Minutes of the meeting of the Senate of MNNIT, Allahabad held on 21.02.2007 (Wednesday) at 3.30 P.M. in the Conference Room of the Institute. (First Senate meeting in 2007)

Following members were present:

1.	Prof. A. B. Samaddar	Chairman
2.	Prof. B.D. Chaudhary	Member
3.	Prof. Krishna Kant	"
4.	Prof. S.K. Agrawal	"
5.	Prof. Satya Sheel	"
6.	Prof. A.K. Misra	"
7.	Prof. T.N. Sharma	"
8.	Prof. V. K. Nema	"
9.	Prof. R. K. Srivastava, CED	"
10.	Prof. P. R. Agarwal	"
11.	Prof. Raghuvir Kumar	"
12.	Prof. S.C. Prasad	"
13.	Prof. R.C. Mehta	"
14.	Prof. P. K. Mishra	"
15.	Prof. Sudarshan Tiwari	"
16.	Prof. Nirjhar Roy	"
17.	Prof. Triloki Nath	"
18.	Prof. Rakesh Mathur	"
19.	Prof. S. K. Duggal	"
20.	Prof. K. M. Gupta	"
21.	Prof. Dinesh Chandra	"
22.	Prof. Vineeta Agarwal	"
23.	Prof. Peetam Singh	"
24.	Prof. Rajeev Tripathi	"
25.	Prof. M. M. Gore	"
26.	Prof. K.K. Shukla	"
27.	Prof. Rakesh Narain	"
28.	Prof. Anuj Jain	"
29.	Dr. P. K. Dutta	"
30.	Dr. Sanjay Chaubey	"
31.	Dr. Geetika	"
32.	Dr. Neeraj Bancrji	"
33.	Prof. Binayak Rath	"
34.	Sri R.P. Tiwari	Registrar/Secretary

Special Invitees

1. Dr. R. K. Tripathi, Dy. Dean (A.A.)
2. Sri Sarvesh Kr. Tiwari, D.R. (Acad)

The Chairman welcomed the members of the Senate & thanked them for taking their time out to attend the meeting.

The following resolutions were passed in the Senate:

1. The minutes of the meetings of the Senate held on 24-08-2006 and 09-11-2006 were confirmed.
2. The Senate considered the Action Taken Report for the decisions taken in the Senate meeting (24-08-2006). It was resolved that the Action Taken Report should also include the date of the meetings in which the decisions were taken.

3. (a) The Senate considered the reports of the examiners and the reports of the oral boards for the following Ph.D. students and approved the award of Ph.D. degree on the basis of recommendations of examiners and oral boards.

S. No.	Name of the Student	Enrol. No.	Department
1.	Mr. Neeraj Pandey	04RMS05	School of Management Studies
2.	Ms. Piyali Ghosh	04RMS03	School of Management Studies
3.	Mr. Anil Kumar	2003REE04	Electrical Engineering Department
4.	Mr. Hadi K. Mohammed	2002RCS01	Computer Science and Engineering Department

(b) The Senate considered the reports of the Ph.D. thesis examiners and also the viva-voce examination report of Ph.D. student, Mr. Mohit Kumar Gupta (Reg. No. 99AU929) of Civil Engineering Department and recommended for the award of Ph.D. degree to the University of Allahabad.

(c) The Senate resolved that in future, the recommendations of the Oral Board for Ph.D. should be approved by the Chairman, Senate after the oral examination and the reports of the oral boards be reported in the next Senate meeting.

4. The Senate considered the proposal submitted by the various departments for starting of new P.G. programmes (Detail course structure is placed as **ANNEXURE-I**). The decisions for the programmes are summarised below:

S. No.	Name of the programme	Department	Decision
1.	Master of Science in Mathematics and Scientific Computing	Mathematics	Approved the programme. Summer training and more electives to be included in the curriculum before the actual start of the programme
2.	M. Phil. in Applied Chemistry	Chemistry	Not approved. It was felt that a technology-oriented programme, offered perhaps in collaboration with an engineering department would be appropriate.
3.	Master of Technology in Fluids Engineering	Applied Mechanics	Approved.
4.	Master of Technology in Biomedical Engineering	Applied Mechanics	Approved.
5.	Master of Arts in Social Work	Humanities and Social Science	Approved in principle, with the change in name as **Master of Social Work**. A workshop to be organised by the department concerned to finalise the curriculum before the actual start of the programme.
6.	Master of Applied Psychology	Humanities and Social Science	The Department withdrew the proposal to take time for comprehensive course material preparation.

5. The Senate considered the syllabus for the B.Tech. Programmes in Chemical Engineering and Biotechnology.

The Senate approved the syllabus of B.Tech.-Chemical Engineering, however, suggested some fine tuning before its implementation **(ANNEXURE-2).**

The Senate approved the syllabus for Third and Fourth semester B.Tech.-Biotechnology **(ANNEXURE-3).**

6. The Senate accepted the recommendation of the Sub Committee of Urgent Academic Matters for not considering the mercy appeals of two M.Tech. students (Mr. Priyank Verma-2006CC14 and Mr. Raj Kumar Sahu-2006CC09) and their mercy appeals for continuing in the programme were rejected.

   The Senate referred the case of Mr. Surendra Yadav (2001/M.Tech./PT/CI/03) a M.Tech. student, to the same committee to examine the case in the light of the ordinance which is to be applicable for him. The recommendations would be forwarded to the Chairman, Senate for taking an appropriate decision.

7. The Senate considered and approved the classification of Ph.D. category with modifications. The modified classification for Ph.D. students is placed as **ANNEXURE-4.**

8. The Senate considered and approved the new Grading System to be adopted for UG/PG programme with modification (placed as **ANNEXURE-5**). The new grading system will be applicable for the batches admitted from the academic session 2007-08 onwards.

9. The Senate considered the fee structure of all the UG/PG programmes and suggested that there should be a maximum of 7-8 sub-heads in fee structure. For fee structure of Self-Financed Foreign candidates for Ph.D. programme, it was suggested that US$500.00 will be charged per annum as tuition fee, while for SAARC and other countries it may be fixed in line of the present norms of DASA/MEA/ICCR.

10. The Senate suggested that appropriate conversion formula for equivalence of Grade and Marks is to be considered. The following committee is constituted to recommend a formula for equivalence of grade and marks, which would forward its recommendations to the Chairman, Senate for approval.

    (1) Prof. Krishna Kant, CSED
    (2) Prof. Rakesh Mathur, AMD
    (3) Dean (Academic Affairs)

11. The Senate approved the proposal of the Department of Applied Mechanics for inclusion of M.Sc. in Chemistry/Physics/Mathematics/Biotechnology in the eligibility criteria for Ph.D. admission for the Department. The eligibility criteria for admission of Ph.D. students in Engineering with a Post Graduate degree in Applied Science as indicated in P.G. manual will also be applied for Applied Mechanics Department.

12. The Senate accepted in principle the proposal originating from DPGC of the Applied Mechanics Department for the award of Post Graduate Diploma (DMNNIT) to those M.Tech. and Ph.D. students, who will complete course work requirement and has completed at least two semesters from the date of commencement of programme, but is not in a position to complete the thesis and other requirements. The Diploma also be awarded additionally to the candidates, who would be

awarded M.Tech. and Ph.D. as it is done in several foreign universities. However, DMNNIT will be awarded on assessing the performance of the student individually on case-to-case basis on the recommendation of DPGC of the concerned department. The details of implementation will be placed by the Dean (Academic Affairs) to the Chairman, Senate for his approval.

13. The Senate approved the procedure for issuance of duplicate degree for those students who had earlier received their degrees from the Institute. The procedure is placed as **ANNEXURE-6**. The Senate also approved correction of spelling of names in a few of the previously awarded degrees, for which requests from students were received by the Dean (Academic Affairs) office. Such degrees received by the students must be returned, so as to enable the Institute to issue the corrected degree certificates to them. This procedure should be effected for such old cases where the application of the same has been received by the Dean (Academic Affairs) office.

    For issuance of degrees missed in first and second Convocations, the Senate desired that these cases be placed in the next senate meeting along with all details and complete profile of the students.

14. The Senate approved the proposal of starting the **M.Tech. by Research programme** for candidates in service/staff/research personnel and faculty members of AICTE approved Institutes. The Senate, however, desired that the programme be reviewed after two years.

15. The Senate decided that the application of Mr. Pitam Singh, Lecturer in the Department of Mathematics be assessed by the Departmental Selection Committee for admission to the Ph.D. Programme and specific recommendations be forwarded to the Chairman, Senate for a suitable decision.

16. With permission of the Chairman, the proposal for new MCA and MBA seat distribution was placed. The Senate considered and approved the following changes in eligibility criteria and seat distribution for admission to MCA Programme and the seat distribution for admission to MBA programme. The changes for MCA programme will be applicable for admission from academic session 2007-08, whereas changes for MBA programme will be applicable for admission from academic session 2008-09.

MCA	**Eligibility:** Candidates, with 60% marks (6.5/10 CGPA) in Bachelor's degree of Full Time 3 years duration from a recognized University with Mathematics / Statistics / Business Mathematics as one of the subjects in any one semester/year, both in graduation and at 10+2 level are eligible. For SC/ST candidates the percentage of marks required is 55%(6.0/10 CGPA). **Seat Distribution:** Admission to all the MCA seats would be done on all India basis as done in other post graduate programmes.
MBA	**Seat Distribution:** Admission to all the MBA seats would be done on All India Basis so as to maintain same norms of admission for all PG programmes of the Institute.

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

20.3.07
(R P Tiwari)
Registrar/Secretary

20/03/07
Chairman, Senate

Confirmed
18/05/07

ANNEXURE-1

Course Structures

of

Post Graduate Programmes

(1) Master of Science in Mathematics and Scientific Computing

(2) Master of Technology in Fluids Engineering

(3) Master of Technology in Biomedical Engineering

(4) Master of Social Work

Approved in the Senate meeting held on 21.02.2007

Master of Science

in

Mathematics and Scientific Computing

DEPARTMENT OF MATHEMATICS
MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY
ALLAHABAD

M. Sc. Program in Mathematics and Scientific Computing

About the programme:
Full time M. Sc. in Mathematics & Computing will be of four semester program. This two year programme offers an exciting opportunity to students who are interested in Mathematics and who wish to pursue courses in teaching and research. This Programme with a broad based curriculum has the following main attractive features:

The programme offers computer oriented courses and training in Mathematics. As part of an effort to learn new mathematical techniques that can be used to address regional industrial problems. "Mathematica and Mapple will be used as the main tool to deal with most of the subject matter of the M. Sc. courses being offered. These courses will include Mathematical Analysis, Statistics, Algebra, Applied Analysis, Applied Algebra-Coding Theory, Industrial Mathematics, Information Theory, Mathematical Statistical and Mechanics.

In the final semester each student will take up a project under the guidance of a faculty member. In the Project, a student explores a specific topic outside the course programme, surveys the available literature on the topic and submits a critical review in the form of a report which may also include original theoretical results and/or results of experimental work. This process provides an initiation into mathematical research and also equips the student with the skills of presentation of research/technical literature.

Eligibility Conditions: A candidate having Bachelor's degree with minimum 60% marks or equivalent grade in Bachelor degree examination with Mathematics as one of the main subject.

2. Seats: No. of students to be admitted – 30 , to begin with 15 students may be admitted.

3. Admission Procedure: On the basis of admission test or on the basis of merit which will be decided by the DPGC of Mathematics Department before admission.

4. Credit Hours Required
Credit hours and performance criterion are given in Article 7.1 and 7.7 of P.G. ordinance, salient points of which are given below:
The minimum credit hours required for the award of M. Sc. Degree is 64.
These 64 credit hours may be earned through minimum of four semesters and maximum of six semesters.
There is a provision of two-semester leave in the duration of M.Sc. Program.

A student has to maintain CPI (Cummulative Performance Index) of 6.0 (out of 10) and SPI (Semester Performance Index) of 5.5 (out of 10) in every semester.

5. Program Structure:

Courses in first semester:

S.N.	Course code	Name of the Course	Credit	L+T+P
1.	MA 111	Advanced Algebra	4	3+1+0
2.	MA 112	Computer Fundamentals and Programming Language (with Lab)	4	2+0+2
3.	MA 113	Mathematical Methods & PDE	4	3+1+0
4.	MA 114	Real Analysis & Measure Theory	4	3+1+0

Courses in second semester:

S.N.	Course code	Name of the Course	Credit	L+T+P
1.	MA 211	Topology	4	3+1+0
2.	MA 212	Complex Analysis	4	3+1+0
3.	MA 213	Data Structure(with Lab)	4	2+0+2
4.	MA 214	Operation Research (with Lab)	4	3+1+2

Courses in third semester:

In this semester there will be three compulsory papers and one optional paper.

S.N.	Course code	Name of the Course	Credit	L+T+P
1.	MA 311	Differential Geometry	4	3+1+0
2.	MA 312	Mechanics Classical Dynamics and Fluid Dynamics	4	3+1+0
3.	MA 313	Advanced Numerical Computational Techniques (with Lab)	4	3+1+2
4.		Elective	4	3+1+0

Students can choose any one papers from the following as elective:

MA 314 Coding Theory
MA 315 Commutative Algebra
MA 316 Riemannian Geometry and Relativity
MA 317 Mathematical Modeling in Industry
MA 318 Algebraic Topology
MA 319 Information Technology
MA 320 Mathematical Methods in Environmental Engineering
MA 321 Computational Linear Algebra
MA 322 Financial Mathematics
MA 323 Computational Statistics

Courses in fourth semester

In this semester students can choose any two papers from the following. Beside these four courses each student will complete one project under a teacher in the department.

S.N.	Course code	Name of the Course	Credit	L+T+P
1.	MA 411	Industrial Mathematics	4	3+1+0
2		Elective –1	4	3+1+0
3		Elective- 2	4	3+1+0
4.		Comprehensive Examination including the evaluation Project	4	

Optional Papers (Elective –1/ Elective -2)

MA 412 Differential Topology
MA 413 Graph Theory
MA 414 Algebraic Geometry Number Theory
MA 415 Functional Analysis
MA 416 Algebraic Number Theory
MA 417 Representation Theory of Finite Groups
MA 418 Software Engineering
MA 419 Automata
MA 420 Image Processing
MA 421 Simulation and Modeling
MA 422 Statistical Techniques in Data Mining
MA 423 Wavelet Analysis
MA 424 Computational Algebra
MA 425 Computer Modeling

Syllabus in detail for M. Sc. in Mathematics and Scientific Computing

MA 111 **Advanced Algebra**

Primes, unique factorization, congruences, Chinese Remainder Theorem, Euler φ-function.

Groups, subgroups and factor groups, Lagrange's Theorem, homomorphisms, normal subgroups. Quotients of groups, Basic examples of groups (including symmetric groups, matrix groups, group of rigid motions of the plane and finite groups of motions). , group actions, Sylow Theorems.

Permutations, sign of a permutation, inversons, cycles and transpositions.

Direct products, Structure Theorem for finite abelian groups.

Rings and fields, elementary properties, polynomials in one and several variables, divisibility, irreducible polynomials, Division algorithm, Remainder Theorem, Factor Theorem, Rational Zeros Theorem, Relation between the roots and coefficients, Newton's Theorem on symmetric functions, Newton's identities, Fundamental Theorem of Algebra, (statement only), Special cases: equations of degree ≤ 4, cyclic equations.

Cyclotomic polynomials, Rational functions, partial fraction decomposition, unique factorization of polynomials in several variables, Resultants and discriminants.

Modules, submodules, quotient modules and module homomorphisms.

Generation of modules, direct sums and free modules. Tensor products of modules. Exact sequences, projective modules. Tensor algebras, symmetric and exterior algebras.

Finitely generated modules over principal ideal domains, invariant factors, elementary divisors, rational canonical forms. Applications to finitely generated abelian groups and linear transformations.

Noetherian rings and modules, Hilbert basis theorem, Primary decomposition of ideals in noetherian rings.

Texts / References

M. Artin, Algebra, Prentice Hall of India, 1994.
D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.
J.A. Gallian, Contemporary Abstract Algebra, 4th ed., Narosa, 1999.
K.D. Joshi, Foundations of Discrete Mathematics, Wiley Eastern, 1989.
T.T. Moh, Algebra, World Scientific, 1992.
S. Lang, Undergraduate Algebra, 2nd Ed., Springer, 2001.
S. Lang, Algebra, 3rd ed., Springer (India), 2004.
J. Stillwell, Elements of Algebra, Springer, 1994.

MA 112 **Computer Fundamentals and Programming**

L	T	P	Credits
2	1	2	4

Computer Fundamentals.

Writing a Simple Program: Learning the form of a C program, Declaring variables, designing program flow and control, defining and using functions, using standard terminal I/O functions.

Fundamental Data Types and Storage Classes: Character types, Integer, short, long, unsigned, single and double-precision floating point, storage classes, automatic, register, static and external.

Operators and Expressions: Using numeric and relational operators, mixed operands and type conversion, Logical operators, Bit operations, Operator precedence and associatively.

Conditional Program Execution: Applying if and switch statements, nesting if and else, restrictions on switch values, use of break and default with switch.

Program Loops and Iteration: Uses of while, do and for loops, multiple loop variables, assignment operators, using break and continue.
Modular Programming: Passing arguments by value, scope rules and global variables, separate compilation, and linkage, building your own modules.
Arrays: Array notation and representation, manipulating array elements, using multidimensional arrays, arrays of unknown or varying size.
Structures: Purpose and usage of structures, declaring structures, assigning of structures.
Pointers to Objects: Pointer and address arithmetic, pointer operations and declarations, using pointers as function arguments, Dynamic memory allocation, defining and using stacks and linked lists.
Unions: Components in overlapping memory, declaring and using unions .h vs. private .c files, Hiding private variables and functions.
Controlling Devices: Bit access and masking, pointing to hardware structures.
Operating System Interaction: Reading command line arguments, creating and accessing files, file opening modes, formatted disk I/O.
The Standard C Preprocessor: Defining and calling macros, utilizing conditional compilation, passing values to the compiler.
The Standard C Library: Input/Output : fopen, fread, etc, string handling functions, Math functions : log, sin, alike, Other Standard C functions.

Books and references:
Herbert Schield, Complete reference in C, TMH
Yashwant Kanetkar, Let US C , BPB
Balaguruswamy, ?Programming in ANSI C, TMH
Yashwant Kanetkar Pointers in C

MA 113 Mathematical Methods

Cartesian tensors, their algebra. Integral theorems. Second order cartesian tensor and matrix functions. Sturm-Liouville Problem; Oscillation Theorems, Orthogonal polynomials, Integral transforms, Integral equations; Classifications, properties and solutions. Partial Differential Equations
First order equations, Cauchy Kowaleski Theorem. Charecteristics. Classification of second order equations. Uniqueness theorems for hyperbolic equations with initial and

boundary conditions, Elliptic equations, Dirichlet and Neumann problems. Maximum Minimum theorem, Poisson's Integrals, Green's and Neumann's functions. Heat equations Asymptotic expansions, Watson's lemma, method of stationary phase and saddle point method. Applications to differential equations. Behaviour of solutions near an irregular singular point, Stoke's phenomenon. Method of strained coordinates and matched asymptotic expansions. Variational principles, Lax-Milgram theorem and applications to boundary value problems. Calculus of variations and integral equations. Volterra integral equations of first and second kind. Iterative methods and Neumann series.

Texts / References

C.M. Bender and S.A. Orszag, Advanced Mathematical Methods for Scientists and Engineers, McGraw-Hill Book Co., 1978.
R. Courant & D.Hilbert, Methods of Mathe-matical Physics, Vol. I & II, Wiley Eastern Pvt. Ltd. New Delhi, 1975.
J. Kevorkian and J.D. Cole, Perturbation Methods in Applied Mathematics, Springer Verlag, Berlin, 1985.
S.G. Mikhlin, Variation Methods in Mathe-matical Physics, Pergaman Press, Oxford 1964.

MA 114 Real Analysis

Review of basic concepts of real numbers: Archimedean property, Completeness.
Metric spaces, compactness, connectedness, (with emphasis on R^n).
Continuity and uniform continuity. Monotonic functions, Functions of bounded variation; Absolutely continuous functions. Derivatives of functions and Taylor's theorem.
Riemann integral and its properties, characterization of Riemann integrable functions. Improper integrals, Gamma functions. Sequences and series of functions, uniform convergence and its relation to continuity, differentiation and integration. Fourier series, pointwise convergence, Fejer's theorem, Weierstrass approximation theorem.

Measure Theory
Semi-algebra, Algebra, Monotone class, Sigma-algebra, Monotone class theorem. Measure spaces. Outline of extension of measures from algebras to the generated sigma-algebras: Measurable sets; Lebesgue Measure and its properties.
Measurable functions and their properties; Integration and Convergence theorems.
Introduction to L^p-spaces, Riesz-Fischer theorem; Riesz Representation theorem for L^2 spaces. Absolute continuity of measures, Radon-Nikodym theorem. Dual of L^p-spaces.
Product measure spaces, Fubini's theorem. Fundamental Theorem of Calculus for Lebesgue Integrals (an outline).

Texts / References

1. T. Apostol, Mathematical Analysis, 2nd ed., Narosa Publishers, 2002.

2. K. Ross, Elementary Analysis: The Theory of Calculus, Springer Int. Edition, 2004.
3. W. Rudin, Principles of Mathematical Analysis, 3rd ed., McGraw-Hill, 1983.
4. P.R. Halmos, Measure Theory, Graduate Text in Mathematics, Springer-Verlag, 1979.
5. Inder K. Rana, An Introduction to Measure and Integration (2nd ed.), Narosa Publishing House, New Delhi, 2004.
6. H.L. Royden, Real Analysis, 3nd ed., Macmillan, 1988.

MA 211 Topology

Prerequiste: Real Analysis

Topological Spaces: open sets, closed sets, neighbourhoods, bases, subbases, limit points, closures, interiors, continuous functions, homeomorphisms.
Examples of topological spaces: subspace topology, product topology, metric topology, order topology.
Quotient Topology : Construction of cylinder, cone, Moebius band, torus, etc.
Connectedness and Compactness: Connected spaces, Connected subspaces of the real line, Components and local connectedness, Compact spaces, Heine-Borel Theorem, Local -compactness.
Separation Axioms: Hausdorff spaces, Regularity, Complete Regularity, Normality, Urysohn Lemma, Tychonoff embedding and Urysohn Metrization Theorem, Tietze Extension Theorem.
Tychnoff Theorem, One-point Compacti-fication.
Complete metric spaces and function spaces, Characterization of compact metric spaces, equicontinuity, Ascoli-Arzela Theorem, Baire Category Theorem. Applications: space filling curve, nowhere differentiable continuous function.

Optional Topics:

1. Topological Groups and orbit spaces.
2. Paracompactness and partition of unity.
3. Stone-Cech Compactification.
4. Nets and filters.

Texts / References

1. M. A. Armstrong, Basic Topology, Springer (India), 2004.
2. K.D. Joshi, Introduction to General Topology, New Age International, New Delhi, 2000.
3. J.L. Kelley, General Topology, Van Nostrand, Princeton, 1955.
4. J.R. Munkres, Topology, 2nd Ed., Pearson Education (India), 2001.
5. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, New York, 1963.

MA 212 Complex Analysis

Complex numbers and the point at infinity. Analytic functions.
Cauchy-Riemann conditions, Mappings by elementary functions, Riemann surfaces, Conformal mappings,Contour integrals, Cauchy-Goursat Theorem.
Uniform convegence of sequences and series. Taylor and Laurent series. Isolated singularities and residues, Evaluation of real integrals,
Zeroes and poles, Maximum Modulus Principle, Argument Principle, Rouche's theorem.

Texts / References

1. J.B. Conway, Functions of One Complex Variable, 2nd ed., Narosa, New Delhi.
2. A.H. Ahlfores, Complex Analysis
3. T.W. Gamelin, Complex Analysis, Springer International Edition, 2001.
4. R. Remmert, Theory of Complex Functions, Springer Verlag.
5. A.R. Shastri, An Introduction to Complex Analysis, Macmilan India, New Delhi.

