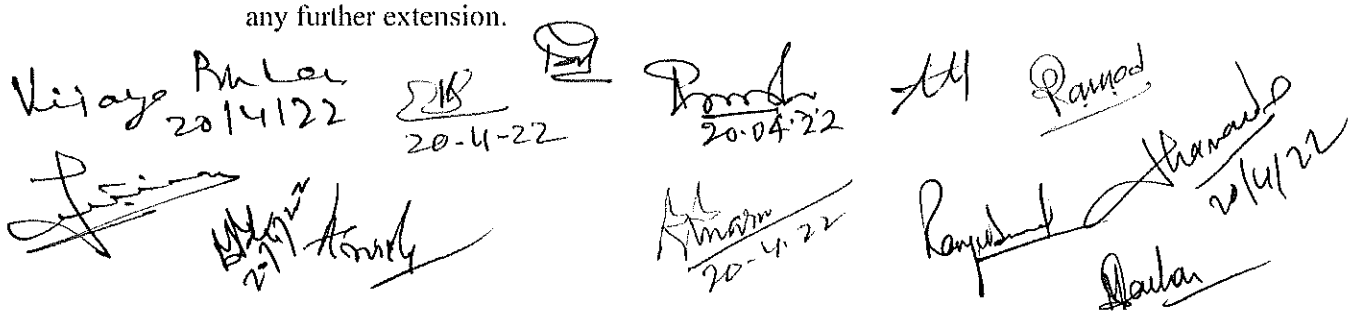
    She has submitted a request dated 6th April 2022 for permission to register in the even semester 2021-22, and extension of one year to complete the PhD programme.

    The DDPC of GIS Cell has recommended for allowing her permission for the above.

    Keeping in view the recommendation of DDPC, the SDPC has resolved to recommend the following.

    I. She may be granted leave for odd semester 2021-22. Further she may be granted leave for even semester even semester 2021-22 because, the semester is coming to an end.

    II. She may be allowed to complete her registration process in the odd semester 2022-23 and complete PhD programme by the end of session 2022-23 without any further extension.



III. This may not be treated as precedence.

26. SDPC deliberated on the recommendation of DDPC of GIS Cell and supported justification with regard to revision in eligibility criteria in PhD admission in GIS Cell and resolved to recommend the same for admission from the session 2022-23.

(Dr Ajaya Bharti)

(Dr. Manisha Sachan) 20/4/2022

(Dr. Rakesh Kumar) 20.4.22

(Prof. D. K. Yadav) 20/4/22

(Prof. S. S. Narvi) 20.4.22

(Dr Nitin Singh) 20/4/22

(Dr. Arun Prakash) 20.4.22

(Dr. Ramji Dwivedi) 20/4/22

(Dr. Meenu Mandal) 20/4/22

(Dr. Pramod Kumar Yadav) 20-04-2022

(Prof. R A Mishra) 20-4-22

(Prof. A. K. Sachan) 20/4

(Prof. V. K. Srivastava) 20-4-2022

(Prof. Vijaya Bhadauria) 20/4/22

Chairperson, SDPC

Director

The meeting of SDPC was held on 8th April 2022. Approval is solicited for the recommendation on point No. 13 to 26.

Vijaya Bhadauria 21/4/22

अध्यक्ष, एस०डी०पी०सी०/Chairperson, SDPC
मो०ने०रा०प्रौ०सं० इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

13 to 25 ok
26 is not clear
22/4/2022

ok 26/4/2022

20.5.22 23.6.22
K-25 1.0

विद्यापरिषद् डॉक्टरल कार्यक्रम समिति 5/27
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
प्रयागराज 211004, उ0प्र0, भारत
Senate Doctoral Programme Committee
Motilal Nehru National Institute of Technology Allahabad
Prayagraj – 211004 [UP] India

Minutes of the meeting of SDPC

A meeting of the Senate Doctoral Programme Committee [SDPC] was held on May 18, 2022 at 11.00 AM in the meeting room of Dean Academic office. Following members were present:

1. Dr Akshay Ranjan Paul	--	Convener, DDPC, AMD (off)
2. Dr. Manisha Sachan	--	Convener, DDPC, Biotechnology
3. Prof. Rakesh Kumar	--	Convener, DDPC, CED
4. Prof. D. K. Yadav	--	Convener, DDPC, CSED
5. Prof. S. S. Narvi	--	Convener, DDPC, Chemistry
6. Dr. Nitin Singh	--	Convener, DDPC, EED
7. Dr. Arun Prakash	--	Convener, DDPC, ECED
8. Dr. Ramji Dwivedi	--	Convener, DDPC, GIS Cell
9. Dr. Mitu Mandal	--	Convener, DDPC,HSS
10. Dr. Pramod Kumar Yadav	--	Convener, DDPC, Maths
11. Dr. Suantak Kamsonlian	--	Convener, DDPC, Chemical Engineering
12. Dr. D K Shukla	--	Convener, DDPC, MED
13. Prof. Tanuj Nandan	--	Convener, DDPC, SMS
14. Prof. R A Mishra	--	Chairman, SMPC
15. Prof. A. K. Sachan, CED	--	Outgoing Chairman SDPC
16. Prof. Neeraj Tyagi	--	Nominee of the Senate
17. Prof. V. K. Srivastava, ECED	--	Nominee of the Senate
18. Ms. Apurva Shukla (R. No. 2019RHU05)		Student member
19. Prof. Vijaya Bhadauria	--	Chairperson, SDPC

Following member did not attend the meeting

1. Dr.Animesh Ojha	--	Convener, DDPC, Physics
2. Mr. Guguloth Nagesh (R. No. 2020REE02)		Student member

Following are the resolutions of the meeting

Following recommendations are approved by SDPC

1. The Committee discussed the recommendation of the DDPC of Department of Applied Mechanics on the request of Ms Nidhi Devi (2016RAM01), regarding three month extension for her thesis submission which was due on April 14, 2022.

19/05/2022

The Committee approved the same as per clause no. 13.1 of Doctoral Programme ordinance.

2. The Committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering for allowing Mr. Rakesh Kumar Rai (2021RCS54) to opt for (Deep Learning for Visual Computing) from Nptel/ MOOC subject to complete the coursework, in accordance with clause 7.1 point no. 4 of Doctoral Programme ordinance.

   The Committee resolved to allow the same as it is permissible under the Doctoral Programme ordinance and forwarded to Dean Academic for further processing.

3. The Committee discussed the recommendation of the DDPC of Department of Electronics and Communication Engineering on the request of Ms. Meenakshi Tripathi (2020REL03), regarding extension of six month for delivering State of Art seminar from the date of her application (i.e. 17.05.2022).

   The Committee approved the one time extension of maximum six months w.e.f. 17.05.2022 as per clause no. 10 of Doctoral Programme ordinance.

4. The Committee discussed the recommendation of the DDPC of Department of Electronics and Communication Engineering on the request of Mr. Shubham Verma (2020REL07), regarding extension of six month for delivering State of Art seminar from the date of his application (i.e. 17.05.2022).

   The Committee approved the one time extension of maximum six months w.e.f. 17.05.2022 as per clause no. 10 of Doctoral Programme ordinance.

5. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Mr Gaurav Singh (2017RCE13) regarding conversion of his Ph. D. program from regular to part time. He has completed the course work, passed comprehensive examination, given state of art which is adjudged as satisfactory and completed residential requirement as per clause 7.1 of Doctoral Programme ordinance.

   The Committee approved the same as per clause 4.5 of Doctoral Programme ordinance.

Following recommendations are submitted to Chairman Senate for approval:

6. The Committee discussed the recommendation of the DDPC of Department of Electrical Engineering on the request of Mr. Ashish Kumar Sankhwar (2019REE106), regarding addition of supervisor Dr Navneet Kumar Singh, Electrical Engineering Department.

   The Committee considered the case and resolved to recommend the same as per clause 12.1 point no. 5 of Doctoral Programme ordinance.

7. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Ms. Krishna Kumar Tiwari (2021RCE06), regarding addition of supervisor Dr Pramod Soni, Civil Engineering Department.

The Committee considered the case and resolved to recommend the same as per clause 12.1 point no. 5 of Doctoral Programme ordinance.

8. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Ms. Sriparna Singh (2021RCE15), regarding addition of supervisor Dr Rama Shanker, Civil Engineering Department.