Data Structures

MA 213 **L T P Credits**
3 1 2 4

Introduction: Basic Terminology: Elementary Data Organization, Data Structure Operations, Algorithms Complexity, Time-Space Trade off.

Arrays: Array Definition and Analysis, Representation of Linear Arrays in Memory, Traversing of Linear Arrays, Insertion And Deletion, Single Dimensional Arrays, Two Dimensional Arrays, Bubble Sorting, Selection Sorting, Linear Search, Binary Search, Multidimensional Arrays, Function Associated with Arrays, Character String in C, Character String Operations, Arrays as parameters, Implementing One Dimensional Array.

Stacks and Queues: Introduction to Operations Associated with Stacks Push & Pop, Array representation of stacks, Operation associated with stacks: Create, Add, Delete, Application of stacks recursion polish expression and their compilation conversion of infix expression to prefix and postfix expression, Tower of Hanoi problem, Representation of Queues Operations of queues: Create, Add, Delete, Front Empty< Priority of Queues, Dequeues.

Linked Lists: Singly linked lists, Representation of linked lists in memory, Traversing, Searching, Insertion into, Deletion from linked list, Polynomial Addition, More on linked list, Header nodes, Doubly linked list, Generalized list.

Trees: Basic Terminology, Binary Trees and their representation, expression evaluation, Complete Binary trees, Extended binary trees, Traversing binary trees, Searching, Insertion and Deletion in binary search trees, Complexity of searching algorithm, Path length, Huffman?s algorithm, General trees, AVL trees, Threaded trees, B trees.

Graphs: Terminology and Representations, Graphs & Multigraphs, Directed Graphs, Sequential representation of graphs, Adjacency matrices, Transversal Connected Component and Spanning trees, Shortest path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths.

Sorting: Insertion Sort, Quick sort, two way Merge sort, Heap sort, Sorting on different keys, External sorting.

File Structure: Physical storage media, File Organization, Organization records into blocks, Sequential blocks, Indexing & Hashing, Primary Indices, Secondary Indices, B+ tree Index files, B tree index files, Static Hash functions, Indexing & hashing comparisons.

Books and References:

1. Horowitz and Sahani, Fundamentals of Data structures, Galgotia publications
2. An introduction to data structures and application by Jean Paul Tremblay & Pal G. Sorenson (McGraw Hill)
3. Tannenbaum, Data Structures?, PHI
4. R.L. Kruse, B.P. Leary, C.L. Tondo, ?Data structure and program design in C , PHI

MA 214 **Operation Research**

L T P Credit
3 1 0 4

Introduction: History of operations research, Nature and Scope of operations research. Allocation, assignment and Transportation models, Construction and solution of these Models.

Linear Programming: Introduction, Mathematical formulation of the problem, Graphical Solution methods, Mathematical solution of? linear programming problem, Slack, and Surplus variables. Matrix formulation of general linear programming Problem.

The Simplex Method: Fundamental properties to solution corroboration of extreme points, Simplex algorithm, Computational procedures, Artificial variables, two phase simplex Method, Formulation of linear programming problems and its solution by simplex method.

Unrestricted variables, problems of degeneracy, Principle of duality in simplex method, Formation of dual with mixed type of constraints.

Solution of primal and dual (Solution of dual constraints, Solution of primal also)

Sensitivity Analysis.

Integer Programming: Formulation and solution of? Integer Programming Problem.

Game Theory: Introduction, Two persons zero sum games, The maxmini and minimax principles.

Graphical Solution: Reduction of game problem? to LPP, the transportation problem,

matrix form of transportation problem, Initial basic feasible solution, Selecting the entering variables, Selecting the leaving variables, Transportation algorithm, Degeneracy in transportation Problem, Inventory Control.

Books and References:

1. Operation Research, Theory and Application by J.K. Sharma, Macmillan India
2. Quantitative techniques in Management by N.D.Vohra, TMH
3. Linear Programming by N.P. Loomba
4. Operation Research: An Introduction by H.A. Taha, PHI

MA 311 Differential Geometry

Graphs and level sets of functions on Euclidean spaces, vector fields, integral curves of vector fields, tangent spaces.
Surfaces in Euclidean spaces, vector fields on surfaces, orientation, Gauss map.
Geodesics, parallel transport, Weingarten map.
Curvature of plane curves, arc length and line integrals.
Curvature of surfaces.
Parametrized surfaces, local equivalence of surfaces.
Gauss-Bonnet Theorem, Poincare-Hopf Index Theorem.

Texts / References

1. Differential Geometry of Curves and Surfaces by M. doCarmo, Prentice Hall, 1976.
2. Elementary Differential Geometry by B. O'Neill, Academic Press, New York, 1966.
3. Differential Geometry by J.J. Stoker, Wiley-Interscience, 1969.
4. Elementary Topics in Differential Geometry by J.A. Thorpe, Springer (India), 2004.

MA 312 Mechanics (Classical Dynamics and Fluid Dynamics)

Dynamical systems, generalized coordinates, degrees of freedom, holonomic and non-holonomic system. Lagrange's equations for holonomic systems. Lagrange's equation for impulsive forces and for systems involving dissipatative forces. Conservation theorems. Hamilton's principle and principle of least action. Hamilton's canonical equations. Canonical transformation with different generating functions. Lagrange and Poisson brackets and their properties. Hamilton-Jacobi equations and separation of variables.

Motion of a particle in two/three dimensional space; Motion in a resisting medium, under constraints, under central forces. Motion of a rigid body, Euler's geometrical and dynamical equations, generalised coordinates, small oscillations.
Book : A.S. Ramsay, Dynamics vol 2

MA 313 Computer Based Numerical & Statistical Techniques

L T P Credits
3 1 2 4

Introduction: Errors in numerical computation, Mathematical preliminaries, Errors and their analysis, Machine Computations, Computer Software.

Algebraic and Transcendental Equations: Bisection method, Iteration method, Method of False Position, rate of convergence, Method for complex root, Muller's Method, Quotient Difference method, Newton-Raphson Method.

Interpolation: Introduction, Errors in Polynomial interpolation, Finite differences, Decision of errors, Newton?s formula for interpolation, Gauss, Sterling, Bessel's, Everett's Formula, Interpolation by unevenly spaced points, Lagrange interpolation formula, Divided Difference, Newton's General interpolation Formula.

Curve Fitting, Cubic Spline & Approximation: Introduction, Method of Least Square curve fitting procedures, Fitting a straight line, Curve fitting by sum of exponential, Data fitting with cubic splines, Approximation of functions.

Numerical Integration and Differentiation: Introduction, Numerical differentiation, Numerical integration, Trapezoidal rule, Simpson 1/3 rule, Simpson 3/8 rule, Booles & Weddles rule, Euler-Maclariaun formula, Gaussian Formula, Numerical evaluation of singular integrals.

Statistical Computations: Frequency Chart, Regression Analysis, Least Square fit, Polynomial fit, Linear and Nonlinear Regression, Multiple Regression, Statistical Quality Control Methods.

Books and References:

(1) Manish Goyal, Computer Based Numerical & Statistical Techniques.
(2) Shastri, Introductory methods of numerical analysis , PHI
(3) V. K. Singh , Numerical and Statistical Methods in Computers

MA 314 Coding Theory

Polynomial rings over fields, Extension of fields, computation in GF(q), Root fields of polynomials, Vector space over finite fields, Binary group codes, Hamming codes, polynomial codes, Linear block codes, The structure of cyclic codes, Quadratic residue codes, Reed Mueller codes, Simplex codes.Nonlinear codes, Golay, Hadamard, Justeen, Kerdock, Nordstorm-Robinson codes. First and Second order Reed-Mueller codes, t-designs, steiner systems. Weight distribution of codes. Generalised BCH codes. Self dual codes and invariant theory. Covering radius problem, Convolutional codes.

Books and References

(1) Coding Theory, Cryptography and Related Areas by J Buchmann, T Hoholdt, H Stichtenoth
(2) Error-correcting codes, self-checking circuits and applications by Wakerly, J. North-Holland, New York 1978.
(3) Algebra und Codes by Wan Zh. Wissenschaftsverlag, Peking, 1980.
(4) Codes and Kryptography, Welsh, D., VCH, Weinheim 1991.
(5) Coding theorems of information theory by Wolfowitz, J., Springer, Berlin, 1978.
(6) Principles of communication engineering by Wozencraft, M., Jacobs, I. John Wiley, New York.
(7) Sequential Decoding by Wozencraft, M., Reiffen, B, M.I.T. Press, Cambridge/Mass.
(8) Codes for error control and synchronization by Wiggert, D. Artech, Boston/Mass, 1988.

MA 315 Commutative Algebra

Prerequisites: Algebra

Dimension theory of affine algebras: Principal ideal theorem, Noether normalization lemma, dimension and transcendence degree, catenary property of affine rings, dimension and degree of the Hilbert polynomial of a graded ring, Nagata's altitude formula, Hilbert's Nullstellensatz, finiteness of integral closure.

Hilbert-Samuel polynomials of modules :

Associated primes of modules, degree of the Hilbert polynomial of a graded module, Hilbert series and dimension, Dimension theorem, Hilbert-Samuel multiplicity, associativity for-mula for multiplicity,

Complete local rings:

Basics of completions, Artin-Rees lemma, associated graded rings of filtrations, completions of modules, regular local rings

Basic Homological algebra: Categories and functors, derived functors, Hom and tensor products, long exact sequence of homology modules, free resolutions, Tor and Ext, Koszul complexes.

Cohen-Macaulay rings:

Regular sequences, quasi-regular sequences, Ext and depth, grade of a module, Ischebeck's theorem, Basic properties of Cohen-Macaulay rings, Macaulay's unmixed theorem, Hilbert-Samuel multiplicity and Cohen-Macaulay rings, rings of invariants of finite groups.

Optional Topics:

1. Face rings of simplicial complexes, shellable simplicial complexes and their face rings.
2. Dedekind Domains and Valuation Theory.

Text/References

(1) D. Eisenbud, Commutative Algebra (with a view toward algebraic geometry) Graduate Texts in Mathematics 150, Springer-Verlag, Berlin, 2003.
(2) H. Matsumura, Commutative ring theory, Cambridge Studies in Advanced Mathematics No. 8, Cambridge University Press, Cambridge, 1980.
(3) W. Bruns and J. Herzog, Cohen-Macaulay Rings, (Revised edition) Cambridge Studies in Advanced Mathematics No. 39, Cambridge University Press, Cambridge, 1998.
(4) N.S. Gopalakrishnan, Commutative Algebra

MA 317 Mathematical Modelling

Elementary mathematical models; Role of mathematics in problem solving; Concepts of mathematical modelling; System approach; Formulation, Analysis of models; Sensitivity analysis; Simulation approach; Pitfalls in modelling, Illustrations

MA 318 Algebraic Topology

Prerequiste: General Topology

Paths and homotopy, homotopy equivalence, contractibility, deformation retracts.
Basic constructions: cones, mapping cones, mapping cylinders, suspension.
Cell complexes, subcomplexes, CW pairs.
Fundamental groups. Examples (including the fundamental group of the circle) and applications (including Fundamental Theorem of Algebra, Brouwer Fixed Point Theorem and Borsuk-Ulam Theorem, both in dimension two). Van Kampen's Theorem, Covering spaces, lifting properties, deck transformations. universal coverings (existence theorem optional).
Simplicial complexes, barycentric subdivision, stars and links, simplicial approximation. Simplicial Homology. Singular Homology. Mayer-Victoris Sequences. Long exact sequence of pairs and triples. Homotopy invariance and excision (without proof).
Degree. Cellular Homology.
Applications of homology: Jordan-Brouwer Separation theorem, Invariance of dimension, Hopf's Theorem for commutative division algebras with identity, Borsuk-Ulam Theorem, Lefschetz Fixed Point Theorem.

Optional Topics:
Outline of the theory of: cohomology groups, cup products, Kunneth formulas, Poincare duality.

Texts / References

(1) M.J. Greenberg and J. R. Harper, Algebraic Topology, Benjamin, 1981.
(2) W. Fulton, Algebraic topology: A First Course, Springer-Verlag, 1995.
(3) A. Hatcher, Algebraic Topology, Cambridge Univ. Press, Cambridge, 2002.
(4) W. Massey, A Basic Course in Algebraic Topology, Springer-Verlag, Berlin, 1991.
(5) J.R. Munkres, Elements of Algebraic Topology, Addison Wesley, 1984.

(6) J.J. Rotman, An Introduction to Algebraic Topology, Springer (India), 2004.
(7) H. Seifert and W. Threlfall, A Textbook of Topology, translated by M. A. Goldman, Academic Press, 1980.
(8) J.W. Vick, Homology Theory, Springer-Verlag, 1994.

MA 319 **Information Technology**

L	T	P	Credits
2	0	2	3

MS WINDOWS xxxx commands, editing and saving files, word processing, file management. LINUX Commands, editors, Files & Directories, UNIX tools.
Internet and World Wide Web : Introduction to Internet, www, Internet browsers Netscape & Explorer, Introduction of PINE/ELMN, FTP, Telnet, Search Engines.
Hypertext Markup Language, HTML Tags, Frames, Creating HYML documents, DHTML.

Books & References

D.S.Yadav , Foundation of Information technology, New age International, 2003
S. Dash , Introduction to Unix, TMH.

MA 320 Mathematical Methods for Environmental Engineering

An introduction to numerical and analytical methods applied to civil and environmental engineering. Methods for solution of non-linear equations, systems of linear equations, interpolation, regression and solution of ordinary and partial differential equations. Applications include trusses, beams, river oxygen balances and adsorption isotherms. Several computer projects are required. Quantitative and fundamental description of water and air pollution problems. Environmental regulations and policy, pollution prevention, risk assessment. Written and oral reports.

Prerequisite: knowledge of procedural computer program language (C++, FORTRAN, etc.).

MA 321 Computational Linear Algebra + Lab.

Basic concepts, floating point numbers and errors in computation, stability of algorithms and conditioning of problems. Numerical solution of linear system, Direct methods : Gaussian elimination with pivotal condensation, operational count and error bound. LU factorization, QR factorization. Condition number and ill conditioned systems. Matrix and vector norms. Error bounds. Wilkinson's algorithm for ill-conditioned systems. Iterative methods : Jacobi, Gauss-Seidel, SOR, convergence and rate of convergence, cojugate gradient method, Arnoldi process and GMRES. Large sparse systems. Matrix inverse. Generalized inverse. Least square solution of linear systems. Numerical eigenvalue problems. computation of eigenvalues and eigenvectors, singular value

decomposition and least square problem, SVD and the pseudo inverse. Jacobi, Givens & Householder's method for symmetric matrices, Hessenberg QR iteration.

MA 322 Financial Mathematics

Financial derivatives: contracts and options. Hedging and risk management. Arbitrage, interest rate, and discounted value. Geometric random walk and Brownian motion as models of risky assets. Initial boundary value problems for the heat and related partial differential equations. Self-financing replicating portfolio. Black-Scholes pricing of European options. Dividends. Implied volatility. Optimal stopping and American options.

Outline:

Part 1. (2.5 weeks) Introduction to financial markets; forward pricing and hedging.
Part 2. (4.5 weeks) Dynamic strategies; models for financial assets; Itô's lemma; Black-Scholes equation; option pricing and hedging.
Part 3. (2 weeks) Binomial trees.

Textbooks:

The Mathematics of Financial Derivatives: A Student Introduction, by Wilmott, Dewynne, and Howison (Cambridge University Press, 1995)

Futures, and Other Derivatives, 5th ed, by Hull (Prentice Hall, 2003)

MA –323 Computational Statistics + Lab.

Analysis of Variance – one way and two way classification. Concept of experimental designs-CRD, RBD, LSD, Factorial designs (22 , 23,and 32). Analysis of covariance model. .Multivariate normal distribution – properties, estimation of parameters, Wishart distribution, Hotelling's T2 and its applications. Classification of observations, Mahalanobis D2 and Fisher's discriminant function. Principal component analysis. Canonical correlations and canonical variables. Concept of regression – simple and multiple regression models.Classical techniques of time – series analysis, smoothing and decomposition

MA 411 Industrial Mathematics

Applied mathematics techniques to solve real-world problems. Topics include mathematical modeling, asymptotic analysis, differential equations and scientific computation. Prepares the student for Math 6512. (1st of two courses)
First in a sequence of two courses designed for beginning graduate students and advanced undergraduates who are interested in solving real-world problems with modern mathematical tools. The sequence is intended to train students who may seek industrial opportunities after graduation. Problems will be approached with a combination of

mathematical analysis and scientific computation. The necessary background is elementary differential equations, a working knowledge of computer programming in FORTRAN, Pascal, or the C language, and basic numerical analysis at the level of Mathematics. This course develops the mathematical and computational tools for applications to industrial problems. The course will treat:
Mathematical modeling, Differential equations, Asymptotic methods, Scientific computation, including numerical methods, parallelization, and visualization

Purpose: The purpose of this course is to introduce the student to a wide variety of mathematical perspectives. The course is designed to expand the student's appreciation of how mathematics applies to quantitative problems that originate in many fields, and to provide opportunities to solve some of these problems.
The student will learn the process of problem-solving. An introduction to logic will provide tools of deductive reasoning that are essential to not only mathematics, but also to other subjects and to daily life. The student will encounter numeration systems, in particular the binary system and its relation to computing devices. Advanced topics in geometry will include such ideas as right triangle trigonometry, graph theory, fractals and projective and non-Euclidean geometry. The formulas of financial mathematics will be derived and applied to problems of annuity, amortization, and interest. Probability and statistics will be introduced.
The student will be required to communicate the results of his/her mathematical work in forms such as write-ups of solutions of selected problems and projects, and oral presentations involving the use of technology such as graphing calculators, MS Excel, LOGO or The Geometer's Sketchpad.

Upon completion of this course, students are expected to have an understanding of:

- ☐ The process of problem solving
- ☐ Set Theory
- ☐ Symbolic logic
- ☐ Numeration systems
- ☐ Euclidean geometry
- ☐ An introduction to non-Euclidean geometry
- ☐ Financial management
- ☐ Probability
- ☐ Descriptive statistics
- ☐ Graph Theory
- ☐ Technology involving such things as graphing calculators, MS Excel, LOGO or The Geometer's sketchpad.

MA 412 **Differential Topology**

Differentiable Manifolds in R^n: Review of inverse and implicit function theorems; tangent spaces and tangent maps; immersions; submersions and embeddings.
Regular Values: Regular and critical values; regular inverse image theorem; Sard's theorem; Morse lemma.
Transversality: Orientations of manifolds; oriented and mod 2 intersection numbers; degree of maps. Application to Fundamental theorem of Algebra.
*Lefschetz theory of vector fields and flows: Poincare-Hopf index theorem; Gauss-Bonnet theorem.

*Abstract manifolds: Examples such as real and complex projective spaces and Grassmannian varieties; Whitney embedding theorems.

(* indicates expository treatment intended for these parts of the syllabus.)

Texts / References:

A. Dubovin, A.T. Fomenko, S.P. Novikov, Modern Geometry Methods and Applications - II, The Geometry and Topology of Manifolds, GTM 104, Springer-Verlag, Berlin, 1985.

V. Guillemin and A Pollack, Differential Topology Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1974.

J. Milnor, Topology from the Differential View-point, University Press of Virginia, Charlottsville 1990.

MA 413 Graph Theory

Graphs, Blocks, Trees, Connectivity, Menger's theorem, partitions, Eulerian and Hamiltonian graphs, Line graphs, tournaments, Factorization, Coverings, Directed graphs, Capacitated directed networks, Max flow-Min cut theorem, Matrices, Planar graphs, Four colour problem. Groups, Schur functions, Polya's theorem, be Burijn's theorem, Redfield's theorem, Matroids, Transversal theory, Hypergraphs, Planarity, Colourability

MA 414 Algebraic Geometry

Course Description. There is a beautiful interplay between algebra and geometry, which is essentially an extension of the fact that the parabola (a geometric object) is the set of points in the plane satisfying $y-x^2=0$ (an algebraic equation). Quickly review of some basic commutative algebra. Then discuss graded objects and varieties in projective space; concentrating on building up a stable of good examples (Grassmannians, curves, rational varieties, secant varieties). Use these examples to illustrate fundamental geometric constructions--tangent spaces, smoothness, dimension and degree, and even (time permitting) connections to things like fundamental forms and Gauss maps. The key idea and main objective of the course is to bring all the abstract concepts to life with lots of examples.

Curves in the plane: rational curves, rational maps, singular points and regular local rings. Affine space: algebraic sets and Zariski topology, regular functions and maps. Rational functions., Quasiprojective varieties: rational fns, regular fns, maps between QPV's. Image of a map: image is closed, finite maps, projections, integral dependence. Dimension: Transcendence degree again, integrality, dimension of fibers of map, fun examples with Grassmannians. Smoothness, again: local ring, tangent space, tangent cone , Power series expansions and properties of smooth points, Birational maps, Normal

varieties. Singularities of a map. Simplicial homology, functors, projective/injective objects. Derived functors, long exact sequence from s.e.s.; Cech cohomology), Divisors, line bundles on curves, Riemann-Roch for curves.

Text : Shafarevich. *Basic Algebraic Geometry 1, ISBN 0-387-54812-2,*

Prerequisite: a graduate class in algebra, and mathematical maturity. Good preparatory reading is the book of Cox-Little-O'Shea ``Ideals, varieties, and algorithms".

MA 415 Functional Analysis

Normed Linear Spaces Fixed point theorem, Baires Category theorem, Banach Spaces, dual spaces, Hahn-Banach theorem, Open mapping and Closed graph theorems, Uniform boundedness principle; Compact operators; Hilbert Spaces; Self adjoint, normal and unitary operators; Banach Algebras.

Text/References:
G.F. Simmons: Topology and Modern Analysis
B. V. Limaye: Functional Analysis
K. Yoshida : Functional Analysis , Springer

MA 416 Algebraic Number Theory

Prerequisites: Algebra

Algebraic number fields, Localisation, discrete valuation rings.
Integral ring extensions, Dedekind domains, unique factorisation of ideals. Action of the galois group on prime ideals. Valuations and completions of number fields, discussion of Ostrowski's theorem, Hensel's lemma, unramified, totally ramified and tamely ramified extensions of p-adic fields.
Discriminants and Ramification. Cyclotomic fields, Gauss sums, quadratic reciprocity revisited.
The ideal class group, finiteness of the ideal class group, Dirichlet units theorem.

Texts / References
K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, 2nd ed., Springer-Verlag, Berlin, 1990.
S. Lang, Algebraic Number Theory, Addison- Wesley, 1970.
D.A. Marcus, Number Fields, Springer-Verlag, Berlin, 1977.

MA 417 Representation Theory of Finite Groups

Prerequisite : Algebra

Representations, Subrepresentations, Tensor products, Symmetric and Alternating Squares.Characters, Schur's lemma, Orthogonality relations, Decomposition of regular represent-ation, Number of irreducible representations, canonical decomposition and

explicit decompositions. Subgroups, Product groups, Abelian groups. Induced representations.
Examples: Cyclic groups, alternating and symmetric groups.
Integrality properties of characters, Burnside's p^aq^b theorem. The character of induced representation, Frobenius Reciprocity Theorem, Meckey's irreducibility criterion, Examples of induced representations, Representations of supersolvable groups.

Texts / References

M. Burrow, Representation Theory of Finite Groups, Academic Press, 1965.
N. Jacobson, Basic Algebra II, Hindustan Publishing Corproation, 1983.
S. Lang, Algebra, 3rd ed. Springer (India) 2004.
J.P. Serre, Linear Representation of Groups, Springer-Verlag, 1977.