   The Committee considered the case and resolved to recommend the same as per clause 12.1 point no. 5 of Doctoral Programme ordinance.

9. The Committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering on the case of Mr. Ravi Prakash (2014RCS53), regarding semester leave for even semester of 2021-22 due to his financial and family problem.

   The Committee resolved to recommend that he may be allowed for semester leave under clause 5.2 of Doctoral Programme ordinance however he has to register himself in this semester.

10. The Committee discussed the recommendation of the DDPC of Department of Mathematics on the case of Ms Sanskriti Jain (2021RMA26), regarding semester leave for even semester of 2021-22 on medical ground.

    The Committee resolved to recommend the same under clause 5.2 of Doctoral Programme ordinance.

11. The Committee discussed the recommendation of the DDPC of School of Management Sciences on the case of Mr. Atul Pandey (2018RMS01), regarding semester leave for even semester of 2021-22 on personal ground.

    The Committee resolved to recommend the same under clause 5.2 of Doctoral Programme ordinance.

12. The Committee discussed the recommendation of the DDPC of Department of Mathematics on the request of Ms. Rupali Pandey (2018RMA02) for permission to deliver her open seminar in the month of May 2022 with a relaxation in clause 12.1.6 of Doctoral Programme ordinance as a special case as change of supervisor was necessitated due to untimely demise of Prof. Manoj Kumar.

    The Committee considered her case sympathetically and resolved to recommend the same as per clause no. 16 of Doctoral Programme ordinance.

13. A query is made during the meeting of SDPC in any other item regarding clarification on clause no. 3.4.5, Part time Scholars (programme Code-15), whether candidates applied from the organization which are having MOU with the MNNIT Allahabad also have to fulfil the condition of serving the present employer for at least 4 years continuously?

    The SDPC deliberated on this query and resolved that to uphold the spirit of MOU, if a candidate applies under programme code 15 with recommendation of an organization

with which MNNIT Allahabad has signed a Memorandum of Understanding (MOU) may be given waver from clause no 3.4.5 point no. 2.

(Dr Akshay Ranjan Paul) 19/5/22

(Dr. Manisha Sachan) 19/05/2022

(Prof. Rakesh Kumar) 19.05.22

(Prof. D. K. Yadav) 19/08/22

(Prof. S. S. Narvi) 19.5.22

(Dr Nitin Singh) 19/5/2022

(Dr. Arun Prakash) 19.05.22

(Dr. Ramji Dwivedi) 19/5/22

(Dr. Mitu Mandal) 19/5/22

(Dr. Pramod Kumar Yadav) 19/05/2022

(Dr. Suantak Kamsonlian) 19/5/22

(Dr. D K Shukla) 19-05-2022

(Prof. Tanuj Nandan) 19/05/22

(Prof. R A Mishra) 19-5-2022

(Prof. A. K. Sachan) 19/5/22

(Prof. V. K. Srivastava) 19-05-22

(Prof. Neeraj Tyagi) 19/5/22

(Prof. Vijaya Bhadauria) 19/5/22

Chairperson, SDPC

मौलाना आज़ाद राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

Chairman (Senate)

A meeting of SDPC was held on 18th May 2022. Approval may kindly be granted for point No 6 to 13. which are recommended from SDPC.

Vijaya Bhadauria 20/5/22

22/06/22

मो. ... इलाहाबाद

08.7.22
12.45
1029

विद्यापरिषद् डॉक्टरल कार्यक्रम समिति
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
प्रयागराज 211004, उ0प्र0, भारत
Senate Doctoral Programme Committee
Motilal Nehru National Institute of Technology Allahabad
Prayagraj – 211004 [UP] India

Minutes of the meeting of SDPC

A meeting of the Senate Doctoral Programme Committee [SDPC] was held on June 30, 2022 at 11.30 AM in the meeting room of Dean Academic office. Following members were present:

1. Dr. Ajaya Bharti	--	Convener, DDPC, AMD
2. Dr. Manisha Sachan	--	Convener, DDPC, Biotechnology
3. Dr. Rama Shankar	--	Convener, DDPC, CED (off)
4. Prof. D. K. Yadav	--	Convener, DDPC, CSED
5. Prof. S. S. Narvi	--	Convener, DDPC, Chemistry
6. Dr. Nitin Singh	--	Convener, DDPC, EED
7. Dr. Arun Prakash	--	Convener, DDPC, ECED
8. Dr. Sonam Agarwal	--	Convener, DDPC, GIS Cell
9. Dr. Mitu Mandal	--	Convener, DDPC,HSS
10. Dr. Pramod Kumar Yadav	--	Convener, DDPC, Maths
11. Dr. Suantak Kamsonlian	--	Convener, DDPC, Chemical Engineering
12. Dr. D K Shukla	--	Convener, DDPC, MED
13. Prof. Tanuj Nandan	--	Convener, DDPC, SMS
14. Prof. R A Mishra	--	Chairman, SMPC
15. Prof. A. K. Sachan, CED	--	Outgoing Chairman SDPC
16. Prof. Neeraj Tyagi	--	Nominee of the Senate
17. Prof. Vijaya Bhadauria	--	Chairperson, SDPC

Following member did not attend the meeting

1. Prof. V. K. Srivastava, ECED	--	Nominee of the Senate
2. Dr. Animesh Ojha	--	Convener, DDPC, Physics
3. Ms. Apurva Shukla (R. No. 2019RHU05)		Student member
4. Mr. Guguloth Nagesh (R. No. 2020REE02)		Student member

Following are the resolutions of the meeting

Following recommendations are approved by SDPC

1. The Committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering on the request of Ms Sakshi Aggarwal (2019RCS51), regarding

conversion of her Ph. D. program from regular to part time. She has completed the course work, passed comprehensive examination, given state of art which is adjudged as satisfactory and completed residential requirement as per clause 7.1 of Doctoral Programme ordinance.

The Committee approved the same as per clause 4.5 of Doctoral Programme ordinance.

2. The Committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering on the request of Ms Ashima Tyagi (2020RCS01), regarding conversion of her Ph. D. program from regular to part time. She has completed the course work, passed comprehensive examination, given state of art which is adjudged as satisfactory and completed residential requirement as per clause 7.1 of Doctoral Programme ordinance.

   The Committee approved the same as per clause 4.5 of Doctoral Programme ordinance.

3. The Committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering on the request of Mr. Abhishek Gaur (2020RCS12), regarding extension of six month for delivering State of Art seminar. His state of seminar due on 16/06/2022 as his comprehensive examination held on16/12/2021.

   The Committee approved the one time extension of maximum six months w.e.f. 16.06.2022 as per clause no. 10 of Doctoral Programme ordinance.

Following recommendations are submitted to Chairman Senate for approval:

4. The Committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering regarding permission for online classes to Mr. Mohit Kumar (2021RCS14) in the even semester 2021-22 from 02/03/2022 onwards till the end of the even semester, on humanitarian grounds. It was also informed by Convener DDPC, CSED that he had written the end semester exam in person in the Institute.

   Keeping in view the above, it is resolved that the matter may be referred to Senate/ Chairman Senate for decision on his request, post facto. Till the decision of the Competent Authority, his result for end semester examination may be withheld.

5. The Committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering regarding the termination of Mr. Neeraj Patel (2021RCS15), who was absent without sanction of leave and not responded to the mails sent by department.

   The Committee considered the case and resolved to recommend the same as per clause 5.5 of new Doctoral Programme ordinance.

6. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Mr Vibham Nayak (2021RCE16), regarding sanction of medical leave from 31.05.2022 to 14.06 2022.

The Committee considered the case and resolved to recommend the same as per clause 5.3 of new Doctoral Programme ordinance.

7. The Committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering on the request of Mr G. V. Eswara Rao (2020RCS03), regarding sanction of medical leave from 30.05.2022 to 13.06 2022.

   The Committee considered the case and resolved to recommend the same on humanitarian ground as this student is covered under old ordinance which is silent on medical leaves. However, as per clause 5.3 of new Doctoral Programme ordinance Fifteen days medical leave is permissible.

8. The Committee discussed the recommendation of the DDPC of Department of Applied Mechanics on the request of Ms. Nidhi Devi (2016RAM01), regarding extension of her Ph.D. program by one year starting from July 2022. The DDPC of Department of Applied Mechanics recommends one semester extension. The committee noted that the student has requested for extension of the one year which is recommended by both the supervisors. The student has requested first time for extension which is recommended by supervisors also.