MA 418 Software Engineering

- Software Engineering: The software crisis, principles of software engineering, programming-in-the-small vs. programming-in-the-large
- **Software process:** The software lifecycle, the waterfall model and variations, introduction to evolutionary and prototyping approaches
- **Project management:** Relationship to lifecycle, project planning, project control, project organization, risk management, cost models, configuration management, version control, quality assurance, metrics
- **Teamwork:** Team dynamics, communication skills, sharing work, fulfilling obligations
- **User considerations:** Human factors, usability, internationalization, user interface documentation, user manuals
- **Software requirements:** Requirements analysis, requirements solicitation, analysis tools, requirements definition, requirements specification, static and dynamic specifications, requirements review.
- **Software design:** Design for reuse, design for change, design notations, design evaluation and validation
- **Implementation:** Programming standards and procedures, modularity, data abstraction, static analysis, unit testing, integration testing, regression testing, tools for testing, fault tolerance
- **Maintenance:** The maintenance problem, the nature of maintenance, planning for maintenance
- **Documentation:** Documentation formats, tools, internal documentation

- **Other topics:** Formal methods, tools and environments for software engineering, role of programming paradigm, process maturity

MA -419 **Automata Theory**

L T P Credits
3 1 2 4

Introduction: Deterministic and Nondeterministic Finite Automata, Regular Expression, Two way Finite Automata, Finite Automata with output, Properties of regular sets, pumping lemma Closure properties, My-Hill-Nerode Theorem.

Context Free Grammars: Derivation trees, simplification forms.

Pushdown Automata: Definitions, Relationship between PDA and context free language, Properties of context free languages, Decision Algorithms.

Turing Machine: The Turing Machine Model, Complete Languages and Functions, Modification of Turing Machines, Church 's Machines, Undecidability.
Properties of recursive and recursively enumerable languages, Universal turing Machines, Post correspondence problems, introduction to recursive function theory.

Chomsky Hierarchy : Regular grammars, unrestricted grammars, Context Sensitive Language, Relation between classes of languages.

Books & References:

1. Hopcroft and Ullman, ?Introduction to Automata Theory, languages and computation, Addision Wesley.
2. Kohan, Theory of Computer Sciences?.
3. Korral, Theory of Computer Sciences?.
4. Mishra & Chandrashekharan, ?Theory of Computer Sciences?, PIII.

MA 420 **Image Processing**

Catalog Description: Discrete time signals, and systems. Sampling, reconstruction, and quantization. Digital image representation. Digital image fundamentals. Image transforms. Image enhancement. Image restoration. Image segmentation and description.
Course Objectives: To provide development of skills to effectively integrate new concepts in image processing almost independently with the previous knowledge.

Course Conduct:

- The digitized image and its properties
- Data structures for image analysis
- Image pre-processing

- Segmentation
- Shape representation and description
- Mathematical morphology
- Linear discrete image transforms
- Image data compression
- Texture

Text Book:

- M. Sonka, V. Hlavac, R. Boyle, "Image Processing, Analysis, and Machine Vision".

References:

- R. C. Gonzalez, R. E. Woods, "Digital Image Processing", Addison-Wesley.
- A. K. Jain, "Fundamentals of digital Image Processing", Prentice-Hall.
- K. R. Castleman, "Digital Image Processing".
- M. Seul, "Practical Algorithms for Image Analysis: Descriptions, Examples, and Code".

MA 421 Simulation and Modeling

L T P Credits
3 1 0 4

Basic Simulation Modeling: The Nature of Simulation Systems, Models, and Simulation Discrete-Event Simulation ? Simulation of a Single-Server Queueing? Alternative Approaches to Modeling and Coding Simulations, Parallel and Distributed Simulation ,Simulation across the Internet and Web-Based Simulation ,Steps in a Sound Simulation Study ,Other Types of Simulation : Continuous Simulation ,Combined Discrete-Continuous Simulation Monte Carlo Simulation. Advantages, Disadvantages, and Pitfalls of Simulation.

Modeling Complex Systems : Introduction, List Processing in Simulation, Approaches to Storing Lists in a Computer Linked Storage Allocation, A Simple Simulation Language: simlib. Single-Server Queueing Simulation with simlib Time-Shared Computer Model Job-Shop Model Efficient Event-List Manipulation

Simulation Software : Comparison of Simulation Packages with Programming Languages Classification of Simulation Software General-Purpose Simulation Packages Object-Oriented Simulation
Building Valid, Credible, and Appropriately Detailed Simulation Models Experimental Design, Sensitivity Analysis, and Optimization Simulation of Manufacturing Systems.

Reference Books:

1. Simulation Modeling and Analysis Third Edition By Law Kelton (Mc-Graw Hill)

MA 422 Statistical Techniques in Data Mining

Pre-requisite: Statistical Inference

Introduction to Data Mining and its Virtuous Cycle.

Cluster Analysis: Hierarchical and Non-hierarchical techniques. Classification and Discriminant Analysis Tools: CART, Random forests, Fisher's discriminant functions and other related rules, Bayesian classification and learning rules.

Dimension Reduction and Visualization Techniques: Multidimensional scaling, Principal Component Analysis, Chernoff faces, Sun-ray charts.

Algorithms for data-mining using multiple nonlinear and nonparametric regression.

Neural Networks: Multi-layer perceptron, predictive ANN model building using back-propagation algorithm. Exploratory data analysis using Neural Networks – self organizing maps. Genetic Algorithms, Neuro-genetic model building.

Discussion of Case Studies.

Text Books/References:

L. Breiman, J.H. Friedman, R.A. Olshen and C.J. Stone, Classification of Regresion Trees, Wadsowrth Publisher, Belmont, CA, 1984.

D.J. Hand, H. Mannila and P. Smith, Principles of Data Minng, MIT Press, Cambridge, MA 2001.

M.H. Hassoun, Fundamentals of Artificial Neural Networks, Prentice-Hall of India, New Delhi 1998.

T. Hastie, R. Tibshirani & J. H. Friedman, The elements of Statistical Learning: Data Mining, Inference & Prediction, Springer Series in Statistics, Springer-Verlag, New York 2001.

R.A. Johnson and D.W. Wichern, Applied Multivariate Analysis, Upper Saddle River, Prentice-Hall, N.J. 1998.

S. James Press, Subjective and Objective Bayesian Statistics: Principles, Models, and Applications, 2nd Edition, Wiley, 2002.

MA 423 Wavelet Analysis

The Scalable Structure of Information: The New Mathematical Engineering, Good Approximations, Wavelets: A Positional Notation for Functions, Review of linear algebra: Vector spaces, basis, dimension, linear transformations, matrices and digitalization, inner products and orthonormal bases. Wavelet Theory: Algebra and Geometry of Wavelet: Matrices, One-Dimensional Wavelet Systems, Examples of One-Dimensional Wavelet Systems, Higher Dimensional, Wavelet Systems. Wave lets on Z, Z_n, l^2(Z), Fourier series, transform and convolution on l*2.

Wavelet Approximation and Algorithms: The Mallat Algorithm.

MA 424 Computational Algebra

Investigations of groups on computers , coset enumeration , some examples using coset enumeration, Defining relations for subgroups of finite index of groups with finite presentation, Nielsen transformations , Calculation with the elements of a finite group given by generators and defining relations , Algorithms and Programs for the determination of the automorphism group of a finite group, A computational method for determining the automorphism group of a finite solvable group, Combinatorial construction by computer of the set of all subgroups of a finite group by composition of partial sets of its subgroups. Construction of the character table of a finite group from generators and relations, Program for calculation of characters and representations of finite groups. Program for the drawing of the lattices. Computer algebra programs, GAP. Calculations in rings group rings and Lie algebra

MA 425 Computer Modeling and Environments

DESCRIPTION

Introduction to 3D graphics for experimental artists. Utilizes sophisticated software tools to explore object modeling, environment construction, surface texturing, and image rendering. Through lectures, viewings, tutorials, and projects, students develop a multi-purpose skill set that can be used for innovative content creation, visualization, project planning, documentation, and cross-media integration. Application required.

This course is specifically designed for the Center for Digital Arts and Experimental Media and it's goals. To that end, narrative character animation in the style produced for popular films is heavily de-emphasized as that subject is being expertly covered by the Animation Research Lab in CSE.

The class will concentrate on still images and moving sequences that feature camera animation only. All other movement techniques will be introduced in the second class in this series. It is geared so that all students will have both hands-on experience as well as a technical understanding of how 3D is creatively manipulated. The course provides a grounding in fundamental concepts and gives students an opportunity to use these tools in an expansive and unconventional manner. Active sharing of resources, techniques, and inspiration is expected from all students in the class and creates a open environment for creativity.

COURSE GOALS

- Understand how visual information is created and produced in 3d
- Model complex objects and environments
- Apply and create materials that control surface appearance

- Create sophisticated illuminated environments
- Render images that showcase your creative talents
- Explore and expand the practice of 3D graphics for experimental art

STUDENT RESPONSIBILITIES AND REQUIREMENTS

- Willingness to experiment and take genuine artistic risks.
- Ability to be resourceful and seek out help when needed.
- Participation in all class activities (discussions, workshops, labs, etc.) is very important and will be monitored closely.
- Group critiques are vital to the experience of the class and your evolution as an artist. Each student will be required to give a verbal presentation of their work as well as critique the work of their classmates.
- You are encouraged to share knowledge amongst yourselves during lab times - remember, there's alot you can learn from each other. Please be respectful, however, if someone is working hard and needs to concentrate.
- Taking notes in class is encouraged and will help you remember what you've learned when you are working on your own time.
- Please do not read email or surf the web during lectures and discussions - it's distracting to all of us!

PROJECTS

Assignment 1 - Form and Fascination. Using techniques of NURBS modeling, create a complex work of virtual sculpture that is compelling in both it's construction and content.

Assignment 2 - World View. Envision and create a web-based VRML world that is modeled from polygon forms. The environment should be complex, yet still navigable and well-planned to fit the constraints of a system limited by speed and interaction.

Assignment 3 - Augmented Virtuality. Expand and reimagine a preexisting scene by concentrating on the material surfaces of the objects.You will use previously created models and some photographic images that must be integrated to form a drastically new interpretation.

Assignment 4 - A Slice of Space. Combining techniques of modeling, texturing, and rendering, create a piece that creatively explores the format of the 3D lenticular print.

READING MATERIALS

The Complete Reference by Tom Meade, Shinsaku Arima

The Art of Maya (newest version required) by Sybex

Various articles and excerpts from journals, conferences, and books covering topics such as critical theory, experimental new media art, and computer graphics.

SUPPLEMENTAL MATERIALS

Gnomon Maya DVD series available for student checkout.

Screenings of videos, and Internet media documenting artists and working methods.

Descriptions and further information about the DVDs available to you for checkout can be found at www.thegnomonworkshop.com. Access the titles by clicking the "Digital DVDs" drop-down menu.

Master of Technology

in

Fluids Engineering

Applied Mechanics Department
Motilal Nehru National Institute of Technology
(Deemed University) Allahabad-211 004.

About the Programme:

Fluid mechanics, being the highly applied science are used in various engineering application for the centuries. With advent of modern technology, the application of fluid mechanics & fluid power has multiplied to a great extent. But at M.Tech level, only 4 or 5 technical institutions in India currently offer Fluids Engineering as a specialization. To meet the growing industry demand of engineering post-graduates with a sound knowledge in fluids, the department of Applied Mechanics proposes a new M.Tech programme in Fluids Engineering.

Besides the Department of Applied Mechanics, the proposed programme is expected to have inputs from the departments of Mechanical Engineering, Electronics & Communication Engineering, Civil Engineering and Mathematics department of this institute and thus have an interdisciplinary character. The programme has been proposed at M.Tech. Level, so that we do not lag behind the developed countries in the various fields of Fluids Engineering.

M.Tech. in Fluids Engineering– An Edge over Others:

Several technical institutions in India run post-graduate programmes titled "Hydraulic Engineering" or "Water Resources Engineering". But contents of these programmes are confined to the study of liquids (mainly water) only. Besides, some institutions run the programme on "Thermal & Fluids Engineering", under which thermal engineering portion gets the importance. Unlike these programmes, the proposed programme gives a prime importance on fluids- both liquids and gases and its applications. Besides, the proposed programme maintains a balance between the theories of Fluid Mechanics and the application areas of it (for example, Theory and design of impeller pumps, Hydropower and hydraulic turbines, Fluid power control etc.) and therefore, has an edge over all such M.Tech. programmes exist in India.

Who Can Apply?

The programme is designed in such a way that its targeted students would be coming from Mechanical Engineering background. However, the students from Aeronautical, Chemical, Power and Civil engineering may also apply for the course. In each academic year, 15 students will get admission with B.Tech degree in either from Mechanical, Aeronautical, Chemical and Power Engineering background and with a valid GATE score.

List of Courses:

M.Tech. (Fluids Engineering)

Course Code	Core Courses:	L-T-P	Credit
AM	Advanced Fluid Mechanics	3-0-2	4
AM	Turbulent Flow	4-0-0	4
AM	Computational Fluid Dynamics	3-0-2	4
AM	Theory & Design of Impeller Pumps	4-0-0	4
AM	Experimental Methods & Analysis	3-0-2	4
AM	Applied Numerical Methods	3-0-2	4
M	Advanced Engineering Mathematics	3-1-0	4
AM	Advanced Solid Mechanics	3-1-0	4
AM	Mini Project	0-0-4	4
	Total		**36**
	Electives (Any Five)		
AM	Hydropower & Hydraulic Turbines	4-0-0	4
AM	Fluid Power Control	4-0-0	4
ME	Advanced Gas Dynamics	4-0-0	4
AM	Boundary layer Theory	4-0-0	4
AM	Multiphase Flow	4-0-0	4
ME	Gas Turbine & Jet Propulsion	4-0-0	4
ME	Thermo-Fluid Dynamics	4-0-0	4
AM	Non-Newtonian Fluid Flow and Applications	4-0-0	4
ME	Fans, Blowers and Compressors	4-0-0	4
CE	Environmental Fluid Mechanics	4-0-0	4
EC	Instrumentation & Control	4-0-0	4
	Total		**20**
AM	Thesis		**16**
	Grand Total		**72**

Programme Structure:

M.Tech. (Fluids Engineering)

SEMESTER-I

Code	Course		L-T-P	Credits
AM	Advanced Fluid Mechanics		3-0-2	4
AM	Experimental Methods & Analysis		3-0-2	4
M	Advanced Engineering Mathematics		3-1-0	4
AM	Applied Numerical Methods		3-0-2	4
	Elective-I		4-0-0	4
	Elective-II		4-0-0	4
		Total	**20-1-6**	**24**

SEMESTER-II

AM	Turbulent Flow		4-0-0	4
AM	Theory & Design of Impeller Pumps		4-0-0	4
AM	Advanced Solid Mechanics		4-1-0	4
AM	Computational Fluid Dynamics		3-0-2	4
	Elective-III		4-0-0	4
	Elective-IV		4-0-0	4
	Elective-V		4-0-0	4
		Total	**27-1-2**	**28**

SEMESTER-III

AM	Mini Project		0-0-4	4
AM	Thesis		0-0-20	4
		Total	**0-0-24**	**8**

SEMESTER-IV

AM	Thesis		0-0-25	12
		Total Credit	**0-0-25**	**72**

List of Electives

Elective-I & II			
Code	**Course**	**Code**	**Course**
AM	Hydropower & Hydraulic Turbines	ME	Thermo-Fluid Dynamics
AM	Fluid Power Control	ME	Advanced Gas Dynamics
Elective-III, IV & V			
AM	Non-Newtonian Fluid Flow and Applications	ME	Fans, Blowers and Compressors
AM	Boundary layer Theory	ME	Gas Turbine & Jet Propulsion
AM	Multiphase Flow	EC	Instrumentation & Control
CE	Environmental Fluid Mechanics		

Course Code: AM **Course Title:** Advanced Fluid Mechanics.

Contact Hours: L: 3 T: 0 P: 2 **Credit:** 4

Course Type: Core.

Examination Pattern: Class Test-I (15 marks), Class Test-II (15 marks), End Sem (40 marks). Assignment (10 marks), Practical (20 marks).

Pre-requisite: B.Tech. level knowledge in Engineering Fluid Mechanics.

Objective of the Course: The purpose of the course is to develop an understanding of fluid mechanical phenomena on the basis of a differential equation formulation of the equations of motion. The course broadens the basic knowledge of fluid mechanics and gives experience of technologically important fluid phenomena.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Basic Conservation & Governing Laws:* Statistical & continuum methods, Eulerian & Lagrangian coordinates, material derivatives, control volumes, Reynolds' transport theorem (RTT), conservation of mass, momentum and energy, constitutive equations, Navier-Stokes equations-differential & intergral approach, energy equations, governing equations for Newtonian fluids, boundary conditions.	12
2	*Potential Flows:* Stokes stream functions, solution of potential equation, flow in a sector, flow around a sharp edge, flow near a blunt nose force and moment on a circular cylinder and sphere, conformal transformations, Joukowski transformations, Elements of airfoil and wing theory.	4
3	*Viscous Incompressible Flows:* Exact solutions for Couette flow, Poiseuille flow, flow between rotating cylinders, Stokes' first problem, Stokes' second problem, pulsating flow between parallel surfaces, stagnation-point flow, flow in convergent and divergent channels, flow over porous wall. Stokes approximation, rotating sphere in a fluid, uniform flow past a sphere and cylinder, Ossen's approximation, Hele-Shaw flow.	14
4	*Turbulent flows:* concept of Reynolds stress, mean flow equations, Prandtl mixing length theory, turbulent boundary layers, drag and resistance laws, law of the wall, law of the wake, turbulent jets, wakes, and. shear layers, Kolmogorov hypotheses.	6
5	*Introduction to Compressible Flow: Introduction:* Velocity of sound and its importance, physical difference between incompressible, subsonic and supersonic flows, three reference speeds, dimensionless velocity, concepts of static and stagnation parameters. Pressure waves, finite, shock and detonation waves, compound waves, Analysis of piston excited waves, shock tubes, one-dimensional isentropic flow, normal shocks, Rayleigh flow, Fanno flow.	6
		42

Suggested Readings:

1. "Fundamental Mechanics of Fluids", I. G. Currie.
2. "Advanced Fluid Mechanics", K. Muralidhar & G. Biswas, Narosa Publishing, 2005.
3. "Boundary Layer Theory", H. Schlichting, 6th Edition, McGraw-Hill Inc., 1986.
4. "Fundamentals of Fluid Mechanics", B.R. Munson, D.F. Young & T.H. Okiishi, 2nd Ed., John Wiley.
5. "Viscous Fluid Flow", F. M. White, 2nd Edition, McGraw-Hill, 1991.
6. "Foundations of Fluid Mechanics", S.W. Yuan, Prentice-Hall India Pvt. Ltd, New Delhi.
7. "Introduction to Fluid Mechanics", R.W. Fox & A.T. McDonald, 5th Edition, John Wiley, 2001.
8. "Turbulent Flow", R. J. Garde, 2nd Edition, New Age International Publishers.
9. "Fundamental Mechanics of Fluids", Victor Streeter, McGraw-Hill, N.Y.

Course Code: AM **Course Title:** Turbulent Flow.

Contact Hours: L: 4 T: 0 P: 0 **Credit:** 4

Course Type: Core.

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks). Assignment (20 marks).

Pre-requisite: AM (Advanced Fluid Mechanics).

Objective of the Course: This course gives a detailed description of turbulent flow and describes various methods of analyzing and solving turbulence.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Introduction to turbulence*: Transition of flows, Origin of turbulence- its consequences, Phenomenological theories of turbulence, Reynolds Equation, physics of turbulent motion, characteristic scales of turbulence and order of magnitude- Kolmogorov scales. Isotopic and homogeneous turbulence. Energy Equation- correlation and spectrum. Linear Instability Theory, Nonlinear Stability Analysis, Dynamical Systems, Introduction to Chaos.	5
2.	*Dynamics of turbulence:* Vorticity dynamics- Reynolds stress and vorticity, vortex stretching, mean vorticity equation, kinetics energy and mean flow, kinetic energy of fluctuations, Navier-Stoke's equation for turbulent flow.	6
3	*Turbulent Shear Flows:* Free Shear Flows- jet flows including heat transfer- wall jet and plane jets, its structure; turbulent mixing layer and buoyancy effects- its structure; wake flows; wall-bounded shear flows- its structure; boundary layer flows; thermal plume.	5
4	*Experimental Techniques of Turbulent flows:* Photographic technique, tracer technique, pressure measurement, Hotwire and hot-film anemometry- principle, calibration methodology and data reduction; Digital Oscilloscope, Spectrum analyzer; Multi-sensor probes; Laser Doppler velocimetry (LDV); Particle image velocimetry (PIV).	5
5	*Statistical Theories of Turbulence:* Turbulent diffusion, Homogeneous Isotropic Turbulence- Karman-Howarth Equations. Probability Density Function Approach- Lundgren's Theory, Chang's Kinetic Theory of Turbulence, Pope's pdf Model. Proper Orthogonal Decomposition Method- Orthogonal Basis, First Order System, Navier-Stokes System.	5
6	*Stochastic Methods:* Coherent Structures, Wavelet Transform, Stochastic Estimation, Pseudo-Flow Visualization, Lagrangian mean approaches.	4
7	*Turbulence modeling:* Phenomenological theories of turbulence, general comments on turbulence models, Method of solving turbulent equations- Direct numerical simulation (DNS), Large-eddy simulation (LES), Reynolds averaged Navier-Stokes equation (RANS), k-ε model. Turbulence models: Eddy viscosity models -zero equation models (constant eddy viscosity and mixing length models), one equation models, two equation models; Reynolds stress transport models (RSM).	8
8	*Applications of turbulence modeling:* Channel and zero-pressure gradient boundary layer flow, flow separation- diffuser flow, hill flow, rotational flow, duct flows, duct with curvature effects, stagnation point flow.	4
		42

Suggested Readings:

1. "Turbulent Flow: Analysis, measurement and Prediction", Bernard, P.S. ad Wallace, J.M., John Wiley & Sons Inc., New Jersey, 2002.
2. "Turbulent Flows", Biswas, G. and Eswaran, V. Narosa Publishing, 2002.
3. "Turbulent Flows" (3rd ed.), Garde, New Age International, New Delhi.
4. "Turbulence", Hinze, McGraw Hill Inc.

Course Code: AM **Course Title:** Computational Fluid Dynamics.

Contact Hours: L: 3 **T:** 0 **P:** 2 **Credit:** 4

Course Type: Core.

Examination Pattern: Class Test-I (15 marks), Class Test-II (15 marks), End Sem (40 marks). Teacher's Assessment (10 marks), Practical (20 marks).

Pre-requisite: AM (Advanced Fluid Mechanics)

Objective of the Course: This course offers an in-depth knowledge of computational methods normally used to get results in various complex problems of fluid dynamics.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Basic ideas of CFD:* Introduction to CFD, role of CFD and its applications, future of CFD. *Governing equations (GE's) of Fluid dynamics:* Modeling of flow, control volume concept, substantial derivative, physical meaning of the divergence of velocity. Continuity equation, momentum equation, energy equation and its conservation form. Equations for viscous flow (Navier-Stokes equations), equations for inviscid flow (Euler equation). Different forms of GE's, initial and boundary conditions.	4
2	*Mathematical properties of Fluid dynamic equations:* Classification of partial differential equations (PDE's)– linear vs. non-linear, parabolic, elliptic and hyperbolic equations. Discretization of PDE's basic aspects of finite difference methods (FDE's), Taylor series and polynomial representation. Explicit and implicit approaches, numerical errors.	5
3	*Solutions of parabolic PDE's:* Von-Neumann stability analysis, CFL condition and consistency, Dufort-Frankel method, Fourier stability analysis of implicit schemes. *Solutions of elliptic PDE's:* Convergence theorem, relaxation technique and its use with low speed inviscid flow, alternate direction implicit (ADI) technique.	5
4	*Solutions of hyperbolic PDE's:* Explicit methods– FTCS scheme, First upwind difference method, Mid-point leap frog method, Lax-Wendroff method and selected applications. Implicit methods Fully implicit FTCS methods, Crank-Nicholson method, Mac-Cormack scheme and selected applications in solving boundary layer equations.	5
5	*Grid Generation:* General transformation of the equations. Metices and Jacobians. Types of grids, grid generation methods. Coordinate stretching, boundary-fitted coordinate systems. Elliptic and hyperbolic grid generation method, orthogonal grid generation for Navier-Stokes equations.	5
6	*Finite element methods in CFD:* Strong and weak formulation of boundary-valued problems (BVP's), finite element interpolation, finite element with continuity, implementation of FEM in CFD and solution.	4
7	*Finite volume method in CFD:* Finite volume discretization, geometric constraints of FVM, FVM for three-dimensional flows, evaluation of viscous terms, first-order upwinding and central differencing schemes, high resolution finite-volume upwind schemes (TVD scheme), spectral resolution FVS scheme (QUICK scheme).	4
8	*Solution techniques of Navier-Stokes equations:* Stream function, vorticity formulation for two-dimensional flows, solution of stream function equation (SFE), wall-vorticity estimation, solution of vorticity transport equation (VTE), solution of Navier-Stokes equations using MAC and SIMPLE algorithm (pressure correction technique).	5
9	*Introduction to turbulence modeling:* Reynolds averaged N-S equations, various turbulence models– mixing length, k-epsilon, Reynolds stress. Boundary conditions, paraboloid N-S equations, direct numerical simulations (DNS) and large-eddy simulation, sub-grid models, pseudo-spectral method, examples.	5
		42

Suggested Readings:

1. "Computational Fluid Dynamics, The Basics with Applications", J.D. Anderson, Jr., McGraw-Hill, 1995.
2. "Computational Techniques for Fluid Dynamics Volume I & II" (2nd edition), C.A.J. Fletcher, Springer-Verlag, 1991.
3. "Computational Fluid Mechanics and Heat Transfer" (2nd edition), J.C. Tannehill, D.A. Anderson and R.H. Pletcher, Taylor and Francis, 1997.
4. "Principles of Computational Fluid Dynamics", P. Wesseling, Springer-Verlag.
5. "Numerical Computation of Internal and External Flows" (Vols. I & II), C. Hirsch, Wiley International, 1988.
6. "Computational Fluid Dynamics for Engineers" (Vols. I & II), K. Hoffmann and S. T. Chiang, Engineering Education System, 1993.
7. "Numerical Heat Transfer and Fluid Flow", S.V. Patankar, McGraw-Hill, New York, 1980.

8. "An Introduction to Computational Fluid Dynamics: the Finite Volume Method", H.K. Versteeg and W. Malalasekera, Longman Scientific & Technical, 1995/Addison-Wesley, 1996.
9. "Computational Methods for Fluid Dynamics" (3rd edition), J.H. Ferziger and M. Peric, Springer, 2001.
10. "Fundamentals of Computational Fluid Dynamics", T. K. Sengupta, Universities Press, Hyderabad, 2004.
11. "Computational Fluid Flow and Heat Transfer" (2nd edition), K. Muralidhar and T. Sundararajan, Narosa Publishing, 2004.

List of Experiments:

Grid generation (meshing) and solutions of governing equations of Fluid dynamics are to be carried out with help of programming.

Course Code: AM **Course Title:** Theory & Design of Impeller Pumps.

Contact Hours: L: 4 **T:** 0 **P:** 0 **Credit:** 4

Course Type: Core.

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks). Assignment (20 marks).

Pre-requisite: B.Tech. level knowledge in Hydraulic Machinery.

Objective of the Course: The purpose of the course is to teach the application of laws of fluid mechanics in impeller pumps.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Introduction:* Classification of pumps, layout of rotodynamic pumps, head, discharge, power and efficiencies. Dimensional analysis, non-dimensional parameters, condition of similarity, specific speed and its significance. Elements of pumps- impeller, casings, diffusers etc.	4
2	*Centrifugal Pumps:* Classification, single stage and multi-stage pumps, components, priming, pressure rise in pumps, cavitation, NPSH, Thomas cavitation factor, axial thrust.	6
3	*Flow through Impeller:* Euler's fundamental equations, theoretical head for an infinite number of blades, influence of a finite number of blades, pressure and velocity distribution in impeller passages, influence of circulation in impeller passages, influence of pre-whirl on head, choice of blade outlet angle, stalling and surging.	6
4	*Axial & Mixed Flow Pumps:* Geometry of the axial flow impeller vanes, experimental design factors- impeller hub ratio, chord spacing ratio, number of vanes, vane curvature and thickness. Airfoil theory of vanes. Helical pumps and diagonal pumps.	6
5	*Impeller Design:* Geometrical velocity fields, evolution of impeller shapes, impellers with blades of single and double curvature, design calculation of the impeller- principal dimensions. Blade design- blade surface area, blade shape and blade angles, method of determining blade angle for centrifugal and axial impellers. Relation between overall efficiency and specific speed.	6
6	*Pump Casing:* Flow at the outlet of the impeller, volute casing, volute design for optimum efficiency, circular volutes. Crossover, diffusion casing and diffusion rings, axial diffusers.	4
7	*Pump Characteristics:* Classification of characteristics, non-dimensional characteristics, pump operation at off-design conditions, affinity of characteristic curves, iso-efficiency curves, flow conditions corresponding to the optimum efficiency, influence of flow conditions on pump operation,. Pump in series and parallel. Matching of pumps to system characteristics; multi-stage pumps. Losses in pumps, total head-discharge curves.	6
8	*Pump for special duties:* Deepwell pump submersible pump and vertical turbine pump. Storage pump, turbine pump, boiler-feed pump, circulating pump, condensate pump, non-clog pump, marine pump, self-priming pump.	4
		42

Suggested Readings:

M.Tech. in Fluids Engineering

1. "Impeller Pumps", Stephen Lazarkiewicz and A.T. Troskolanski, Pergamon Press, Warsaw, 1965.
2. "Centrifugal and Axial Flow Pumps- Theory, Design and Applications", A. J. Stepanoff, John-Wiley & Sons, 1967.
3. "Pumps, Fans and Compressors", A. de Kovats and G. Desmur, Blackie & Son Ltd., Glasgow, 1958.
4. "Rotodynamic Pump Design" by R.K. Turton,
5. Centrifugal Pumps & Blowers" by A. Church and Jagdish Lal, Metropolitan Book Co., Delhi.
6. "Pump Handbook", I.J. Karassic, Tata McGraw Hills Ltd. New Delhi.
7. "Critical Aspects in Rotodynamic Pumps and systems", R.K. Srivastava, Techo Economic Research Institution , New Delhi.
8. "Hydraulic Machines", Jagdish Lal, Metropolitan Book Co., Delhi.
9. "Fluid Mechanics and Thermodynamics of Turbomachinery", 4th Edition,, S.L.Dixon, Butterworth and Heinemann, 1998.
10. "Hydraulic machines", V.P.Vasandani.

Course Code: AM **Course Title:** Experimental Methods & Analysis.

Contact Hours: L: 3 T: 0 P: 2 **Credit:** 4

Course Type: Core.

Examination Pattern: Class Test-I (15 marks), Class Test-II (15 marks), End Sem (40 marks).

Assignment (10 marks), Practical (20 marks).

Pre-requisite: Nil.

Objective of the Course: The course highlights the measurement techniques of various physical parameters and the related system involved in experimental work.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Generalized measurement system:* Basic detector transducer elements, intermediate modifying systems, terminating devices & methods.	2
2	*Statistical Analysis:* The application of various statistical methods to experimental data analysis, Probability analysis, Gaussian error distribution, confidence intervals, linear regression and T-Distributions. Data acquisition, data reduction and experimental uncertainty analysis. Method of rejecting a reading, Chi-square test of goodness of fits, method of least square, graphical analysis and curve fitting. Methods for increasing accuracy of experiments, propagation of errors in experiments. Error analysis. Design of experiments.	8
3	*Dynamics of Instruments:* Ist order, 2nd order	6
4	*Electronic Interfacing of Experiments:* General-purpose electronic instruments, overview of computer interfacing including external communications and A/D, D/A conversion. Data acquisition systems, comparison between automated and manual data acquisition systems. Signal processing & uncertainty, block diagram, time response of first order & second order systems, analysis and application of electromechanical transducers & sensors, computer control of experiments. Recording techniques and Automatic control systems.	9
5	*Velocity Measurements:* Pressure measurements- high and low pressures, dynamical characteristics of pressure measuring devices. Velocity measurements- Hot-wire anemometry, Laser Doppler anemometry, Particle image velocimetry, multi-hole pressure probes.	5
6	*Discharge Measurements:* types of flow-rate meters, venture, orifice, nozzlemeter, rotameter, turbine flowmeter, magnetic flowmeter, coriolis flowmeter, weir & notches.	5
7	*Temperature Measurements:* Temperature measurements by mechanical effects, electrical effects and by radiation, transient response of thermal systems, temperature measurement in high speed flow.	3
8	*Electrical Resistance Strain Gauges:* Principle of operation, type and its fixing, strain rosettes, strain gauge circuits.	2
9	Testing, calibration & standardization of instruments, national and international standards like NABL, ISO.	2

Suggested Readings:

1. "Experimental Methods for Engineers", J.P. Holman, McGraw-Hill Inc., NY, 2001.
2. "Measurement Systems: Applications & Design", E.O. Doebelin, McGraw-Hill Inc.
3. "Mechanical Measurement" (5th ed.), T.G. Beckwith, Pearson Education, New Delhi, 2001.
4. "Turbulent Flow Analysis Measurement and Prediction", P. Bernard, John Wiley, Canada, 2002.
5. "Temperature Measurement" (2nd ed.), L. Michalski, John Wiley & Sons Ltd., NY, 2001.
6. "Mechanical Variables Measurement: Solid, Fluid and Thermal", J.G. Webster, CRC Press, NY.
7. "Mechanical Measurements", D.S. Kumar.

List of Experiments:

Experiments are to be conducted in Fluid mechanics lab with statistical analysis of practical data obtained.

Course Code: AM **Course Title:** Applied Numerical Methods.

Contact Hours: L: 3 T: 0 P: 2 **Credit:** 4

Course Type: Core.

Examination Pattern: Class Test-I (15 marks), Class Test-II (15 marks), End Sem (40 marks). Assignment (10 marks), Practical (20 marks)

Pre-requisite: NIL.

Objective of the Course: The course imparts an idea of construction and use of large numerical systems. Influence of data representation and computer architectures on algorithms choice and development are also to be understood.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	Review of the properties of Hermitian matrices, Gerschgorin's theorem.	2
2	Power method for dominant, subdominant and smallest eigen values.	2
3	Determination of eigen values and eigen vector of symmetric matrix and unsymmetric matrix, methods of Jacobi, Given's and House-Holder's, LR, QR algorithms.	4
4	*Numerical solution of ordinary differential equations:* Taylor series method, Euler and modified Euler methods, predictor-corrector methods, Runge-Kutta methods, Adams-Moulton methods, Adams-Bashforth methods, convergence criteria, errors and error propagation. Methods for stiff equations, Gear's methods. Boundary-value problems for ODEs, applications of eigen values, Finite-difference methods as digital filters: Transfer-function analysis.	7
5	*Numerical solution of partial differential equations:* First-order quasilinear PDEs, Method of characteristics, Burgers' equation, Shock waves and characteristics, Stability analysis of explicit FD methods: Transfer function, von Neumann's method, matrix method, Weighted-differencing methods: upwind differencing, Implicit differencing schemes. Classification of second-order quasilinear PDEs.	7
6	*Parabolic PDEs:* General approach, discretization in space, leading to a system of ODEs in time. Explicit methods; stability analysis; stiffness of resulting system of ODEs, Implicit methods; stability analysis. Crank-Nicholson scheme, Stiff methods.	4
7	*Hyperbolic PDEs:* Method of characteristics (standard formulation), Method of characteristics (matrix formulation), Finite-difference schemes, Dispersion-relation analysis of finite-difference schemes.	4
8	*Elliptic PDEs:* Finite-difference schemes, Iterative methods for solving linear systems, Jacobi, Gauss-Seidel, Successive over-relaxation, Conjugate gradients, Operator-splitting methods, Multigrid methods.	4
9	*Approximation methods:* Methods of weights residuals, Rayleigh-Ritz method, Collocation, Least square and Galerkin's method, variational formulation of given boundary value	8

	problem (Simple example from ODE and PDE.)	42

Suggested Readings:

1. "Applied Numerical Analysis", C.F. Gerald and P.O. Wheatley, 5th edition, Addison-Wesley, 1998.
2. "Numerical Mathematics & Computing", W. Cheney and D. Kincaid, 5th edition, Brooks/Cole, 2004.
3. "Applied Partial Differential Equations", Paul DuChateau and David Zachmann.
4. "Partial Differential Equations for Scientists and Engineers", Stanley J. Farlow.
5. "Numerical Methods for Partial Differential Equations", William F. Ames.
6. "Numerical Methods for Elliptic and Parabolic Partial Differential Equations", John R Levison, Peter Knabner, Lutz Angermann .

List of Experiments:

Assignments include both regular written homework and computer programming, which may involve writing a brief report. Representative problems will be assigned to be solved on the computer in MatLab or Mathematica or any suitable programming languages such as FORTRAN or C.

Course Code: M **Course Title:** Advanced Engineering Mathematics.

Contact Hours: L: 3 **T:** 1 **P:** 0 **Credit:** 4

Course Type: Core.

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks). Assignment (10 marks), Tutorial (10 marks).

Pre-requisite: NIL.

Objective of the Course: Developing applied approach for solving real life problems.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	Systems of Differential equations, Phase Plane,Qualtitive Methods: (i) Introduction: Vectors,Matices,Eigen values (ii) Introductory examples: Mixing problem involving two tanks, Model of electrical network, Mass on spring etc. (iii) Basic Concept and Theory: Existence and Uniqueness theorem, Superposition principle, Basis, General Solution, Wronksian. (iv) Homogeneous Systems with Constant Coefficients: Phase Plane, Critical Points, Stability. (v) Qualitative Methods for Nonlinear Systems: Linearization of nonlinear systems(Free undamped pendulum, damped pendulum equation,Lotka-Volterra Population Model, Vander Pol Equation) (vi) Non-homogeneous linear systems	7
2	Legendre Polynomials, Chebyshev Polynomials, Bessel Functions and Sturm-Liouville Problems: (i) Legendre Polynomials: Rodrigue's Formula, Generating Function, Recurrence relations, Orthogonality. (ii) Chebyshev Polynomials: Chebyshev Polynomials of first and second kind . (iii) Bessel's Functions: Bessel's function of first and second kind (iv) Sturm-Liouville Problem: Orthogonality of Bessel's Functions, Fourier-Bessel Series	7

3	Fourier Integral, Fourier Transform and Z Transform: (i) Fourier Integral Theorem, Fourier Transform, Convolution (ii) Finite Fourier Sine and Cosine Transforms, Parseval's Identity (iii) Fourier Transform Solution of PDE (iv) Z-transforms and its solution to solve linear difference equations	7
4	Calculus of Variations: (i) Functional, Euler's equation and its solution, Geodesics, Isoperimetric Problems, Several dependent variables. (ii) Functional involving higher order derivatives (iii) Hamilton's Principle, Lagrange's equations.	7
5	Linear Programming: (i) Formulation of problem, Graphical Method, General linear programming problem, Canonical and Standard forms of L.P.P. (ii) Simplex Method, Artificial variable techniques, Duality Concept. (iii) Transportation problems, Degeneracy in transportation problems.	7
6	Mathematical Statistics: (i) Random Sampling, Estimation of Parameters, Confidence intervals. (ii) Testing of Hypothesis, Decisions, and Quality Control. (iii) Acceptance Sampling, Goodness of fit, χ^2 -Test. (iv) Nonparametric Test.	7
		42

Suggested Readings:

1 "Advanced Engineering Mathematics", Erwin KreyZig.
2 "Higher Engineering Mathematics",B.V.Ramana.
3 "Advanced Engineering Mathematics", R.K.Jain and S.R.K. Iyengar.

Course Code: AM **Course Title:** Advanced Solid Mechanics.

Contact Hours: L: 3 T: 1 P: 0 **Credit:** 4

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks). Assignment (10 marks), Tutorial (10 marks).

Pre-requisite: Strength of Materials.

Objective of the Course: To develop a close interaction between solid and fluid mechanics.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	Analysis of Stress: Concept of Stress, Stress Components, Equilibrium Equations, Stress on a General Plane (Direction Cosines, Axis Transformation, Stress on Oblique Plane through a point, Stress Transformation), Principal Stresses, Stress Invariants, Deviatoric Stresses, Octahedral Stresses, Plane Stress, Stress Boundary Condition Problem	5
2	Analysis of Strain: Deformations (Lagrangian Description, Eulerian Description), Concept of Strain, Strain Components (Geometrical Interpretation), Compatibility Equations, Strain transformation, Principal Strains, Strain Invariants, Deviatoric Strains, Octahedral Strains, Plane Strain, Strain Rates	4
3	Stress-Strain Relations: Introduction, One-Dimensional Stress-Strain Relations (Idealized Time-independent and Time dependent stress-strain laws), Linear Elasticity (Generalized Hooke's Law), Stress-Strain Relationships for Isotropic and Anisotropic Materials (Plane stress and Plane Strain)	4
4	Basic Equations of Elasticity for Solids: Introduction, Stresses in Terms of displacements, Equilibrium Equations in terms of displacements, Compatibility equations in Terms of	4

	Stresses, Special cases of Elasticity equations (Plane Stress, Plane strain, Polar Co-ordinates), Principle of Superposition, Uniqueness of Solution, St. Venant's Principle, Methods of analysis for Elastic Solutions, Elastic solutions by Displacement and stress Functions, Airy's Stress Function (Plane stress, Plane strain, Polar Co-ordinates)	
5	Plasticity: Introduction, Basic Concepts, Yield Criteria (Tresca, Von-Mises, Mohr Coloumb, Drucker-Prager), Yield Surface, equivalent stress and equivalent strain, Plastic work, Flow Rule-Plastic Potential, Elastic-Plastic and plastic stress-strain relations, Plastic Flow of anisotropic materials	5
6	Viscoelasticity and Viscoplasticity: Introduction, Viscoelastic models (Maxwell, Kelvin-Voigt, Generalized Maxwell and Kelvin models), Creep and relaxation, Viscoelastic stress-strain relationships, Creep laws and Stress-stress relationships, Viscoplasticity	6
7	Application to Simple Problems: Elasticity Problems, Plasticity Problems, Viscoelasticty problems, Viscous Fluid problems	6
8	Solid-Fluid Interaction: Vibrations of elastic structures, Small movements of inviscid fluids, sloshing modes, Hydroelastic vibrations	8
	Total	42

Suggested Readings:

1. "Advanced Strength of Materials" by Seely and Smith.
2. "Advanced Mechanics of Materials" by Boresi.
3. "Advanced Strength of Materials" by L. S. Srinath.
4. "Theory of Elasticity" by Timoshienko.

Course Code: AM **Course Title:** Mini Project.

Contact Hours: L: 0 T: 0 P: 8 **Credit:** 4

Course Type: Core.

Examination Pattern: The assessment of mini project would be done at the end of the third semester by a committee consisting of departmental faculty members of Applied Mechanics. The students will present their mini project before the committee - the complete mini-project report based on the work done should be submitted by the students to the assessing committee one week before the assessment - the committee will award the grades for the individual students in mini project.

Objective of the Course: Students will have to identify a mini technical topic/problem and to study it thoroughly before finally present it to the examiners.

Details of the Course:

The mini project can be a design project, experimental project; industrial problem or computer oriented and will be allotted to each student separately. The topic of the mini project for any student should be different from his/her thesis.

Course Code: AM **Course Title:** Hydropower & Hydraulic Turbines.

Contact Hours: L: 4 T: 0 P: 0 **Credit:** 4

Course Type: Elective.

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks), Assignment (20 marks).

Pre-requisite: B.Tech. level knowledge in Hydraulic Machines.

Objective of the Course: The purpose of the course is to teach the application of laws of fluid mechanics in hydraulic turbines.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Hydropower plants:* Types, main components. Plant load factor, load duration curve, installed capacity, firm power, secondary power, and load prediction.	2
2	*Penstocks and Water Hammer:* Types of penstocks and their design criteria, Economical diameter of penstock, Valves, Bends, Manifolds, Effect of Water-hammer in penstock, Surge tanks.	5
3	*Introduction to Hydraulic Turbines:* Definition of head, discharge, power and efficiency of hydraulic turbines and hydro-unit. Classification based on head, specific speed, degree of reaction and direction of flow. Energy losses in turbines. Euler's energy equation, blade surface equation.	4
4	*Impulse Turbines:* Energy conversion in Pelton turbine, design parameters, design of turbine runner, nozzle, spear.	4
5	*Reaction (Francis)Turbines:* Classification, flow in runner, design parameters, determination of meridional flow, one-dimensional method of designing runner blades, relationship between the shape of blades and two-dimensional flow within runners. Blade designing in potential and rotational meridional flow. Draft tube- design and application. Deriaz turbine.	8
6	*Reaction (Axial Flow) Turbines:* Major definitions and relations concerning the flow within a runner, design parameters, flow upstream and downstream of the runner, determination of velocity triangles at inlet and outlet of the runner. Airfoil method of blade designing cascade analysis and its performance, loss mechanism, blade profiles, forces acting on blades.	7
7	*Cavitation in Hydraulic Turbine:* Condition, types, consequences, remedy. Turbine cavitation coefficient, NPSH. Similarity laws in cavitating flows. Method of cavitation investigation in hydraulic turbines at laboratories and hydropower plants.	4
8	*Turbine Performance Characteristics:* Main characteristics and operating characteristics, iso-efficiency characteristics, Determination of major prototype turbine parameters on the basis of model characteristic curves. Derivation of the complete characteristics of prototype turbine. Distorted model, scale effect and efficiency.	8
		42

Suggested Readings:

1. "Water Power Engineering", H.K. Barrows, McGraw-Hill Book Co., New York.
2. "Hydropower Structures", R.S. Varshney, Nemchand & Brothers, Roorkee (U.P.), 1992.
3. "Incompressible Flow Machines", D.H. Norrie, Edward-Arnold, London, 1987.
4. "Hydraulic Turbines" (Volume I and II), V. V. Barlit, MACT- Bhopal, 1969.
5. "Hydraulic Machines", Jagdish Lal, Metropolitan Book Co., Delhi.
6. "Fluid Mechanics and Thermodynamics of Turbomachinery", 4th Edition,, S.L.Dixon, Butterworth and Heinemann, 1998.
7. "Hydraulic Turbine", M. Nechleba, McGraw-Hill Inc., New York, 1957.

Course Code: AM **Course Title:** Fluid Power Control.

Contact Hours: L: 4 T: 0 P: 0 **Credit:** 4

Course Type: Elective.

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks), Assignment (20 marks).

Pre-requisite: Advanced Fluid Mechanics

Objective of the Course: The purpose of this course is to give a first-hand idea of fluid power application in industrial hydraulics and pneumatics. The laboratory classes involve hydraulic and/or pneumatic circuit analysis with help of trainer kit.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Introduction to Fluid Power:* history, applications, system components and symbolic representation.	3
2	*Properties of Hydraulic Fluids:* weight, density, specific gravity, pressure, Pascal's law, bulk modulus, viscosity. Contamination and Filtration, Heat Generation and Control.	3
3	*Energy and Power in Hydraulic Systems:* Energy and power, application of Pascal's law, conservation of energy, conservation of mass, Bernoulli's equation, Torricelli's theorem, Siphon, power and flow rates Frictional Losses in Hydraulic Pipelines.	3
4	*Basics of Hydraulic Flow in Pipes:* laminar and turbulent flows, Reynolds number, Darcy's equation, frictional losses, losses in valves and fittings, Hydraulic circuit analysis, flow and pressure measurements.	3
5	*Hydraulic Pumps & Motors:* pumping theory, gear, vane, and piston pumps, pump performance and selection. Hydraulic Motors.	3
6	*Fluid Power Actuators:* hydraulic cylinders and cushioning devices, linear and rotary actuators, gear, vane, and piston motors, hydrostatic transmission, electro-hydraulic motors, low-speed, high-torque motors.	3
7	*Control components:* directional control valves (DCV's), pressure control valves (PCV's), flow control valves (FCV's), servo valves, hydraulic fuses, pressure and temperature switches, shock absorbers. Ancillary hydraulic devices.	6
8	*Hydraulic Circuit Analysis:* control of various circuits, regenerative, pump-unloading, double-pump, pressure intensifier, counterbalance, cylinder sequencing, automatic cylinder reciprocating systems, locked cylinders, fail-safe circuits, speed control of motors, air-over-oil circuits, accumulator circuits, servo systems. Maintenance of hydraulic systems.	6
9	*Distribution systems:* Hydraulic conductors and fittings, conductor sizing, pressure rating, pipe materials.	3
10	*Pneumatics:* properties of air, perfect gas laws, air preparation and components, compressors, fluid conditioners. Pneumatic circuit design, pneumatic vacuum systems.	5
11	*Basic Electrical Controls for Fluid Power Circuits: Fluid* Logic control systems, Advanced electrical controls for fluid power systems.	4
		42

Suggested Readings:

1. "Fluid Power with Applications", A. Esposito, Prentice Hall of India, New Delhi, 2003.
2. "Hydraulics and Pneumatics", Andrew Parr, Jaico Publishing, Mumbai, 2002.
3. "Fluid power Controls", J.J. Pippenger, McGeraw-Hill Inc.