   In view of the above the Committee considered the case and resolved to recommend one year extension to Ms. Nidhi Devi (2016RAM01), as per clause 7.3 of Doctoral Programme ordinance.

9. The Committee discussed the recommendation of the DDPC of Department of Applied Mechanics on the request of Mr. Sangharsh Kumar Singh (2016RAM04), for extension of his Ph.D. program by one year starting from July 2022.

   The Committee considered the case and resolved to recommend the one year extension to Mr. Sangharsh Kumar Singh (2016RAM04), as per clause 7.3 of Doctoral Programme ordinance.

10. The Committee discussed the recommendation of the DDPC of Department of Applied Mechanics on the request of Mr. Ram Sumukh Shukla (2014RAM04), for extension of his Ph.D. program by one semester starting from July 2022. As per the recorded minutes of DDPC, AMD, the student was admitted on 22/07/2014 as a regular student and latter converted in to part-time after approval of the same. He was granted two year extension of his PhD programme beyond 6 years (one year each time by the competent authority vide approval dated 01/07/2020 and 18/06/2021). The student is seeking one semester extension further to continue his PhD programme and his Open seminar is already scheduled on 08/07/2022 and he is likely to submit his thesis within the next semester starting from 21/07/2022.

The Committee considered the case and resolved to recommend the one semester extension to Mr. Ram Sumukh Shukla (2014RAM04), as per clause 7.3 of Doctoral Programme ordinance.

11. The Committee discussed the recommendation of the DDPC of Department of Applied Mechanics on the request of Mr. Kishor Kalauni (2016RAM07), for extension of his Ph.D. program by one year starting from July 2022..

    The Committee considered the case and resolved to recommend the one year extension to Mr. Kishor Kalauni (2016RAM07), as per clause 7.3 of Doctoral Programme ordinance.

12. The Committee discussed the recommendation of the DDPC of Department of Computer Science and Engineering on the request of the following candidates for extension of their Ph.D. program by one year / one semester starting from July 2022.

    I. Mr. Praveen Kumar (Reg.No.2013RCS03) for one year

    II. Mr. Rajit Ram Yadav (Reg.No. 2013RCS04) for one year

    III. Mr. Satya Deo Kumar Ram (Reg.No. 2015RCS11) for one semester

    IV. Ms. Garima Singh (Reg.No. 2015RCS07) for one semester

    V. Mr. Brajesh Kumar Umrao (Reg.No. 2015RCS13) for one year

    As per the recorded minutes of DDPC of CSED, the above students were already on extension (Refer. Letter No. 192/SDPC/2021, dated July 12, 2021, Letter No. 192/SDPC/2021, dated July 12, 2021, and Letter No. 192/SDPC/2021, dated July 12, 2021) however due to the current Covid-19 pandemic problem, they could not complete their research work.

    The Committee considered the above cases and resolved to recommend the one year extension to Mr. Praveen Kumar (Reg.No.2013RCS03), Mr. Rajit Ram Yadav (Reg.No. 2013RCS04) & Mr. Brajesh Kumar Umrao (Reg.No. 2015RCS13), and the one semester extension to Mr. Satya Deo Kumar Ram (Reg.No. 2015RCS11) & Ms. Garima Singh (Reg.No. 2015RCS07) as per clause 7.3 of Doctoral Programme ordinance.

    The committee considered the recommendation of DDPC of CSED regarding the application of Ms. Nisha Pal (Reg.No. 2016RCS05) and Ms. Sunita Jalal (Reg.No. 2016RCS07) for one year and one semester extension respectively. They have completed six years of their PhD program in the academic year 2021-22. The Committee considered their cases and resolved to recommend the one year extension to Ms. Nisha Pal (Reg.No. 2016RCS05) and one semester extension to Ms. Sunita Jalal (Reg.No. 2016RCS07) as per clause 7.3 of Doctoral Programme ordinance.

2. The committee reviewed and considered the Mercy appeal of Mr. Ravi Prakash (Reg No. 2014RCS53) duly recommended by the supervisors, convener DDPC and Head of the department of CSED.

The student had not registered in the even semester 2021-22 and subsequently applied for semester leave on 21/04/2022 which was recommended by DDPC of CSED on the same date.