Course Code: ME **Course Title:** Advanced Gas Dynamics.

Contact Hours: L: 4 T: 0 P: 0 **Credit:** 4

Course Type: Elective.

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks). Assignment (20 marks).

Pre-requisite: Advanced Fluid Mechanics.

Objective of the Course: The aim is to develop a concept of compressible flow and its application.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Normal Shocks:* Governing equations, Rankine - Hugoniot, Prandtl and other relations, weak shocks, thickness of shocks, normal shocks in ducts, performance of convergent-	6

	divergent nozzle with shocks, moving shock waves, shock problems in one dimensional supersonic diffuser, supersonic pitot tube.	
2	*Flow in Constant Area Duct with Friction:* Governing equations, working formulas and tables, choking due to friction, performance of long ducts, Isothermal flow in long ducts.	4
3	*Flow in Constant Area Duct with Heating and Cooling:* Governing equations, working formula and tables, choice of end states, choking effects, shock waves with changes in stagnation temperature.	4
4	*Generalized One-Dimensional Flow:* Working equations, general method of solution, example of combined friction and area change, Example of combined friction and heat transfer.	6
5	*Oblique shock:* governing physical equations and general relations, shock polar diagram and auxiliary diagrams, strong and weak shocks, detached shock, interaction and reflection of shocks.	6
6	*Method of characteristics:* general principle of integration using method of characteristics, application to one dimensional isentropic progressive waves, application to steady two dimensional irrotational isentropic supersonic flows, Prandtl-Meyer expansion.	6
7	Boundary layer flow with Prandtl number unity and arbitrary Prandtl number, Integral equations of Laminar boundary layer, Differential and integral equations of Boundary layer, flow past a flat plate with turbulent Prandtl number of Unity. Elementary idea of boundary layer in tubes and in the presence of shock waves. Study of various flow visualization techniques. Study of different types of wind tunnels, their design criteria.	10
		42

Suggested Readings:

1. "Gas Dynamics", E. Rathakrishnan, Prentice-Hall of India, New Delhi, 2002.
2. "Compressible Fluid Flow", M.A. Saad, Prentice-Hall, New Jersey, 1985.
3. "Fundamentals of Compressible Flow", S.M. Yahya, Wiley Eastern.
4. "The Dynamics and Thermodynamics of Compressible Fluid Flow" (2 volumes), A. H. Shapiro, The Ronald Press, New York, 1953.
5. "Wind Tunnel Design", Pope.

Course Code: AM **Course Title:** Boundary Layer Theory.

Contact Hours: L: 4 T: 0 P: 0 **Credit:** 4

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks), Assignment (20 marks).

Pre-requisite: AM (Advanced Fluid Mechanics),

Objective of the Course: To get an insight to the boundary layer problems and its solution techniques.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Introduction:* Review of boundary layers: laminar and turbulent boundary layers; transition; separation. Review of compressible flows: speed of sound; Mach no. Application to subsonic, transonic and supersonic flow around a two-dimensional aerofoil.	6
2	*Equations of Motion:* Continuity, momentum and energy equations for three-dimensional flows. The approximations leading to Bernoulli's equation. The inviscid, irrotational approximation leading to the compressible Bernoulli equation and velocity potential. The incompressible boundary layer approximation leading to the boundary layer and momentum integral equations.	8
3	*Incompressible Laminar Boundary Layers:* Exact solutions of the Navier-Stokes equation exhibiting boundary layer at low viscosity. The boundary-layer equations in the spirit of Prandtl. Scaling, non-dimensionalisation and Reynolds number. Limitations of potential flow past a cylinder. Prandtl's boundary-layer equations in two dimensions deduced by order-of-magnitude arguments. Blasius solution: displacement thickness, skin friction, drag.	10
4	*Transition and Incompressible Turbulent Boundary Layers:* Concept of stability; basis of	8

	boundary layer stability analysis; physics of transition to turbulence. Reynolds stresses, mean velocity and shear stress in a turbulent boundary layer; the log law and power law profiles. Turbulent boundary layers in zero and non-zero pressure gradients. Separation in adverse pressure gradients. Concept of and occurrence in steady flows, and at rear stagnation point of impulsively started cylinder. Form of skin friction near separation point: Goldstein singularity. Introduction to interactive boundary layers. Goldstein near wake. Trailing-edge triple deck.	
5	*Introduction to Perturbation Theory:* Regular and singular perturbations. Examples from algebraic equations and ordinary differential equations. The classical boundary-layer equations of Prandtl as the leading term in a matched asymptotic expansion. Exact solutions of the classical boundary-layer equations like Flow past a wedge: Falkner Skan. Far wake of a flat plate. Two-dimensional jet. Lock's mixing layer. Prandtl transformation. Prandtl-Glauert law for subsonic flow; Ackeret's law and applications. Axisymmetric flows: Mangler's transformation. Split disc Ekman layer problems: Stewartson layers. Glauert wall jet.	10
		42

Suggested Readings:

1. "An Introduction to Fluid Mechanics", Batchelor, G. K., Oxford University Press.
2. "The Laminar Boundary-Layer Equations", Curle, N., Oxford University Press.
3. "Modern Fluid Dynamics, Vol I. Incompressible Flow ", Curle, N. & Davies, H. J., Van Nostrand.
4. "Perturbation Methods", Hinch, E. J., Oxford University Press.
5. "Boundary Layer Theory", Schlichting, H.,. McGraw Hill.
6. "Perturbation Methods in Fluid Mechanics", Van Dyke, M., Parabolic Press.
7. "Laminar Boundary Layers", Rosenhead, L. (Edited), Oxford University Press.
8. "Introduction to Perturbation Techniques", Nayfeh, A.
9. "Introduction to Interactive Boundary Layer Theory", Sobey, I. J., Oxford University Press.
10. "Modern Compressible Flow with Historical Perspective", John D. Anderson, McGraw Hill.
11. "Fundamentals of Aerodynamics" (2nd ed), J. D. Anderson, McGraw Hill.

Course Code: AM **Course Title:** Multi-phase Flow.

Contact Hours: L: 4 T: 0 P: 0 **Credit:** 4

Course Type: Elective.

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks), Assignment (20 marks).

Pre-requisite: Advanced Fluid Mechanics, Theory & Design of Impeller Pumps.

Objective of the Course: The course imparts an idea of two-phase flow (solid-liquid, liquid-gas etc.) and their practical applications.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Introduction to Multiphase Flow:* History of multiphase flow investigation, Multiphase Flow in Engineering, Parameters, characterizing multiphase flow.	5
2	*Classification of Multiphase Flow:* Flow Patterns (Solid-Liquid, Solid-Gas, Gas- Liquid), Dispersed flow, intermittent flow, Separated flow.	5
3	*Basic Equation:* Mass, momentum and energy conservations, Constitutive law.	5
4	*Cavitation Phenomena:* Homogeneous flow, Bubbly flow, Separated flow, Intermittent flow, Inception and Cavitation Nuclei, Bubble Dynamics, Developing Process of Cavitation, Cavitation Characteristics.	6
5	*Numerical Methods for Complex Multiphase Flow:* Mathematical Modeling- Homogeneous flow model, Drift-flux model, Two-fluid model, Void fraction and pressure drop estimation, Homogeneous flow model, Separated Flow model. Mathematical Modeling and Numerical Analysis of Gas-Liquid Two-Phase Flow. Numeical Simulation	8

	of Cavitating Flow.	
6	Wave propagation, Flow instability, Flow pattern transition, Ledinegg type flow instability.	3
7	*Slurry Pumps:* Design & uses.	5
8	Recent advancement in multiphase flow.	5
		42

Suggested Readings:

1. "Cavitation and Multiphase Flow Phenomena", F.G. Hammitt, McGraw-Hill Inc., NY, 1980.
2. "Two Phase Flows and Waves", D. Joseph Daniel, Springer-Verlag, NY, 1990.
3. "Two phase Flows and Heat Transfer", S. Kakac & T.N. Veziroglu, Hemisphere Publishing, London.

Course Code: ME **Course Title:** Gas Turbines & Jet Propulsion

Contact Hours: L: 4 T: 0 P: 0 **Credit:** 4

Course Type: Elective.

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks), Assignment (20).

Pre-requisite: AM (Advanced Gas Dynamics)

Objective of the Course: The course offers an idea of gas turbine, its construction, working, performance and uses along with jet propulsion techniques.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Gas Turbine Outline:* Review of Thermodynamic principles, Gas turbine cycles, main components of Gas turbine power plants, performance characteristics, typical Gas Turbine Plants.	3
2	Methods of improving efficiency and power output of gas turbine plants.	1
3	Design considerations of Centrifugal and axial flow compressors.	4
4	Types of Gas turbine plants and their theory of operation, design consideration of gas turbine plants.	4
5	Detailed study of main systems of gas turbine plants.	4
6	Selection of materials of Gas turbine components.	1
7	Trouble shooting, maintenance and actual performance evaluation of gas turbine plants.	2
8	Recent development of gas turbine plants.	1
9	*Jet Propulsion Outline:* Basic theory of Jet & rocket propulsion devices and historical development. Types of various jet propulsion plants like air screw, turboprop, turbojet, Ram jet, pulse jet, rocket propulsion, etc. and their comparative study.	5
10	Performance study of various jet propulsion devices from ideal and practical consideration.	5
11	Study and design considerations of main components of jet propulsion plants. Thrust augmentation devices and their thermodynamic analysis.	5
12	Combustion performance, products of combustion and their properties.	3
13	Troubleshooting and maintenance of jet propulsion plants.	2
14	Rocket engines, of chemical propellant, liquid and solid propellants.	1
15	Recent advances in jet propulsion and Rocket propulsion devices.	1
		42

Suggested Readings:

1. "Gas Turbine Fundamentals", Cohen, Rogers and Saravanamutto, Pearson Education.
2. "Jet Propulsion", Jack D. Mattingly, McGraw Hill Inc.
3. "Gas Turbines", V. Ganeshan, Tata-McGraw-Hill, New Delhi.
4. "Gas Turbines", R. Yadav.

Course Code: ME **Course Title:** Thermo-Fluid Dynamics.

Contact Hours: L: 4 T: 0 P: 0 **Credit: 4**

Course Type: Elective.

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks), Assignment (20 marks).

Pre-requisite: B.Tech. level understanding of Thermodynamics Fluid Mechanics.

Objective of the Course: This course supplements the close interaction between thermal and fluid mechanics in various practical problems.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*Thermodynamic State Equations:* Perfect and real gases, state equation of perfect gas, Amagat's isothermals, Detailed study of Van der Waal, Dieterio, Berthelot, Redlich and Kwong and other state equations for real gases, compressibility factor and compressibility chart, generalized chart.	4
2	*Review of Thermodynamic Laws and Entropy:* Reversibility and irreversibility, statements of second law and their discussion Equivalence of Kelvin-Planck and Clausius statements, Carnot engine and Carnot refrigeration, Thermodynamic temperature scale and absolute zero temperature, Clausius theorem and Clausius inequality, concept and characteristics of entropy Principle of increase of entropy and entropy of universe.	6
3	*Availability and Irreversibility:* Available energy lost work and degradation of energy, Maximum work, Availability in a closed system and in a steady flow system, Gibbs function, Helmholtz function, Irreversibility and its measurement.	5
4	*General Thermodynamic Relations:* General relations from energy equations, specific heat relations, relations for internal energy, enthalpy and entropy, Joule-Thomson coefficient, Applications of general thermodynamic relations to ideal gas, Van der Waal and other state equations.	3
6	*Review of Basic Equations and Steady State Conduction:* General three-dimensional heat conduction equation, Steady one-dimensional heat conduction through simple and composite planes, cylindrical and spherical walls without heat generation, Effect of variable thermal conductivity, Critical thickness of insulation. Steady one-dimensional heat conduction through plane wall, hollow cylinder, solid cylinder and solid sphere with uniform heat generation, Heat transfer from finned surfaces, general equation, efficiency and effectiveness of fins, conduction in cooling of turbine balding, optimum dimensions, comparison of fin materials. Two-dimensional steady state heat conduction, Numerical and graphical methods, Analogical solution.	8
7	*Unsteady State Heat Conduction:* Heating and Cooling with negligible internal resistance, Temperature-time response of thermocouple, Heating and cooling with negligible surface resistance, Transient heat conduction in semi-infinite solids, Laplace's equation, Separation of Variables, Lumped capacitance methods, Heating and Cooling of infinite plate with finite internal and surface resistance, Numerical and graphical analysis.	8
8	*Convection:* Laminar and turbulent flow, hydrodynamic and thermal boundary layer. Dimensional analysis and dimensionless numbers for free and forced convection. Empirical relations and practical solution of free and forced convection in pipes, over plates and across cylinders and spheres, combined free and forced convection, combined free convection and radiation heat transfer.	8
		42

Suggested Readings:

1. Introduction to Thermodynamics, Classical and Statistical, Third Edition, Sonntag, R.E., and Van Wylen, G, John Wiley and Sons, 1991.
2. Advanced Engineering Thermodynamics, Bejan, A., John Wiley and Sons, 1988.
3. Advanced Thermodynamics for Engineers, Kenneth Wark Jr., McGraw-Hill Inc., 1995.
4. Fundamentals of Heat & Mass Transfer, Incropera F.P. and DeWitt. D.P., John Wiley & Sons, 1996.
5. Analysis of Heat and Mass Transfer, Ozisik. M.N., McGraw Hill Co., 1980.
6. Heat Transfer - Basic Approach, Eckert. E.R.G., and Drake.R.M., McGraw-Hill Co., 1985.
7. Convection Heat Transfer, Bejan. A., John Wiley and Sons, 1984.

Course Code: AM **Course Title:** Non-Newtonian Fluid Flow and Application.

Contact Hours: L: 4 T: 0 P: 0 **Credit:** 4

Course Type: Elective.

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks). Teacher's Assessment (20 marks).

Pre-requisite: AM 933 (Advanced Fluid Mechanics)

Objective of the Course: The course offers an idea of non-Newtonian fluid flow, its mechanics and its widespread application in various fields including Bio-fluid dynamics.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*A. Rheology:* Definition of Rheology, Analysis of vectors and tensors- stress tensor, principal stresses, neo-Hookean solid, rate of deformation tensor, Newtonian liquid. Mass and momentum conservation, Constitutive equations, continuum mechanics, Review of Newtonian fluid mechanics, Constitutive equations for non-Newtonian fluids- power-law, Bingham and viscoelastic fluids etc., Examples of pipe flows, free-surface flows of non-Newtonian fluids.	6
2	*Viscoelastic Theory:* Linear viscoelasticity- general LVE model, stress relaxation, creep, sinusoidal oscillations, curve fitting relaxation modulus. Nonlinear Viscoelasticity- Deborah number, nonlinear phenomena, simple nonlinear constitutive equations, more accurate constitutive equations.	6
3	*Rheometers and Measuring Techniques:* Drag Flow method- falling ball, concentric cylinders, cone and plate, parallel plate, drag flow indexers. P-driven flow method- capillary rheometry, slit rheometry, comparison of methods.	4
4	*Extensional Rheology:* introduction, Trouton ratio, techniques, experimental difficulties, stagnation flows, entrance flows.	4
5	*Suspension Rheology:* Einstein equation, particle-particle interactions.	2
6	*Rheology of Polymeric Liquids:* intrinsic viscosity, concentration regimes, Rouse and Zimm models, scaling concepts, entanglement concept. Self-assembling fluids like surfactants, liquid crystals. Micro-fluidics, Micro-rheology, colloidal System.	4
7	*B. Bio-Fluid Dynamics:* Bio-fluid dynamics: Blood system network and physiology, blood rheology, Vessel structure and mechanical properties Lymphatic system; Body fluids and their motions; Flow of Newtonian and non-Newtonian fluids in rigid tubes, flexible tubes and collapsible tubes.	6
8	Heart and pumping process, Blood flow in body, Flow dynamical study of circulatory system, heart and blood vessels, anatomy and physiological considerations; Components and functions of arterial and venous systems;; Blood flow through arteries and veins; Kinetic energy, flow, pressure-flow relations in vascular beds; Cardiac cycle; Cardiac valve dysfunctions; Blood pressure, regulation and controlling factors; Coronary circulation, heart failure. Engineering applications – dialysis, heart-lung machines. Lung and airways system network and physiology	10
		42

Suggested Readings:

1. "Understanding Rheology", Faith Morrison, Oxford.
2. "Rheology: Principles, Measurements, and Applications", Christopher W. Macosko, VCH Publishers, New York (1994).
3. "The Structure and Rheology of Complex Fluids", R. Larson. Butterworths, Boston (1988)
4. "Engineering Rheology", R.I. Tanner.
5. "Transport Phenomena", Bird, Stewart and Lightfoot.
6. "Non-Newtonian Fluids", Wilkinson.
7. "The Colloidal Domain", Evans and Wennerstrom.
8. "Dynamics of Polymeric Liquids" (Vol.I. Fluid Mechanics and Vol.II. Kinetic Theory), Bird, R.B., R.C. Armstrong and O. Hassager., Wiley (1987).

Course Code: ME **Course Title:** Fans, Blowers and Compressors.

Contact Hours: L: 4 T: 0 P: 0 **Credit:** 4

Course Type: Elective.

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks). Teacher's Assessment (20 marks).

Pre-requisite: AM (Advanced Fluid Mechanics)

Objective of the Course: The objective of the course is to provide the fundamental design concept and working of compressible flow machines like fans, blowers and compressors.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	Introduction to compressible turbomachines, transfer of energy to fluids, Difference between fans, blowers and compressors, fan types, blower types. fan performance evaluation and efficient operation system; system characteristics and fan characteristics, fan curves, fan laws. Fan design and selection criteria: fan performance and efficiency, safety margin.	5
2	*Centrifugal Blowers:* Theoretical characteristic curves, Eulers characteristics and Eulers velocity triangles, losses and hydraulic efficency, flow through impeller casing , inlet nozzle, volute, diffusers. Leakage, disc friction, mechanical losses. Multivane impellers of impulse type, crossflow fans.	5
3	*Axial flow fans:* Rotor design, airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist, stage design, surge and stall, stator and casing, mixed flow impellers.	5
4	*Testing & Control of Fans:* Fan installation, fan testing, noise control, materials and components, blower regulation, speed control, throttling control at discharge and inlet, series and parallel operation, fan performance assessment.	3
5	Special design and applications of blowers, induced and forced draft fans for air-conditioning plants, cooling towers, ventilation systems, booster systems.	2
6	*Air compressor:* Application of compressed air , classification of compressor, reciprocating compressors, construction , work input, necessity of cooling , isothermal efficiency, heat rejected, effect of clearance volume, volumetric efficiency, necessity of multistaging, construction, optimum intermediate pressure for minimum work required, after cooler, free air delivered, air flow measurement, capacity control.	6
7	*Centrifugal flow compressor:* Work done and pressure rise, velocity diagram, diffuser vane design considerations, theory of operation, losses, adiabatic efficiency, effect of compressibility, diffuser, prewhirl, pressure coefficient, slip factor, performance characteristics.	6
8	*Axial flow compressor:* Velocity triangles, degree of reaction, polytropic efficiency. Three dimensional flow- cascade performances, losses, stage designing. Air angle distributions for free vortex and constant reaction designs, compressor blade design, multi-staging, surging, chocking and stalling phenomenon, performance characteristics.	6
8	*Radial flow compressor:* Main design parameters, rotor design, vaneless and vaned	4

	diffusers, mixed flow compressors, two stage radial flow compressor, inter-cooling system, performance characteristics of radial flow compressors.	
		42

Suggested Readings:

1. "Fluid Mechanics and Thermodynamics of Turbomachinery", 4th Edition,, S.L.Dixon, Butterworth and Heinemann, 1998.
2. "Turbines, Compressors and Fans", S. M. Yahya, Tata McGraw-Hill, 1983.
3. "Centrifugal Pumps and Blowers", Austin H. Church, , John Wiley & Sons, 1980.
4. "Axial Flow Compressors", J.H. Horlock, Butterworth Scientific, London.
5. "Turboblowers", A.J. Stepanoff , John Wiley & sons, 1970.
6. "Fans", Bommoeck, Pergamon Press, 1973.

Course Code: CE **Course Title:** Environmental Fluid Dynamics.

Contact Hours: L: 4 T: 0 P: 0 **Credit:** 4

Examination Pattern: Class Test-I (20 marks), Class Test-II (20 marks), End Sem (40 marks). Teacher's Assessment (20 marks).

Pre-requisite: AM (Advanced Fluid Mechanics)

Objective of the Course: The purpose of the course is to understand the fluid dynamical phenomena of atmosphere and ocean and to apply the laws of fluid dynamics to these areas.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*A. Atmospheric Flow Dynamics Outline:* *Introduction:* Fluid properties and fluid forces, equation of state. Hydrostatic balance, geopotential height, hypsometric equation, pressure as a vertical coordinate. Flow characterization, natural coordinates, vorticity and circulation, divergence and deformation, non-divergent flow.	4
2	*Dynamics in an inertial reference frame:* Conservation of mass, momentum and energy; reference frames; momentum, thermodynamic, and continuity equations. *Dynamics in a rotating reference frame:* Spherical coordinates, Centrifugal and Coriolis forces, effective gravity, equations of motion.	4
3	*Balanced flows:* Scale analysis; geostrophic approximation; inertial, gradient, and cyclostrophic flow; thermal wind; planetary boundary layer; barotropic and baroclinic atmospheres.	4
4	*Quasi-geostrophic theory:* quasi-geostrophic approximation; vorticity, height tendency, and omega equations; forcing of vertical motions; potential vorticity equation.	4
5	*Introduction to atmospheric waves:* Linear theory and perturbation methods, wave properties, Rossby waves. Upper tropospheric waves. Structure and evolution of mid-latitude cyclones and anticyclones. Introduction to numerical weather prediction. Plotting and analysis of atmospheric soundings: vertical stability analysis. Overview and application of diagnostic tools for synoptic meteorology.	6
6	*B. Ocean Flow Dynamics Outline:* Deformation and rotation of a fluid particle, vorticity vector, Stokes theorem, equation of salt diffusion. Newton's law of motion, integal formulation, external forces, internal stresses, differential formulation. Angular momentum equation, thermodynamics of sea water, entropy equation. adiabatic motion, heat equation.	4
7	*Basic Approximations:* Boussinesq approximations, basic equations in spherical coordinates. Turbulencein the ocean, nature of turbulence, Reynolds rules of averaging, averaging of the basic equations, parameterization of turbulent mixing, coefficients of turbulent mixing. Thin-layer and quasi-static approximations, local Cartesian coordinates, vorticity equation in the quasi-static approximation. Geostrophic relations, thermal wind	6

	relations. Ekman boundary layers, straightforward analysis for the homogeneous ocean, asymptotic approach, Ekman pumping, buoyancy frequency. Quasi-geostrophic approximations- homogeneous ocean, potential vorticity equation, beta plane approximation. Quasi-geostrophic approximations- continuously stratified ocean, potential vorticity equation, Rossby radius of deformation.	
8	*Layer (isopycnal) models of ocean circulation:* Continuity equation, cross-interface velocities, momentum equations, potential vorticity equation, quasi-geostrophic approximations. Some widely-used layer models. Vertical modes- the two-layer model and the continuously stratified ocean.	5
9	*Sverdrup Relation:* Rossby-wave mechanism of western boundary-layer formation. Sverdrup relation- the continuously stratified ocean, the 2.5-layer model. Validity of the Sverdrup relation.	5
		42

Suggested Readings:

1. "Meteorology: The Atmosphere and the Science of Weather" (4th ed.), J.M. Morgan, 1994.
2. "Atmosphere: An Introduction to Meteorology" (5th), F.K. Lutgens and E.J. Tarbuck, Prentice-Hall, New Jersey, 1979.
3. "Atmosphere-Ocean Dynamics", A.E. Gill, Academic Press, 1982.
4. "Introduction to Geophysical Fluid Dynamics", Cushman-Roisin, B., Prentice-Hall, 1994.
5. "Ocean Circulation Theory", J. Pedlosky, Springer-Verlag, 1996.
6. "Fluid Mechanics", P.K. Kundu & I.M. Cohen, Elsevier Academic Press, Amsterdam, 2004.