The SDPC in the meeting dated 18/05/2022,considered his application and recommendation of DDPC of CESD and resolved that 'he may be allowed for semester leave under clause 5.2 of Doctoral Programme ordinance however he has to register himself in this semester'.

Subsequently the student has submitted a mercy appeal for grant of semester leave without fulfilling the requirement of registration fee on the ground of his poor financial condition.

The committee resolved that the chairman senate may consider his appeal sympathetically and may grant his mercy appeals a special case.

However, it is further resolved that the students must be careful with regard to registration formalities within stipulated time for registration.

13. The Committee discussed the recommendation of the DDPC of Department of Biotechnology on the request of Ms Sandhya Rai (2016RBT02), for extension of his Ph.D. program by one semester starting from July 2022..

    The Committee considered the case and resolved to recommend the one semester extension to Ms Sandhya Rai (2016RBT02), as per clause 7.3 of Doctoral Programme ordinance.

14. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Ms. Sanskriti Pandey (2021RCE56), regarding addition of supervisor, Prof. P. K. Mehtal, Department of Civil Engineering.

    The committee considered the case and resolved to recommend the same as per clause 12.1 point no. 4 and 6 of new Doctoral Programme ordinance.

15. The Committee discussed the recommendation of the DDPC of Department of Civil Engineering on the request of Ms. Pushpaanjali Verma (2021RCE54), regarding addition of supervisor, Dr. P. R. Paul, Department of Civil Engineering.

    The committee considered the case and resolved to recommend the same as per clause 12.1 point no. 4 and 6 of new Doctoral Programme ordinance.

16. The Committee discussed the recommendation of the DDPC of Department of Civil on the case of Mr. Sachin Kumar Gupta (2016RCE08), regarding semester leave for odd semester of 2021-22 due to family problem (illness of his mother). The committee noted that the student has requested for leave of the odd semester 2021-22 which is already over and the request is to be considered post facto.

The committee considered it as special case. On the basis of the recommendation of the supervisor and the DDPC of CED and resolved to recommend the semester leave of odd semester 2021-22 with retrospective effect as per clause 5.2 of Doctoral Programme ordinance.

06/07/2022
(Dr Ajaya Bharti)

06/07/2022
(Dr. Manisha Sachan)

06/07/2022
(Dr. Rama Shankar)

06/07/2022
(Prof. D. K. Yadav)

6/7/22
(Prof. S. S. Narvi)

06/07/2022
(Dr Nitin Singh)

06.07.22
(Dr. Arun Prakash)

06.07.2022
(Dr. Sonam Agarwal)

6/7/22
(Dr. Mitu Mandal)

06/07/2022
(Dr. Pramod Kumar Yadav)

06/7/22
(Dr. Suantak Kamsonlian)

06-7-2022
(Dr. D K Shukla)

06/07/22
(Prof. Tanuj Nandan)

06-7-2022
(Prof. R A Mishra)

6/7/22
(Prof. A. K. Sachan)

6/7/22
(Prof. Neeraj Tyagi)

6/7/22
(Prof. Vijaya Bhadauria)

Chairperson, SDPC

18/7/22

Chairman Senate

Minutes of SDPC meeting, conducted on 30th June 2022, are submitted for your consideration and approval please.

7/7/22

अध्यक्ष, एस०डी०पी०सी०/Chairperson, SDPC
मो०नै०रा०प्रौ०सं० इलाहाबाद/MNNIT Allahabad
प्रयागराज-211004 (भारत)/Prayagraj-211004 (INDIA)

ANNEXURE–V

गणित विभाग
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद, प्रयागराज
DEPARTMENT OF MATHEMATICS
MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY ALLAHABAD
PRAYAGRAJ-211004

Date: May 31, 2022

With reference to letter no. 1272/Acad./2022, dated July 01, 2022 and letter no. 190/Math./2022, dated July 04, 2022, the minutes of the meeting of "Equivalence Committee" consisting of three eminent subject experts from Central Government Institutions held on July 15, 2022 at 11:00 AM in the HOD office Department of Mathematics, MNNIT Allahabad. Following members of "Equivalence Committee" attended the meeting.