Course Code: EC **Course Title:** Instrumentation & Control.

Contact Hours: L: 4 T: 0 P: 0 **Credit:** 4

Course Type: Elective.

Examination Pattern: Class Test-I (15 marks), Class Test-II (15 marks), End Sem. Exam. (40 marks), Assignment (10 marks), Practical (20 marks).

Pre-requisite: AM (Experimental Methods & Analysis)

Objective of the Course: The aim of this course is to provide the fundamental concepts used in instrumentation and control engineering.

Details of the Course:

Sl. No.	Particulars	Contact Hours
1	*General Purpose Electronic Instruments:* CRO, digital voltmeters & multimeters, electronic counters, signal generators, amplifiers, frequency response analyzers.	6
2	*Signal Conditioning:* Amplifiers, instrumentation amplifiers, filters, A/D and D/A converters.	3
3	*Recording Techniques:* Mechanical, electrical, electronic, pneumatic, and hydraulic.	2
4.	*Automatic Control Systems:* Open loop systems, closed loop systems, sensors, actuators, P, PI, PD & PID controllers.	6
5	*Basic Digital Devices and Circuits* : Logic gates, decoders, multiplexers, demultiplexers, flip-flops, registers, counters, semiconductor memory elements, ALU	5
6	*Microprocessor:* Architecture and programming of a typical 8/16 bit microprocessor, microcomputer organization, I/O techniques, interrupts, serial and parallel I/O.	8
7	*Interfacing with Microprocessor* : Memory interfacing, I/O interfacing, programmable peripheral interface, analog interfacing, digital interfacing, programmable timer/counter, microprocessor based system design, microprocessors in process control.	8
8	*Microcontrollers*: Fundamentals of microcontrollers, design examples. * Experiments on microprocessor programming and interfacing are required to be conducted.	4
		42

Suggested Readings:

1. David A. Bell, "Electronic Instrumentation and Measurements", 2nd edition, Prentice Hall of India.
2. W.D. Cooper and A.D. Helfrick, "Electronic Instrumentation and Measurement Techniques", Prentice Hall of India , New Delhi.
3. Ramakant A. Gayakwad, "Opamps and Linear Integrated Circuits", Prentice Hall of India.
4. I. J. Nagrath and M. Gopal, "Control System Engineering", 2nd edition, Wiley Eastern, New Delhi, 1982.
5. M. Morris Mano, "Digital Design", Third Edition, Prentice Hall 2002.
6. Ramesh S. Gaonkar, "The Microprocessor: Architecture, Interfacing, Programming and Design," Penram International.
7. Kenneth J. Ayala, "The 8051 Micro-controller: Architecture, Programming and Applications," Penram International Publication.
8. Douglas V. Hall, "Microprocessors and Interfacing," Second Edition, Tata McGraw Hill.

Course Code: AM / AM **Course Title:** Thesis.

Contact Hours: L: **T:** 0 **P:** 20/25. **Credit:** 4 (in 3rd Sem), 12 (in 4th Sem)

Examination Pattern: The assessment of all the theses would be done at the end of the third semester by a committee consisting of departmental faculty members of Applied Mechanics specialized in the fields. The students will present their theses before the committee - the complete thesis report is not expected at the end of the third semester - however partial report based on the work done should be submitted by the students to the assessing committee - the project guides along with the committee members will award the grades for the individual students in the thesis.

Objective of the Course: Students will have to identify a problem and work on it under the guidance of his/her thesis supervisor to contribute some original in the field.

Details of the Course:

The thesis work can be a design type, experimental type; industrial problem or computer oriented on any of the topics related to the programme specialization and will be allotted to each student separately.

The thesis work started in the third semester will continue in the next semester also. The students should complete the thesis work in this semester and present it before the assessing committee. Students will submit the copies of the completed project report signed by the guide to the department. The head of the department will certify the copies and return them to the students; one copy will be kept in the departmental library for records.

Master of Technology

in

Biomedical Engineering

Applied Mechanics Department
Motilal Nehru National Institute of Technology, Allahabad
(Deemed University)

About the programme

Biomedical Engineering education & research has emerged as highly technical, interdisciplinary and significant area in the present health & system. Biomedical engineering is the integration of biology, medicine, physics, chemistry, and engineering. In addition to the traditional role of Biomedical engineers as a maintenance of Biomedical equipments, they are also called upon to take the active part in the diagnostic process like design of medical prostheses, robotic surgery, medical imaging, medical signal processing, Biomechanical studies of human body, Biofluid flow, etc.

The highly interdisciplinary nature of this area needs for a careful design of the M.Tech. Program keeping in view the diversified background of the potential students and the requirement of "well rounded" biomedical engineers.

In the India biomedical engineering education is still in its preliminary stage. Recently a few numbers of colleges in India have started under graduate & postgraduate programmes in biomedical engineering. Biomedical engineering education is integration of physiology & Anatomy biomechanics, biochemistry, biomaterial, rehabilitation engineering, bio transport processes, biomedical instrumentation, biomedical imaging, biomedical signal, biological system & control etc.

The proposed programme is expected to have input from almost all the departments of the institute and have an interdisciplinary character. The programme has been proposed at M.Tech. level, so that we do not lag behind the developed countries in the various fields of biomedical engineering.

Eligibility: B.Tech./B.E. in any branch of Engineering /M.Sc(Biomedical Instrumentation), M.Sc.(Physics)or M.Sc.(Electronics).

Admission:The admission shall be made through GATE

COURSE PROFILE

M.Tech. (Bio-medical Engineering)

SEMESTER-I

	L-T-P	Cr
AM 961 Basics of Anatomy & Physiology for Engineers	4-0-0	4
AM 962 Bio-Mathematics	4-0-0	4
AM 963 Bio Mechanics	3-0-2	4
AM 964 Bio-medical Instrumentation	3-0-2	4
AM 965 Bio Materials	4-0-0	4
Total		20
SEMESTER-II		
AM 966 Bio-medical Signal &Image Processing	3-0-2	4
AM 967 Bio-fluid dynamics	4-0-0	4
Elective I	4-0-0	4
Elective II	4-0-0	4
Elective III	4-0-0	4
Total		20
SEMESTER-III		
AM 998 Special Study		4
AM 999 Thesis		12
Total		16
SEMESTER-IV		
AM 999 Thesis		16
Total Credit		72

List of Electives

AM 968 Advanced Biomechanics
AM 969 Effects Of Radiation And Bio-Medical Application Of Radiation
AM 970 Biomedical Ethics, Standards & IPR Issues
AM 971 Rehabilitation Engineering
AM 972 Electro Diagnostics, Therapy and Electrical Safety
AM 973Biomedical Engineering Design & Ergonomics
AM 974 Computers In Bio-Medical Engineering
AM 975 Medical Imaging
AM 976 MEMS & Bio-MEMS

SEMESTER-I

AM 961 Basics of Anatomy &Physiology for Engineering

Bio-medical Engineering fields of activities, research, development, and design for bio-medical problems, diagnosis of disease and therapeutic applications. Fundamental Phenomena of Life. The cell and its differentiation. Tissues and organs of the body.

Introduction to Anatomical terms and Endocrine glands.
Elementary Knowledge on various parts of human Body, systems and organs. General structure and functions of various tissues of the human body. Basic anatomy and types of endocrine glands. Physiology of endocrine glands and their hormones. General mechanism of hormonal secretion.

Anatomy & Physiology of Skeletal, Muscular & Nervous system:
General structure and composition of bones and types of Joints. Structure of muscles and muscle cells, limbs and their functions. General Structure of nervous system and nerve cell and their functions, Brain Spinal Cord, Peripheral and Autonomous Nervous System,
General physiology of neuro-muscular System, Velocity of nerve impulse and muscle action potential and coupling mechanism, Physiology of nerve Impulse, Nerve transmission, Reflex arc, Bioelectrical phenomena involved in learning and memory.

Anatomy & Physiology of Blood Circulatory, Respiratory & Digestive system:
General structure of blood circulation in humans-Heart and major blood vessels and their functions, Special properties of Cardiac Muscle and Pace Maker, Blood and Lymphatic System- composition, blood groups, role of R.B.C and W.B.C. Mechanism of blood oxygenation. Biophysical aspects of blood pressure and its recording and regulating techniques. General structure of respiratory system and functions- Lungs and Trachea Cardio, Respiratory, Respiratory Pathways. Functional aspects and mechanics of respiration. General structure and functions of digestive system in human beings, stomach, intestine, liver, gall bladder and pancreas. General mechanism of digestion and role of various gastro intestinal secretions and their role in the absorption and digestion of food.

Anatomy & Physiology of Sensory Excretory, Reproductive System:
Basic anatomy of special senses :Eye, Ear, Tongue, Nose and skin. Properties and functions of nervous system with respect to sensory organs. Structure and functions of excretory system, kidney and urinary bladder. General structure and functions of Male and Female reproductive system. Hormone production and physiology of menstruation and fertilization, Mechanism of family planning.

References:

- Charles E. Tobin, Basic human Anatomy
- J. H. Green An Introduction to Human Physiology
- H.B. Charles and B.N. Taylor; The Physiological Basis of Medical Practice. William and Wilkins, Baltimore, 1985.
- C.A. Keele and Eric Neil; Samson Wright's Applied Physiology. ELBS, London,1984.
- S. West, E.R. Todd, W.S. Mason and H.J.T. Van Bruggen; Text Book of Biochemistry. Macmillan Co., 1976.
- A.G. Guyton; Textbook of Medical Physiology; Saunders, Philadelphia, 1986.

homogeneous equations, operator method, sequence and series, power series methods: Laplace transform and its applications, Fourier series, Fourier transform and application in biomedical engineering. Partial differential equations, Models in physiology, introduction to solution technique such as Variable separation, product method and Laplace transform method.

References::

- E.Kreyszig,"Advanced Engineering Mathematics",5th edition , Wiley Eastern.
- Murray J.D., "Mathematical biology",Springer-Verlag,Berlin,1989

AM 963 Bio Mechanics & Kinesiology

Quantitative and qualitative description of the action of muscles in relation to human movement. Introduction to rigid body dynamics and dynamics of multi link systems using Newtonian and Lagrangian approaches, Muscle models, Muscle skeletal System – Elastic model of bones Properties of bones. Human body dynamics and locomotion analysis. Application of Kinesiology to basic performance patterns.

Introduction to Tissue Biomechanics, Movement Biomechanics, Implant Biomechanics, Orthopaedic Biomechanics, Prosthetics & Orthotic. Recent developments in Biomechanics .

References:

- Fung Y.C.,Biomechanics,Springer Verlag,1984.
- Winter,D.A.,Biomechanics and Motor Control of Human Movement .
- Frankel V.H.&Nordin Margareta ,Basic Biomechanics of the Skeletal System,LEA &FEBIGER,1980.

AM 964 Bio-medical Signal, Systems & Transducers

Theory, Analysis and design of biomedical transducers: optical, photo-electric, electrochemical, electrical, mechanical, electromechanical and thermoelectric. Applications to biomedical systems. Transducer characteristics sensors for physical measurands, sensors for measurement of chemicals. Medical measurands; sensor characteristics and design for measurement of medical parameters like ECG, arterial blood pressure heart sounds, bio-potential amplifiers. Various types of electrodes used in ECG, EEG and EMG.

Measurement of EEG, EMG and their diagnostic applications in Medicine Flow and pressure measuring instruments in biomedical engineering. Development of non-invasive diagnostic instruments for tissue abnormalities.Medical Ultrasonography. Latest biomedical Instruments: Electro surgical unit; Pulse Oximeter, Defibrillators, Foetal ECG.

References::

- Khandpur R.S., Hand book of Biomedical instrumentation ,TMH,2003.

- Tompkins ,Biomedical Digital Signal Processing.
- Cromwell L. et al., Bio medical Instrumentation & Measurements, PHI , 2005.
- Carr & Brown , Introduction to Biomedical Equipment,PHI,2005.
- Webester J.G. ,Medical Instrumentation ,3rd Edition,John Wiley,1997.

AM 965 Bio Materials

Structure and property relationship in materials,Metals,alloys, ceramics and polymers as biomaterials; Interactions materials with human body; Influence of micro-structure and environment on fatigue fracture of materials. Composite material concepts and applications; Materials for Orthopedic implants, artificial organs, dental implant;Dermal and facial prosthesis. Bio-compatibility of materials. Recent developments in Biomaterials.Legal issues related to development of biomaterials .Natural materials for various biomedical applications.

References:

- Park ,J.B. &Lakes R.S.,Biomaterials :An Introduction,Plenum Press,New York,1992.
- Silver F.H., Biomaterials ,Medical Devices &TissueEngineering :An Interated approach,Chapman &Hall,1994.

SEMESTER-II

AM 966 Bio-medical Signal & Image Processing

Biosignals and their Characteristics –Signal Sampling and conditioning,DFT properties-Frequency Domain Analysis of Signals,FFT Algorithms,Digital Filter Design.
Time Domain Modelling-AR modelling,Spectral Estimation,Data Compression Techniques-Wavelet Transformation,Vector Quantization,Linear and Non Linear prediction of Biosignals ,Waveform detection and Pattern Recognition.
Digital Image representation,Elements of digital Image Processing System.Image Transforms-Discrete Fourier Transform and properties ,Separable Image Transforms.Image Enhancement.Image Restoration,Image segmentation,Image Reconstructions from projections.
Data compression-DPCM,Vector quantisation,JPEG,MPEG,Wavelet Transforms.Brief description of CT,MRI,Ultrasound,PET and SPECT images.

References:

- Cohen, Biomedical Signal Processing ,Vol 1&2 ,CRC Press,1986.
- Tompkins W.J.,Biomedical Digital signal Processing,Prentice Hall,1993.
- Jain A.K.,Digital Image Processing,PHI,1989.
- Hicho.Z. et.al. ,Fundamentals of Medical Imaging ,John Wiley.

AM 967 Bio-fluid dynamics

Introduction to fluid mechanics; Fluid properties, basic laws governing conservation of mass momentum and energy; Laminar flow, Couette flow and Hagen-Poiseuille equation, turbulent flow.

Bio-fluid dynamics: Blood system network and physiology, blood rheology, Vessel structure and mechanical properties Lymphatic system; Body fluids and their motions; Flow of Newtonian and non-Newtonian fluids in rigid tubes, flexible tubes and collapsible tubes.

Heart and pumping process, Blood flow in body, Flow dynamical study of circulatory system, heart and blood vessels, anatomy and physiological considerations; Components and functions of arterial and venous systems;; Blood flow through arteries and veins; Kinetic energy, flow, pressure-flow relations in vascular beds; Cardiac cycle; Cardiac valve dysfunctions; Blood pressure, regulation and controlling factors; Coronary circulation, heart failure.

Engineering applications - dialysis, heart-lung machines. Lung and airways system network and physiology.

References:

- MazumdarJ.N., Biofluid Mechanics, (World Scientific, 1992).
- FungY.C., Biomechanics:Motion, Flow, Stress, and Growth, (Springer-Verlag, 1990).
- BerneR.M. and. LevyM.N. ,Cardiovascular Physiology, (8th Edition, Mosby, 2001).

Elective I ,II & III

AM 968 Advanced Biomechanics

General principles of solid mechanics applied to analytical and experimental investigations of biological systems.
General principal of Biomechanics: Analysis of biological subsystem from biomechanical view.
Tissue biomechanics : Direct, shear, bending & torque actions and the corresponding stresses, strains in biological tissues. Stress relaxation & creep. Stability and instability. Biomechanical characterization of bone and the soft connective (skin, tendon and ligaments) covering structure, function and physiological factors. Elastic models of bones, anisotropy, mechanics of tissue remodeling.
Stress wave propagation in bones.
Movement Biomechanics: kinesiology, Gait analysis, body and limb mass and motion characteristic actions, force transmitted by joints. Joint forces result in the normal and disabled human body, normal & pathological Gait & sports Biomechanics.
Implant Biomechanics : Dental forces, implant tissue biomechanics, crack propagation in bones, dynamic models.
Orthopedic Biomechanics : Wolf's law and introduction to orthopedic biomechanics, human body analysis & locomotion analysis.

Prosthetics & Orthotics : Principles in designing Orthotics & prosthetic devices.
Principles of three point pressure, total contact, partial weight relieving.
Appreciations of limb Orthotics & prosthetics:
Lower extremity orthosis and prosthesis, upper extremity orthotic & prosthetic devices. Recent developments in Biomechanics & prosthetics and Orthotics.

References:

- FungY.C., Biomechanics:Motion, Flow, Stress, and Growth, (Springer-Verlag, 1990).
- A Textbook of Biomedical Engineering by R. M. Kenedy.
- Hand Book of Bioengineering by Richard Shalak & shu chien.
- Winter.D.A.,Biomechanics and Motor Control of Human Movement.
- Frankel V.H.&Nordin Margareta, Basic Biomechanics of the Skeletal System,LEA &FEBIGER,1980.

AM 969 Effects of Radiation and Bio-medical Application of Radiation

Types and characteristics of electromagnetic radiations, influence on living beings with particular emphasis on human beings, Bio-medical applications and effects of X-rays, Gamma rays, Microwaves, Ultrasound etc., Laser and their biomedical application.Hazards of radiation.

References:

- A Sorenson and Phelps, Physics of Nuclear Medicine, W.B. Saunders co, 1987.
- J.R. Cameron and J.G. Skofronick, Medical Physics.
- Christenson, Physics of Diagnostic Radiology, John Wiley, 1979.

AM 970 Biomedical Ethics, Standards & IPR Issues

Value theory Risk and Reliability-Decision theory, Injury and damage control, Epidemiology of accidents, Human tolerance to energy inputs, Biomedical & Biomechanics aspects of long term, Exposure to hazardous environment.Standards,Ethics &IPR issues related to biomedical engineering.

References:

- Patents by N.R. Subbaram, Pharma Book Syndicate, Hyderabad, 2003.
- Singh K, Intellectual Property Rights on Biotechnology, BCIL, New Delhi.

AM 971 Rehabilitation Engineering

Medical, Psychological and social issues influencing the rehabilitation of people with spinal cord injury, stroke, traumatic brain injury, Hemiplegic, Spasticity, Myopathy, Cerebral injury and limb amputation., Rehabilitation management. Artificial replacements limbs as multi disciplinary design concepts and engineering problems under stringent constraints. Artificial organs: Kidney, heart, pancreas, liver etc. Rehabilitation Engineering for the restoration of variety of human activities for disabilities that include sensory, motor of cognitive losses. Burn injury rehabilitation.

References:

- Smith, Raymond V. & John H. Leslie, Rehabilitation Engineering. CRC Press, 1990.
- Mann, William C. and Joseph P. Pane, Assistive Technology for Persons with Disabilities.The American Occupation Therapy Association Inc., 1991.

- Webster, John G. et al, Electronic Devices for Rehabilitation. John Wiley & Sons, 1985.

AM 972 Electro diagnostics, Therapy and Electrical Safety

Electrodes as bioelectric transducers : Various types of specification & selection criteria for electrodes. Polarizable and non-polarizable electrodes; practical considerations. Instrumentation for biopotential recording: practical considerations for optimum performance; reduction of interference, grounding, safety. Electrical Stimulation for generating evoked potentials, ECT, pacemakers, defibrillators; Stimulation parameters; Safety limits and precautions. Safety: Hazards associated with the use of electrical & electronic instruments; clinical safety norms.

References:

- M.J. Aminoff: Electrodiagnosis in Clinical Neurology, 3rd edition.
- J.A. Delisia, H.J. Lee, E.M. Baran, K.S. Lai & N. Spielholz: Manual of nerve conduction, Academic Press NewYork, 1993.
- J. Kimura (Ed.) : Peripheral Neuropathy vol. 1, W.B. Saunders & Co., Philadelphia, 1984.

AM 973 Biomedical Engineering Design & Ergonomics

Introduction to Ergonomics and its application; Man-Machine-Environment System; Anthropometrics and joint motions; Work posture, Environmental factors and human performance. Designing of controls and displays, control panel organisation, principles of product design and recent trends on Ergonomics related issues in Medicine.

References:

- E.J. Mccormick, Human factors in Engineeering and Design, TMH.
- O.P. Astrand and R. Kaare, Textbook of Work Physiology, Mc Graw Hill
- E.R. Tichauer, The Biomedical basis of Ergonomics, Wiley

AM 974 Computers in Bio-medical Engineering

Data and Information capture in health care management and clinical delivery systems. Multimode data; Epidemiology and etiology data; Data quality; importance of data organization. Data base systems in medical applications, Intelligent system approaches in medicine. Networked systems; Well building of decision-making support systems for clinical applications.

Introduction to analog and digital computers, simulation in biological sciences, simulation of normal and pathological states, automated patient history taking, Artificial Intelligence and expert systems, Algorithms for automated analysis of ECG, EEG, EMG, etc. Computer in Hospital management.

References:

- H.D. Convveyet, Computers in Practice of Medicine, Addisson Wesley.
- Edward Shortliffe, Computer Based Medical Consultation, Elsevier Scientific.
- Joseph Bronzino, Computer Application in Patient Care, Addisson Wesley.

AM 975 Medical Imaging

Review of atomic structure and atomic particles; electrons, protons, neutrons, positrons etc; classification of elements as per the periodic table; atomic transitions, electron transitions and the generation of X-rays; Nuclear transitions and radio active nuclear. Characteristics of X-ray beam; interaction with matter. Theory of CT scanning, spiral CT scanning & PET physics of Nuclear Magnetic Resonance and its application in the field of diagnostics. Gamma camera SPECT and other latest Medical imaging systems. Physics of ultrasound imaging uses in diagnosis Image quality description & patient risk.

References:

- Albert Macouski, Medical Instrumentation, Prentice Hall
- Chris Tenson, Physics of Diagnostics Radiology
- A Sorenson & Phelps, Physics of Nuclear Medicine, W.B. Saunders and Co., 1987.
-

AM 976: MEMS & BIO-MEMS

Introduction; photolithography; mask design; wet and dry etching; thin film deposition and growth, electroplating, molding, LIGA, bonding and sacrificial processes, polymer processing and rapid prototyping, biomaterials and biocompatibility issues, micro total analysis system (μTAS): Fluid control components, μ-TAS: sample handling, μ-TAS: separation components, μ-TAS: detection, cell handling and characterization systems, systems for biotechnology and PCR, polynucleotide arrays and genetic screening, miniature biosensors, biosensors arrays and implantable devices, neural interfaces, microsurgical tools, micro needles, and drug delivery.Microsystems for tissue engineering, tissue scaffolds, optical biosensors, MEMS metrology, MEMS packaging.

References:

- R. Hicho et al., Fundamentals of Medical Imaging, John Wiley
- A. Manz and H. Becker, Eds. Microsystem Technology in Chemistry and Life Sciences Springer-Verlag, New York, 1999. ISBN: 3-540-65555-7
- Max.I..Madou, "Fundamentals of Micro Fabrication, the Science of Miniaturization", Nanogen corporation, USA, CRC press, March 2002.

Course structure of

P. G. Programme

Master of Social Work

Department of Humanities and Social Sciences
Motilal Nehru National Institute of Technology
(Deemed University)
Allahabad-211004

Contents of the Proposal

1. Introduction About the Course
2. Credits for course
3. Course Design
4. Eligibility for Course
5. Selection Procedure
6. Career Opportunity
7. Requirement to Run the course
8. Existing Faculties
9. List of Non Government Organization(Where our students can get field work and Job Placement)

    - Indian NGOs
    - International NGOs
    - Leading NGOs

MASTER OF SOCIAL WORK

1. Introduction

The Master of Social Work is a full-time, two year programme. This programme offers the following 5 specialisations:

- Industrial Relation and Personnel Management
- Family and Child Welfare
- Medical and Psychiatric Social Work
- Social Welfare Administration
- Urban and Rural Community Development

2. Course Credit Hours

The total credit hours for the Master of Social Work programme is 81, divided between the first and second years of the programme as detailed below.

Year	**CREDT HOURS**
First Year	
First Semester	
Courses(Including Field Work)	21
Second Semester	
Courses(Including Field Work)	18
Total	**39**
Second Year	
Third Semester	
Courses(Including Field Work)	21
Fourth Semester	
Courses(Including Field Work)	21
Total	**42**
GRAND TOTAL	**81**

Each course carries the weightage of Three credits.

3. Course Design

Basic Courses

First Semester

Course Code		Name of the Course	Credits	L+T+P
BC	1	Social Case Work I	3	2+1+0
BC	2	Computer Application	3	1+0+2
BC	3	Community Organisation	3	3+0+0
BC	4	Administration of Social Welfare Organisations	3	2+1+0
BC	5	Social Work Research I	3	2+1+0
BC	6	Historical Ideologies and Social Work	3	3+0+0
BC	7	Social Policy and Development	3	3+0+0

Second Semester

Course Code		Name of the Course	Credit	L+T+P
BC	1	Social Group Work II	3	2+1+0
BC	3	Research methodology	3	2+1+0
BC	8	Contemporary Ideologies and Social Work	3	2+1+0
BC	9	Field Work with NGOs	3	0+0+3
BC	12	Communication: An Introduction to Audio-Visual Media	3	3+0+0

Optional Courses (One Course will be selected by the II Semester students)

Course Code		Name of the Course	Credits	L+T+P
OC	1	Sociology	3	3+0+0
OC	2	Psychology	3	3+0+0
OC	3	Economics	3	3+0+0
OC	4	Political Science	3	3+0+0
OC	5	Community Nutrition	3	3+0+0
OC	6	Social Issues in India	3	3+0+0

respective specialization courses.

Industrial Relation and Personnel Management

Third Semester

Course Code		Name of the Course	Credit	L+T+P
IR	1	Principles of Management	3	3+0+0
IR	2	Business Environment	3	3+0+0
IR	3	Legal Environment: Labour Laws	3	3+0+0
OC	8	Organisational Behaviour	3	3+0+0
IR	4	Human Resource Management	3	3+0+0
OC	9	Counselling: Theory and Practice	3	3+0+0
IR	5	Seminar	3	0+1+2

Fourth Semester

Course Code		Name of the Course	Credit	L+T+P
IR	7	Strategic Human Resource Management	3	3+0+0
IR	8	Manpower Planning and Development	3	3+0+0
IR	9	Industrial Psychology	3	3+0+0
IR	10	Case Studies	3	0+3+0
IR	11	Management of Change	3	3+0+0
IR	12	Stress Management	3	3+0+0
IR	13	Dissertation	3	0+0+3

Family and Child Welfare

Third Semester

Course Code		Name of the Course	Credit	L+T+P
FC	1	Child in India	3	3+0+0
FC	2	Policies and Programmes for Vulnerable Children in India	3	3+0+0
FC	3	Family Life Education	3	3+0+0
FC	4	Family in India	3	3+0+0
FC	7	Seminar on Women's Issues: Policies and Programmes	3	0+1+2
OC	8	Organisational Behaviour	3	3+0+0
OC	9	Counselling: Theory and Practice	3	3+0+0

Fourth Semester

Course Code		Name of the Course	Credit	L+T+P
FC	5	Population Dynamics and Family Planning	3	3+0+0
FC	6	Strategic Management of NGOs	3	3+0+0
FC	7	Non-Formal Education	3	3+0+0
OC	10	Field Instruction in Social Work Education	3	3+0+0
OC	11	Women and Law	3	3+0+0
OC	12	Social Work in Industry	3	3+0+0
FC	8	Dissertation	3	0+0+3

Medical and Psychiatric Social Work

Third Semester

Course Code		Name of the Course	Credit	L+T+P
MP	1	Social Sciences and Health	3	3+0+0
MP	2	Therapeutic Work with Individuals, Families and Groups I	3	3+0+0
MP	4	Health and Development	3	3+0+0
MP	5	Seminar on Advanced Psychiatry I	3	0+1+2
MP	6	Health Management for Social Workers	3	3+0+0
OC	8	Organisational Behaviour	3	3+0+0
OC	9	Counselling: Theory and Practice	3	0+1+2

Fourth Semester

Course Code		Name of the Course	Credit	L+T+P
MP	7	Therapeutic Work with Individuals, Families and Groups II	3	3+0+0
MP	8	Advanced Psychiatry	3	3+0+0
MP	9	Social Work in the Field of Mental Health	3	3+0+0
MP	10	Health Problems	3	3+0+0
MP	11	Population Dynamics and Family Planning	3	3+0+0
OC	12	Social Work in Industry	3	3+0+0
MP	12	Dissertation	3	0+1+2

Social Welfare Administration

Third Semester

Course Code		Name of the Course	Credit	L+T+P
SWA	1	Public Welfare Programmes and Administration	3	3+0+0
SWA	2	Voluntary Action in Development	3	3+0+0
SWA	3	Seminar on Social Welfare Institutions	3	0+1+2
SWA	4	Social Work in the Field of Mental Health	3	3+0+0
SWA	5	Project Planning, Monitoring and Evaluation	3	3+0+0
OC	8	Organisational Behaviour	3	3+0+0
OC	9	Counselling: Theory and Practice	3	3+0+0

Fourth Semester

Course Code		Name of the Course	Credit	L+T+P
SWA	6	Management of Social Welfare Organisations	3	3+0+0
SWA	7	Social Enterpreneurship	3	3+0+0
SWA	8	Management of Change, Innovation and Conflict	3	3+0+0
SWA	9	Advocacy in Social Work	3	3+0+0
SWA	10	Social Welfare Administration Seminar	3	3+0+0
OC	12	Social Work in Industry	3	3+0+0
SWA	11	Dissertation	3	0+1+2

Urban and Rural Community Development

Third Semester

Course Code		Name of the Course	Credit	L+T+P
CD	1	Urban and Rural Sociology	3	3+0+0
CD	2	Urban Community Development and Municipal Administration	3	3+0+0
CD	3	Seminar on Community Organisation Practice	3	0+1+2
CD	4	Cooperation	3	3+0+0
OC	8	Organisational Behaviour	3	3+0+0
OC	9	Counselling: Theory and Practice	3	3+0+0
OC	13	Development and Welfare Services for SCs/STs/OBCs	3	3+0+0

Fourth Semester

Course Code		Name of the Course	Credit	L+T+P
CD	5	Disaster Management	3	3+0+0
CD	6	Rural Community Development and Panchayati Raj	3	3+0+0
CD	7	Development Project and Social Work Practice	3	3+0+0
CD	8	Employment Opportunity in Rural Areas	3	3+0+0
CD	9	Field Instructions in Social Work Education	3	3+0+0
OC	13	Cottage Industries in Rural Area	3	3+0+0
			3	0+1+2

4. Eligibility

- A Bachelor's Degree of a minimum 3 years duration or its equivalent (under the 10+2+3 or 10+2+4 or 10+2+2+1 year bridge course pattern of study or any other pattern fulfilling the mandatory requirements of 15 years formal education) from a recognised university in any faculty with a minimum aggregate of 50 % marks (40 % for Scheduled Castes [SCs] and Scheduled Tribes [STs] and 45 % for Kashmiri Migrants).
- A candidate who has appeared for all the papers and practicals of the examinations of the Bachelor's degree may also apply in anticipation of the results, provided he/she produces university/college mark/grade sheets showing an overall average of the marks mentioned above in the first and second year college/university examinations taken together, if the degree course is of three years; and the first, second and third year college/university examinations, if the degree course is of four years, for all the subjects examined. A candidate who has appeared for the one-year bridge course examination, in view of the two-year Bachelor's degree (to complete the 10+2+3 stream of studies) may also apply provided he/she has the above mentioned percentage of marks. In such cases, admission to the Master in Social Work programme of MNNIT will be provisional. If a provisionally admitted student fails in the final year Bachelor's degree examination, the offer of provisional admission will be automatically cancelled.

5. Selection Procedure

Those satisfying the eligibility requirements will be assessed for selection through the following:

Academic Background (30 marks)

Marks are awarded to each applicant on the basis of the overall percentage of marks secured in the Bachelor's Degree Examination. However, high academic achievement is not the only criterion on which the candidate will be selected.

Essay Test (60 marks)

The essay test (ET) aims at assessment of knowledge about contemporary issues in the field and sensitivity to social issues, expressed through written analysis in English.

Group Discussion (40 marks)

The group discussion (GD) aims at assessment of knowledge about contemporary issues in the field and sensitivity to social issues expressed orally in English in a group situation.

Personal Interview (70 Marks)

To become eligible for the personal interview, a candidate should secure a minimum combined score of 45 marks (35 marks for SCs and STs) in the ET and GD put together. The candidate is also expected to be acquainted with the programme for which he/she has applied for, as questions may be asked on the topic during the interview.

6. Career Opportunities

Industrial Relation And Personnel Management

Employment opportunities in Business Organisation, Consultancies, Non Government Organization, Government Undertaking ,social welfare departments and also other departments of the Central and State Governments involved in Human Resource And Public Welfare, human rights organizations, research and teaching.

Family and Child Welfare

The Family and Child Welfare graduates are absorbed in broad-based as well as specific settings in government and voluntary organisations and in formal and informal sectors. Some of the settings in which our students are employed are special and regular schools, mental health settings, child care services, rehabilitation centres, family counselling centres, family courts, special cells for women in police stations, national and international funding organisations, etc.

Medical and Psychiatric Social Work

This programme sensitises students on health and mental health issues at both the micro and macro levels. Health is viewed in the context of changing social and economic realities and students are prepared, through course work, to simultaneously address issues arising out of such a situation. Several avenues to work on health issues in the context of development at policy and programme levels exist. Students have opportunities of working in mental and community health settings and substance abuse prevention programmes, hospitals, child guidance and counselling centres, schools,

research organisations and public health programmes in both the government and voluntary sectors at the national and international levels.

Social Welfare Administration

The programme guides students to understand the nature, purpose, scope, evolution and changes in social development/welfare services in the context of society. It helps students in planning and, implementing development/ welfare projects. Using social science knowledge gained in the programme, the students will able to engage in policy studies and policy formulation. The programme prepares them for mobilising resources, participation in or management of ongoing social development/welfare organisation/projects, undertake research, short-term consultancies in training/report preparation and public relations.

Job opportunities for students exist in government and non-government social development/welfare organisations. Employment opportunities also exist with networking, issue-based, intermediary, and local/national/international funding organisations, as well as charitable trusts and social responsibility divisions of corporate houses.

Urban and Rural Community Development

The nature of opportunities for work in this field ranges from service delivery for community development, organising communities for change and organising capacity- building training programmes for local groups, government officials or other specialised groups. Many graduates with this specialisation are also involved in providing policy inputs at various levels of decision-making within government agencies, advocacy work for the disadvantaged sections, and documentation of development activities. The specialisation qualifies students for development work in areas such as natural resources management, gender justice, human rights, education, health, and disaster management. Job opportunities also exist as instructors and lecturers in training centres for community development personnel, funding agencies, and as development consultants.

[redacted]

List of Non Government Organization

Following list of Non Government Organization can helpful for Field Work as well as Placement.

ANDHRA PRADESH

1. Dr. M. Vijaya Kiran,
Society for Integrated Development in
Urban and Rural Areas(SIDUR),
B51/F1, Vijayanagar Colony,
Hyderabad-500057.
Tel:-040-221108, 3320709(O),
Fax:-040-229583, 040-841697

2. Shri J. Samba Sivrao,
Secretary,
Action for Integrated Rural and
Tribal Development
Social Services Society, (AIRTDS),
D.No.1-27-14, Tanka Salawari Street,
Nazarpet, Tenali-522201,
Ph:- (08644) (25739), Fax:- 24560

3. Dr. Ramesh Babu, Chief Functionary,
BOSS
(Blood Donors' Organisation for Social Service)
7-46, Vasavi Nagar (M.R. Palli),
Tirupati-517 502.
Chittoor District,
Andhra Pradesh.
Ph:- 08574-50050

4. Dr. G. Prabhakar,
Mahila Vikas Sansthan,
1-4-126, Naurajee Road,
Vishakapatnam.

5. Dr. Koutikuppala Surya Rao,
Child Foundation of India,
Plot 120, D.No.39.5.30,
Muralinagar,
Vishkapatnam-530007.
Ph:- 558529

ANDAMAN AND NICOBAR ISLANDS

MEGHALAYA

48. Mr. A.O. Johny,
Project Officer,
Bosco Reachout,
Don Bosco,
Guwahati-1.
Tel:-510457.

MIZORAM

49. Dr. J.C. Chhuanliana,
Programme Coordinator,
Community Health Action Network (CHAN),
P.O. Box 5,
Aizwal-796 001.
Mizoram.
Tel:- 0389-26106, 27609

NEW DELHI

50. Ms. Anjali Gopalan, Director,
The NAZ Foundation(India) Trust,
D-45, Gulmohar Park,
New Delhi.
Tel:- 6851970, 6851971.
Fax:- 6859113.

51. Ms. Shenaz Akhtar,
Rajiv Gandhi Foundation,
1, Rajendra Prasad Road,
Jawahar Bhawan,
New Delhi-110001.
Tel:- 3755117, 3755118
Fax:- 3755117

52. Shri Shankar Chowdhury,
Addl.Prof & Coordinator,
NGO-AIDS Cell,
Centre for Community Medicine,
AIIMS. Ansari Nagar,
New Delhi-110029.

7. Shri Neeraj Kumar Balaiah,
General secretary,
Dweep Youth Club,
c/o Nehru Yuvak Kendra,
Head Post Office,
Port Blair-744101
A&N Islands

ASSAM

8. Dr. S. I. Ahmed
AIDS Prevention Society,
Zoo Narangi Road,
Guwahati, Assam,-781021.
Tel:-03786-22328
Guntur District, Andhra Pradesh.
Ph:- 0361-560992.

9. Ms Reeta Devi, Trustee
ILA TRUST,
D-44, Sujan Singh Park,
New Delhi-110003.
Telefax:-91-11-4629541
Fax:-91-11-6830291

BIHAR

10. Shri Ganesh Prasad Singh,
ADITHI
2/30, State Bank Colony II,
Baley Road, Patna-800014.
Telefax:-0612-283018

11. Mr. Vinoy Kumar Ohdar,
Bihar Voluntary Health Association,
West of Ganga Apartment,
Opp. L.C.T. Ghat,Mainpura,
Patna-800 001.
Ph:- (0612) (266605).
Fax:- 266884.

12. M. Pilar Gueden,
Mahila Jagriti Kendra,
P.O. IE Gomia,
Dist.Bokaro,
Pin-829112.
Ph:- (06544) (61040)

13. Shri Atanu Majumdar,
Bhorukha Public Welfare Trust,
Raxaul, Bihar.

CHANDIGARH

Tel:-6852785

53. Ms. Elizabeth Vatsyayan,
AIDS Awareness Group(AAG),
119-Humayunpur,
Safdarjung Enclave,
New Delhi-110029.
Tel:- 6187953/6187954

54. Dr. Sushma Sengupta,
Drishtikon,
1207, Sector D, Pocket-1,
Vasant Kunj,
New Delhi-110070.

55. Dr. Nalini Sahay,
TORCH,
D-1033, New Friends Colony,
New Delhi.
Tel:- 6821636
Fax:- 6828383.

56. Dr. Bitra George,
Salaam Baalak Trust,
2492, Sec-D, Pocket-II,
Vasant Kunj,
New Delhi-110070.
Tel:- 6898129

57. Mr. Luke Sampson,
SHARAN,
G-46, 1st floor,
Green Park, Main,
New Delhi-110016.

58. Mr. Rajesh Kumar,
Society for Promotion of
Youth and Masses (SPYM),
B-4/3054, Vasant Kunj,
New Delhi-110067.
Tel:- 6893872
Fax:- 6896229

59. Mr. Ramesh Venkatraman,
Positive Life,
2466, Sec-D-Pocket II,
Vasant Kunj,
New Delhi-110070.

60. Ms. S. Lalitha,
Joint Women's Programme,
14, Jangpura-B,
Mathura Road,
New Delhi-110014.

Citizen Awareness Group,
2812, Sector-28-C, Chandigarh.

15. Shri Onkar Chand, Secretary,
Servants of the People Society,
Lajpat Rai Bhawan, Sec-15-B,
Chandigarh.
Ph:-780611

GOA

16. Ms. Marriette Gorrea, Director,
Positive Life,
Flat No.A/7, Skylark Apartments,
Near Cine A1 Dorado,
Panji, Goa-403 002.
Ph(832) (224 428) (231 827)
Fax:- 229355.

GUJARAT

17. Ms. Suchi Rawal,
Gujarat AIDS Awareness and
Prevention Unit,
8/01, Siddha Chakra Apartments,
Ahmedabad,
Gujarat.
Ph:- 6575282, Fax:- 6572962.

18. Fr. Cedric Prakash,
St. Xaviers Social Service Society,
P.O. Box 4088, Navrangpura,
Ahmedabad-380 009.
Tel:- 495238.
Fax:- 642 6362.

19. Mrs. Bunny Nag,
Baroda Citizens Council,
Above Health Museum,
Sayoji Baug, Baroda-390018.
Tel:- (0256) 7934 15/794596.

20. Dr. Barath Bhagat,
Lok Sevak Mandal,
C. H. Bhagat Working Women Hostel,
Near Dalal Apartments,
Vikas Gruti Road, Paldi,
Ahmedabad-380 007.
Tel:-419 260.
Fax:- 6612608

Fax:- 4313681, 4313660

61. Ms. Sadha Mohan,
Editor, Nexus,
Population Services International India,
C-445, Chittranjan Park,
Post Box-7360,
New Delhi-110019.
Ph:- 6428379,
Fax:- 6467419

62. Shri Ravi Chopra,
Secretary,
DISHA,
13/8 8, Block C-4-B,
Janakpuri,
New Delhi-58.
Ph:-5554530
Fax:- 5685670

ORISSA

63. Shri B. P. Patnaik,
Indo National Socio
Economic Foundation, A/8,
Ashok Nagar, Bhubaneshwar-751009.
Tel:- (0674) 404717)
Fax:-420333

64. Shri M.R. Mishra,
Jeevan Rekha Parisad,
N I/150, I.R.C. Village,
Nayapalli,
Bhubaneshwar-751015
Tel: 452464.

65. Dr. P.K. Sahoo,
Project Coordinator,
SHED
(Society for Health Education and Development)
AT/PO/ Dist. Rayagada, Orissa-1.
Tel:- (06856) 22031

66. Shri K.C. Panigrahi,
Indian Management of Technical Society,
116, Station Square,
Bhubaneshwar,
Tel:- 503128.

67. Dr. Geeta Mohanty,
C.D.M.U.
97. Forest Park, Bhubaneshwar.

HARYANA

21. Shri J.H.Gopal,
Secretary General, Jetty Foundation,
203, Sector-37, Faridabad-121003
Haryana

22. Ms. Sumitra Chowhar,
Nari Chetana Sangaythan,
1322, Sec.-14, Sonipat,
Ph:- (01264) - 43459.

23. Shri J.N. Gahlant,
Secretary,
Indian Red Cross Society,
Rohtak,
Tel:- (01262) 44588.

HIMACHAL PRADESH

24. Mr. Mukesh Kumar Sinha,
Himachal Pradesh Voluntary
Health Association,
Eleant Bhawan, Khalina, Shimla-171002.
Tel:- 223132.

JAMMU AND KASHMIR

25. Mr. Shabir Ahmed, Mustafa,
General Secretary,
Imam Hussain Foundation,
8/3, Polo View,
Sri Nagar - 190 001.
Kashmir,
Ph:- 478053.

KARNATAKA

26. Ms. Edwina Pereira,
International Nursing Services
Association,
2/1, Benson Road, Benson Town,
Bangalore - 560 046.
Tel:- 080-5513299.
Fax:- 080-5574633.

27. Shri R.B. Laivgo,
Assistant Project Officer,
SAMRAKSHA,
402, Ranka Park Apartments,
4th Block, Ground Floor,
456, Lal Bagh Road,
Bangalore-560027.

Telefax:- (0674) 408605

PONDICHERRY

68. Smt. Shyamala Ashok,
(Executive Director),
SOCIETY FOR DEVELOPMENT,
RESEARCH & TRAINING (SFDRT),
Ratna Talkies Complex,
Pondicherry-605001.

69. Smt. Shyamala Natraj/Smt. A. Baby,
South Indian AIDS Action Programme,
(SIAAP)
2/45, Ayyanar Koil Street,
Thattanchavadi, Pondicherry.
Ph:- 416141, 417224
Fax:- (044) 4918747

PUNJAB

70. Ms. Kulvinder Kaur,
Project Coordinator,
AIDS Prevention Society Punjab,
1058/1, Sector-39, Chandigarh,
Punjab.
Tel:- (0172) 696361

71. Mr. Mandeep Sharma,
Registered Motivator,
Blood Donors Council,
Rahon Road, Nawan Shahar,
Punjab-144514.
Tel:- 20974, 20212

72. Mr. G.D. Arora,
President,
International Forum for Education &
Development,
Head office 16, Sewa Nagar, Putlighar,
Amritsar-143001.
Tel:-210811, 210833, 272607, 272802.

RAJASTHAN

73. Dr. C.L. Paliwal,
Medical Officer,
Seva Mandir,
Fatehpura, Udaipur.

74. Dr. Dinesh Mathur,
Shanti Deep,
S-JA-13, Jawahar Nagar.

Ph:- (080) (2238297)

28. Mr. Bhagwandas,
Karnataka State Trainers Collective,
1st floor, Rowan Villa Compound,
Daddalkad-NH-17-Link Road,
Post Ashoknagar, Daddalkad
Mangalore-575006.
Ph:- (080) (561503)

29. Mr. Belle Gowda, Project Officer,
MYRADA,
No.2, Service Road,
Dumlur Layout,
Bangalore-560071.
Tel:-554 3166, 5572028, 5564457,
Fax:-556 9982.

KERALA

30. Shri Rajesh Williams,
Administrative Officer,
ADIC-India,
T.C.26/2203, Spencer Junction,
Trivandram-695001.
Telefax:- (0471) (462086)

31. Dr. George Joseph C.,
Kusumagiri Mental Health Centre,
Kusumagiri PO,
Kakkanad,
Kochi-682 030.
Tel:-422 215.

MADHYA PRADESH

32. Shri Umesh Vashisht,
Centre for Integrated Development,
42, Manik Vilas, Gwalior.
Tel:- 326174, 424686.

33. Daniel J. Theophilas,
Centre for Labour Education and
Social Research,
C-14 Indira Vihar, Seepat Road,
PB No.58, Bilaspur-495001.
Tel:- 07752/20464, (04452) (40144)
Fax:- 20144, 23306.

34. Shri R.P. Saraf, Secretary,
Madhya Pradesh Bal Kalyan Parishad,
(Street Children),
Hostel No.5, Pilani, Bhopal-462 021.