1. Dr. Gorakh Nath — Convener
   Associate Professor and Head
   Mathematics Department, MNNIT Allahabad
2. Prof. L. P. Singh — Subject expert
   Professor, Dean Students Affairs and Former Head
   Department of Mathematical Sciences,
   Indian Institute of Technology (BHU),
   Varanasi, India
   Email: lpsingh.apm@iitbhu.ac.in
3. Prof. Somesh Kumar — Subject expert
   Professor, Department of Mathematics
   Indian Institute of Technology Kharagpur, India
   Email: smsh@maths.iitkgp.ac.in
4. Prof. Ajay Shukla — Subject expert
   Professor, Department of Applied Mathematics and Humanities,
   Sardar Vallabhbhai National Institute of Technology, Surat, India
   Email: aks@amhd.svnit.ac.in

The convener extended a warm welcome to the members of Equivalence Committee and thanked them for attending the Equivalence Committee meeting. The recommendation of the Equivalence Committee on agenda item is as follows:

गणित विभाग
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद, प्रयागराज
DEPARTMENT OF MATHEMATICS
MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY ALLAHABAD
PRAYAGRAJ-211004

Agenda: To examine the course curriculum of the M.Sc. (Mathematics and Scientific Computing) programme offered by the Department of Mathematics, MNNIT Allahabad and evaluate its equivalence with Two Year M.Sc. (Mathematics) P.G. course offered by other Indian Universities/Institutes.

Recommendations: The Equivalence Committee examined the course curriculum of the M.Sc. (Mathematics and Scientific Computing) programme offered by the Department of Mathematics, MNNIT Allahabad. The committee was of the view that this course is equivalent to Two Year M.Sc. (Mathematics) P.G. course offered by other Indian Universities/Institutes.

(L. P. Singh) 15/07/2022

(Somesh Kumar) 15/7/22

*(Ajay Shukla)

(Gorakh Nath) 15/7/2022

online
* Prof. Ajay Shukla attended the meeting and his concern to the minutes annexed.

MNNIT WEBMAIL

Head Maths Department <hmathd@mnnit.ac.in>

Equivalence committee minutes , Seating charge and Proforma for Direct payment and transfer of amount

3 messages

Head Maths Department <hmathd@mnnit.ac.in> Fri, Jul 15, 2022 at 4:35 PM
To: aks@amhd.svnit.ac.in

Dear Sir
Please find herewith the Equivalence committee meeting minutes held in online/offline mode today and bill for seating charge. You are requested to return the signed copy of the minutes and bill.
With regards
G Nath

--

hmathd@mnnit.ac.in

3 attachments

Proforma_Sitting_Charge.pdf
190K

Minutes.pdf
671K

Proforma Direct payment and transfer.docx
30K

Dr. A. K. Shukla SVNIT <aks@amhd.svnit.ac.in> Sat, Jul 16, 2022 at 3:16 PM
To: Head Maths Department <hmathd@mnnit.ac.in>

Dear Dr.Gorakhnath Ji,
PLease find herewith attached duly signed minutes of meeting.
With kind regards,
yours Sincerely,
Ajay Shukla

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IF YOU SALUTE YOUR DUTY ,YOU NEED NOT TO SALUTE ANY BODY, BUT IF YOU POLLUTE YOUR DUTY , YOU HAVE TO SALUTE EVERY BODY.

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S. V. National Institute of Technology,
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गणित विभाग
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद, प्रयागराज
DEPARTMENT OF MATHEMATICS
MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY ALLAHABAD
PRAYAGRAJ-211004

Agenda: To examine the course curriculum of the M.Sc. (Mathematics and Scientific Computing) programme offered by the Department of Mathematics, MNNIT Allahabad at equivalent to two year M.Sc. Mathematics PG programme of Indian Universities/ Institutes.

Recommendations: The Equivalence Committee examined the course curriculum of the M.Sc. (Mathematics and Scientific Computing) offered by the Department of Mathematics, MNNIT Allahabad. The committee found the M.Sc. (Mathematics and Scientific Computing) programme equivalent to two year M.Sc. (Mathematics) PG programme offered in the Indian universities/ institutes.

(U. P. Singh)

Somesh Kumar 15/7/22
(Somesh Kumar)

Ajay Shukla
15.VII.2022
(Ajay Shukla)

Prof. Ajay Shukla attended the meeting online and his comments were incorporated.