Jaipur-302004.
Tel:- 560291, 560244
Fax:- (0141) 365268

75. Mr. Rakesh Snehi
Rajasthan Mahila Kalyan Mandal,
Vishwamitra Ashram,
Anandpura (Topdara),
Ajmer.
Tel:- 420635, 427840

SIKKIM

76. Dr. Yogesh Verma,
Rotary Club
Gangtok,
Sikkim,
Tel:- 24555

TAMIL NADU

77. Dr. S. Sunderaman,
Director,
AIDS Research Foundation of India,
20/2, Bagirathy Ammal Street,
T. Nagar, Madras-600 017.
Tamil Nadu.
Tel:- 8258014, 8234797

78. Dr. Suniti Solomon,
Director,
Y.R.G. Care
Raman Street, Chennai-600 017.
Tel:- 8264242
Fax:- 8259600

79. Ms. L. Kumaramangalam,
PRAKRITI,
6, Jagannathan Road,
Nungambakkam,
Chennai -600 034.
Tel:-8276222
Fax:-044-8269625.

80. Ms. Jaya Sreedhar,
Media Foundation,
No.6, Nungambaam High Road,
Chennai -6.
Tel:-044-8278870.
Fax:-821 2138

81. Shri Ashok Pillai,
Indian Network of People Living with

Ph:-586851.

MAHARASHTRA

35. Dr. J. S. Gilada,
Indian Health Organisation,
Municipal School Building,
JJ Hospital Compound,
Mumbai-400 008.
Tel:- 3738999
Fax:- 3864433

36. Dr. Vimala Nadkarni,
Tata Institute of Social Sciences,
(Dept. of Medical & Psychiatric Social work),
Post Box No.8313,
Sion-Trombay Road, Deonar.
Mumbai-400 088.
Tel:-556 3290 -96.
Fax:-556 2912.

37. Dr. V.S. Gore,
Sevadham Trust,
C/o Manoj Clinic,
1148, Sadashiv Peth, Pune - 411 030.
Tel:-472700

38. Dr. R. Gowd.(President)
Service of Society,
'A' Wing, Umiya Apartments,
Canada Corner,
Nasik-422 005.
Tel:-(0253) 578793, 570707
Fax:- 350750

39. Dr. Asha Apte,
Vanchit Vikas,
405/9, Narayanpet,
Behind Modi Ganpati Temple,
Pune-411 030
Ph:- 454658, 483050

40. Dr. Jairaj G. Thanekar,
ASHA Project,
AIDS/STD and Health Action,
Mumbai Municipal Corporation,
IInd floor, Municipal Eye Hospital,
Maulana Shaukat Ali Marg,
Mumbai-400008.
Tel:-3080486, 3088609(O)
Fax:- 3005175.

41. Sr. Anne John R.J.M.,
Catholic Nurses Guild of India.
HIV/AIDS (INP+),
20-C, Thrimalai Pillai Road,
Chennai:-600 017.
Tel:-(044) 8258014
Fax:- (044) 8256842

82. Dr. Bimal Charles,
Assistant Director - NGO Programme,
AIDS Prevention and Control Project
(APAC)
Voluntary Health Services,
Adiyar, T.T.T.I. post,
Chennai-600113

83. Dr. Saraswati Sankaran,
DESH,
3 D' Monte Colony,
TTK Road, Alwarpet, Chennai -600 018.
Tel:- 499 5580
Fax:-4970354.

84. Shri L.D. Xavier,
Managing Trustee,
Reaching the Unreached Trust,
Susai Nagar, Pathiavaran,
Tamil Nadu - 632326.
Ph:- (04175) 25020

TRIPURA

85. Dr. Ms.Shreelekha Rai,
Voluntary Health Association of Tripura,
Near Bangladesh Post Office,
Agartala-799007.
Tel:-0381-222849.

UTTAR PRADESH

86. Dr.(Mrs.) Madhur Chopra,
Medical Officer in charge,
Sarjivan Kalyan Samiti,
275, Katghar,
Allahabad.

87. Shri Bimal Arora,
CIDRAP,
485/14, Mohan Meakin Road,
Daliganj, Lucknow-20 (U.P.)
Ph:-323863, 370461
Fax:- 212714

88. Mrs. Sutapa Mukherjee,(Secretary)
Gram Niyojan Kendra,

C.N. G.I. National Secretariat 2,
St. Michael Annex, 2nd Floor,
Mahim, Mumbai-400 016.
Tel:-4456135
Fax:-4456135.

42. Dr. Mandeep Dhaliwal,
Lawyers Collective,
4th Floor, Jalaram Jyot,
63, Ghogha Street,
(Janambhoomi Lane), Flora Foundation,
Mumbai-400001.
Tel:-2830957, 285-2543,
Fax:-282 3570.

43. Dr. Subhash Hira,
Director,
AIDS Research & Control Organisation
(ARCON),
STD Building,
JJ Hospital,
Mumbai-400 008.
Ph:- 3742193
Fax:- 444 0378

MANIPUR

44. Shri Nobokishore Singh,
Secretary,
Centre for Social Development,
Place Compound (West),
Imphal-795001. Manipur
Tel:-230004.

45. Dr. Jayanta Kumar,
Institute for Social Diseases,
Singhjamei, Mathak,
Chowngtham Leokai,
Imphal-795001. Manipur.
Tel:-(0385)-227574

46. Shri H. Raghumani Singh
Lifeline Foundation
Keishamthong, Top Leirak,
Imphal-395001.
Telefax:- 0385-224186.

47. Shri Vikram Nepram,
Project Director,
Continuum of Care Project,
C/o Medical Directorate,
Govt. of Manipur,
Lamphelpat, Imphal-4,
Manipur.

R-10/1181, New Raj Nagar,
Ghaziabad-201002.
Tel:- 91717291, 91723782

89. Ms. Dee Nair,
Women Action Group, CHELSEA,
House No.181, Sec-37,
NOIDA,
Dist.-Gautambudh Nagar.
Tel:- 8572483
Fax:- 857 2425

90. Dr. S.N. Bhargawa, Secretary,
Voluntary Action for Community Health
(VACH),
B/M-213, Kedar Nagar, Agra-282010.
Tel:-0562-261484

WEST BENGAL

91. Ms. Anandita Roy,
Child in Need Institute(CINI),
Post Box No.16742,
Calcutta-700027.
Tel:- 4678192, 4671206

92. Mr. Apurba Ghosh.
West Bengal Voluntary Blood Donors Forum,
73, Pioneer Park, Barasat,
North 24, Paraganas,
West Bengal-743201.
Tel:-5525277

93. Ms. Taposhi Bhattacharya
Vivekananda Education Society,
13/3, Kalicharan Dutta Road,
Calcutta-61.
Tel:- 4680365, 4681550
Fax:- 468-0364

94. Ms.Papia Sen,
West Bengal Voluntary Health Association,
AIDS Control & Prevention Programme,
19 A, Dr. S.M. Avenue,
Calcutta -700014.
Tel:- 2446754
Fax:- 2487628

95. Shri Ravi Kant,
Jan Shakti Vahini,
A-139, Shivalik, Malviya Nagar,
(Opp. Aurobindo College),
New Delhi.
Tel:- 6283054, 8-271267.
Fax:- 6852080

96. Shri Deepak Meshram,
Voluntary Health Association of India,
40, Institutional Area,
South of IIT, Near Qutab Hotel,
New Delhi-110 069.
Tel:-6518071/2, 6515018

97. Dr. T.C. Sharma,
Indian Red Cross Society,
1 Red Cross Road,
New Delhi-110001.
Tel:-3711551, 37164441, 3716305
Fax:-3717454.

98. The Branch Manager,
Family Planning Association of India,
FPAI, Bhawan, Sec-4, R.K. Puram,
New Delhi-22.
Tel:- 6172359

99. Dr. S. Nath,
SULABH,
Sulabh International Institute of
Health & Hygiene,
Sulabh Bhawan, Mahavir Enclave,
Plam-Dabri, New Delhi.
Tel:- 5553823, 5501494

100. Dr. Shobha Yoman,
Christian Medical Association of India,
A-3, Plot No.2,
Local shopping Centre, Janak Puri,
New Delhi-110058.
Tel:-559971-3
Fax:-5598150.

101. Ms. Niharika Sinha
Parivar Seva Sausthan,
J-125, Sahet,
New Delhi-17,
Tel:- 6965710, 6967473.
Fax:- 6967473.

102. Dr. Rajiv Tandon,
Regional Director (HIV/ AIDS),
Rotary International South East Asia,
c/o Tandon Nursing House,
C-55, Anand Niketan,
New Delhi- 21.
Telefax:- 6875354

103. Dr. Christopher Nathan,
Medical Officer,
The Catholic Health Association of India,
P.B. No.2126, Gunroch Enclave,
Secunderabad-500003.
Tel:- 8482923

104. Shri Madhab Lal chaterjee,
Indian society of Blood Transfusion
& Immunohaematology,
C/o 73, Pioneer Park, Barasat,
North 24, Paraganas,
West Bengal.

List of Foreign Agencies

1. Ms.Doris D' Cruz Grote,
UNAIDS - India,
C-199, Defence Colony,
New Delhi-110 024.
Tel:- 6875760
Fax:- 6885540

2. Shri Mehboob Dada,
European Commission,
42-A, Golf Link,
New Delhi-110003.
Tel:- 4627896

3. Mr. Bob Fryatt/
/Mr. G. Balasubramanium /
Ms. Madhu Deshmukh,
DFID-Health & Population Office,
50-M, Shantipath,
(Gate No. 4, Niti Marg,)
Chanakyapuri,
New Delhi-110021.
Tel:- 6871657

4. Ms. Geetanjali Mishra,
Programme Officer,
Ford Foundation,
55, Lodi Estate,
New Delhi-110003.
Tel:- 4619441

5. Ms.Poonam Mutreja,
MacArthur Foundation,
Core C, Zone VA, 1st Floor,
India Habitat Centre,
Lodi Estate,
New Delhi-110003.

6. Dr. Ravi Anand,
CEDPA,
IIPS,
Liason Office,
4/2, Shanti Niketan.

11. Ms. Asa Anderson,
UNESCO,
UNESCO House,
9, Poorvi Marg, Vasant Vihar,
New Delhi-110057.
Tel:-6141437

12. Mr. Wasim Zaman/Dr. Farah Usman,
UNFPA, Representative,
55, Lodi Estate,
New Delhi - 110003.
Tel:-4628877, 3782317

13. Mrs. Geeta Sethi,
Officer-in-charge,
Regional Project on HIV and
Development,
C-199, Defence Colony,
New Delhi-110003.
Tel:-4632339
Fax:-4631647

14. Dr. Abdul Latif,
Regional Representative,
UNDCP,
11C, 40 Max Mueller Marg,
New Delhi- 110003

15. Dr. K. Sudhakar,
Office of Population, Health & Nutrition,
USAID, B-28, Institutional Area,
Qutab Hotel Road,
New Delhi-110016.
Tel:-6865301
Fax:-6868594

16. Mr. Werner K. Blenk,
Director, ILO Area Office,
3rd Floor, India Habitat Centre,
Lodhi Road, New Delhi- 110003.

17. Dr. Isabelle de Zovsa.

New Delhi-110021.

7. Mr. J.P. Narain,
Regional Advisor on AIDS,
WHO House,
I.P. Estate,
New Delhi.
Tel:-331 7804, 3317323
Fax:- 3318412

8. Ms. Jillian Nellsop,
AusAid,
Australian High Commission,
New Delhi.
Tel:- 6888223
Fax:- 6887492

9. Ms. Yasmin Zaveri,
SIDA,
C/o Swedish Embassy,
Nyaya Marg,Chanakya Puri,
Behind Russian Embassy,
New Delhi-21.
Tel:-6875760
Fax:- 6885540

10. Dr. Sanjiv Kumar,
UNICEF, India Country Office,
73, Lodhi Estate, New Delhi-110003.
Tel:- 4690401
Fax;- 4690410

Population Council of India,
Zone 5A, Ground Floor,
India Habitat Centre,
Lodhi Road, New Delhi - 110003.
Tel:-4642901
Fax:-4642903

18. Ms. Tara A. Sharma,
Programme Officer,
NORAD,
50-C, Shantipath,
Chanakyapuri,
New Delhi-110019.

19. Dr. Jomes Abraham,
Director,
HOPE Foundation,
(An affiliate of Hope World wide),
D-32, 1st Floor, Jangpura Extension,
New Delhi-110014.
Tel:-4321515, 4311359
Tel:-4319672

20. Dr. Raj Kumar,
Public Health Specialist,
World Bank, New Delhi.
Tel:-4617241

21. Dr. Henry Alderfex,
Project Concern International,
Tel:-4641624
Fax:-4641625

22. Dr. T. Walia,
WHO/WR India,
Tel:- 3018955.

ANNEXURE-2

SYLLABUS

B.TECH.
(CHEMICAL ENGINEERING)

MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY, ALLAHABAD –211 004
INDIA

STRUCTURE FOR B.TECH IN CHEMICAL ENGINEERING

SEMESTER-I						SEMESTER-II					
S.N.	Subject	L	T	P	Cr	S.N.	Subject	L	T	P	Cr
PH 101	Physics-I	3	1	3	5	PH 201	Physics-II	3	1	2	5
MA 101	Mathematics-I	3	1	0	4	MA 201	Mathematics-II	3	1	0	4
CS 101	Introduction to Engg. Profession	2	0	2	3	CS 201	Computer Programming	2	1	2	4
EX 101	Electrical & Electronics Engg.	4	0	2	5	HS201 / CH201	English Language and Composition/ Chemistry	2 3	1 1	1 2	3 5
HS/101 CH/101	English Language and Composition/ Chemistry	2 3	1 1	1 2	3 5	AM 201	Engineering Mechanics	3	1	2	5
ME 101 / MC 101	Introduction to Manufacturing Processes/ Engineering Graphics	2 2	0 0	2 4	3 4	ME201 / MC201	Introduction to Manufacturing Processes/ Engineering Graphics	2 2	0 0	2 4	3 4
TOTAL CREDITS		16 / 17	3 / 3	10 / 13	23 / 26	TOTAL CREDITS		15 / 16	5 / 5	9 / 12	24 / 27

SEMESTER-III						SEMESTER-IV					
S.N.	Subject	L	T	P	Cr	S.N.	Subject	L	T	P	Cr
MA 301	Mathematics-III	3	1	0	4	ME 401	Computational and Statistical Techniques	2	0	2	4
CE 301	Environment and Ecology	3	1	0	4	CL 401	Fluid Particle Mechanics and mechanical operations	3	1	2	5
AM 301	Material Science and Engineering	3	1	2/2	4	CL 402	Heat Transfer Operations	3	1	2	5
ME 301	Engineering Thermodynamics	3	1	2	5	CL 403	Mass Transfer - I	3	1	0	4
CL 301	Fluid Flow Operations	3	1	2/2	4	CL 404	Organic and Physical Chemistry	2	1	2	4
CL 302	Chemical Process Principles	3	1	0	4	CL 405	Chemical Technology - I	2	1	0	3
TOTAL CREDITS		18	6	4	25	TOTAL CREDITS		15	5	8	25

SEMESTER-V						SEMESTER-VI					
S.N.	Subject	L	T	P	Cr	S.N.	Subject	L	T	P	Cr
CL 501	Chemical Reaction Engineering -I	3	1	0	4	ME 612	Process equipment design	3	2	0	5
CL 502	Chemical Engineering Thermodynamics	3	1	0	4	CL 601	New Separation Processes	3	2	0	5
CL 503	Mass Transfer - II	3	1	2	5	CL 602	Transport phenomena	3	2	0	5
CL 504	Process dynamics and control	3	1	2	5	CL 603	Environmental Pollution, Monitoring and Control	3	1	2	5
CL 505	Chemical Technology II	3	1	2	5	CL 604	Chemical Reaction Engineering - II	3	1	2	5
HS 501	Principles of management	2	1	0	3	HS 602	Soft skills workshop	0	0	2	0
TOTAL CREDITS					26	TOTAL CREDITS					25

SEMESTER-VII						SEMESTER-VIII					
S.N.	Subject	L	T	P	Cr	S.N.	Subject	L	T	P	Cr
CL 701	Plant Design and Economics	3	2	0	5	CL 801	Hazards and Safety in Chemical Industries	3	2	0	5
OE 701	Open El-I	3	1	0	4	OE 801	Open. El-II	3	1	0	4
CL 702	Prof. El-I	3	1	0	4	CL 802	Prof. El-III	3	1	0	4
CL 703	Prof. El-II	3	1	0	4	CL 803	Prof. El-IV	3	1	0	4
CL 704	Major Project I	0	0	16	8	CL 804	Major Project II	0	0	16	8
TOTAL CREDITS					25	TOTAL CREDITS					25

SEMESTER -I

PHYSICS-I

1. Special Theory of Relativity

Frame of Reference, Galilean Transformation, Inertial and Non-inertial frames, Postulates of Special Theory of Relativity, Michelson-Morley Experiment, Lorentz transformation of space and time, Length contraction, Time dilation, Simultaneity in relativity theory, Addition of velocities, Relativistic dynamics, Variation of mass with velocity, Equivalence of mass and energy.

2. Thermal Physics

Maxwell-Boltzmann Law of distribution of molecular velocities, Evaluation of r.m.s.velocity and of average and most probable speeds, Mean free path, Transport phenomena.

3. Geometrical Optics

Combination thin lenses, Cardinal points of coaxial optical systems, thick lenses, location and properties of cardinal points, Newton's formula, graphical construction of images. Eye pieces, Aplantic points. Optical Instruments-Spectrometer (Prism and grating), Sextant.

4. Physical Optics

Interference- Condition of observing interference. Degree of coherence and visibility of fringes. Production of interference fringes and determination of wavelength using Fresnel's Biprism. Michelson interferometer and its uses. Interference due to thin films. Wedge shaped films. Newton's rings.

Diffraction- Fresnel's Diffraction, Fresnel's Half Period Zone, Zone Plate, Fraunhofer's diffraction by single slit, double slit. Theory of plane grating. Width of principal maxima. Rayleigh's criterion of resolution. Resolving power of prism and grating.

Polarisation- Unpolarised, polarized and partially polarized lights. Polarisation by reflection. Double refraction by uniaxial crystals, Polaroids, Huygen's theory of double refraction. Half wave and quarter wave plates. Production and analysis of plane elliptical and circularly polarized light. Optical activity. Fresnel's theory of optical rotation, Specific rotation, Biquartz and Laurent half-shade polarimeters.

5. Holography

Basic principles, Holography and its applications.

6. Lasers

Stimulated and spontaneous emission, Einstein coefficients, relative contribution of stimulated and spontaneous emissions, population inversion, Laser emission, Ruby and He-Ne lasers, characteristic of Laser light.

7. Acoustics

Production and detection of Ultrasonics, Measurement of Velocity in Liquids, Applications of Ultrasonics. Accoustics of building.

References

1. Mechanics-D.S.Mathur
2. Optics-A.K.Ghatak
3. Heat and Thermodynamics-Brijlal & Subramanium

4. Thermal Physics-B.K.Agarwal
4. Physics of Oscillations and Waves-R.B.Singh
5. Engineering Physics-A.S.Vasudeva

List of Experiments

Minimum ten experiment to be completed out of the following-

1. To determine the co-efficient of viscosity of water by capillary flow.
2. To determine the co-efficient of viscosity of liquid by rotating cylinder method.
3. To determine the surface tension of water by capillary rise.
4. To determine the surface tension of water by Jager's Method.
5. To determine the co-efficient of thermal conductivity of good conductor by Searle's method.
6. To determine the co-efficient of thermal conductivity of bad conductor by Lee's method.
7. To determine the co-efficient of thermal conductivity of rubber.
8. To determine the value of mechanical equivalent of heat by Callender's & Barne's method.
9. To determine the height of building by Sextant.
10. To determine the focal length of combination of two thin lenses by Nodal slide assembly and its verification.
11. To determine the wavelength of light by Fresnel's biprism.
12. To determine the wavelength of light by Newton's ring method.
13. To determine the wavelength of light by Diffraction Grating.
14. To determine the dispersive power of the given material of the prism.
15. To determine the specific rotation of canesugar using Polarimeter.

MATHEMATICS-I

Quadric surfaces in three dimensions, Sequences and series, Power series, Limit, Continuity, Differentiability, Mean value theorem, Taylor's theorem for functions of one and two variables, Transformation of one system of coordinates into another system, Extrema of functions of multi-variables, Definite integrals, Trapezoidal and Simpson rule, Improper integrals, Applications, Vector calculus- Gradient , Directional derivatives, Curl and divergence, Double, triple, line and surface integrals, Green, Gauss, Stoke's theorems and applications.

References

1. Thomas and Finney, Calculus and Analytic Geometry, Narosa Pub. House, New Delhi.
2. N. Piskunov, Differential, and Integral Calculus, Vol I & II, Mir Pub, Moscow.
3. Jain and Iyenger, Advanced Engineering Mathematics, Narosa Pub. House, New Delhi.
4. T. Mazumdar, Engineering Mathematics, New Central Book Agency.
5. Jaggi and Mathur, Higher Engineering Mathematics, Khanna Publishers, New Delhi.
6. Bali and Iyengar, Engineering Mathematics, Khanna Publishers, New Delhi.

INTRODUCTION TO ENGINEERING PROFESSION

Information Technology portion:

MS WINDOWS, commands, editing and saving files, word processing, file management.

LINUX Commands, editors, Files & Directories, UNIX tools.

Internet and World Wide Web :

Introduction to Internet, www, Internet browsers Netscape & Explorer, Introduction of PINE/ELMN, FTP, Telnet, Search Engines.

Hypertext Markup Language, HTML Tags, Frames, Creating HYML documents, DHTML.

References

1. D.S.Yadav , Foundation of Information technology, New age International 2003
2. S. Dash ,Introduction to unix, TMH

ELECTRICAL AND ELECTRONICS ENGINEERING

A. Electrical Engineering

Introduction to Electrical Engineering

Generation: Types of power Plant, Functional Block diagram of Generating stations (Hydel & Thermal Stations)
Transmission: Standards (AC & DC), Substations, Grids
Distribution: Industrial, Commercial and Domestic Standards.
Utilization: Types of loads, UPS and domestic inverters.
Domestic Wiring: Materials, accessories & ratings of the wiring materials, types of wiring: stare case, fluorescent tube and simple domestic wiring layout, earthing and electricity rules.
Steady-state analysis of AC circuits: Sinusoidal and phasor representation of Voltage & current, single phase ac circuit behavior of R, L and C. Combination of R, L and C in series and parallel. Resonance.
Three Phase AC circuits: Line and phase voltage/current relationship for star & delta connections.
Measuring Instruments: Types of instruments, working principles of Ammeter, Voltmeter, Wattmeter & Energy meter.
Transformer & Rotating Machines: Principle of operation and construction of single-phase transformer, phasor diagram and equivalent circuits, efficiency and voltage regulation. Principle of electromagnetic energy conversion, Starting and speed control of DC and AC motors

B. Electronics Engineering

Junction Diode : p-n junction, v-i characteristics, diode resistance, capacitance, switching time, diode applications. Breakdown mechanism, Zener and avalanche, break down characteristics, Zener diode and its applications voltage regulator.

Bipolar -junction Transistor : Bipolar junction transistor, CE, CB and CC configurations and characteristic curves, Requirement of biasing, types of' biasing.

JFET and MOSFET: The JFET and MOSFET action; characteristics.

Linear IC and its applications

Digital Electronics: Number systems, conversion of bases, Boolean Algebra, logic gates, Concept of universal gate, Flip-Flops and counter.

Electronics Instruments :Oscillators, Digital Multimeter and its applications, CRO and its applications.

ENGLISH LANGUAGE AND COMPOSITION

1. Remedial Grammar: It is the basic core for the development of the English language and it can be more enhanced through our mini language lab currently, though in future with computerised language lab containing tense busters and other softwares to develop interests in students to learn language through games.

Content: Articles, Prepositions, Tenses, Active and Passive forms.

2. Effective comprehension: In this global era effective comprehension is an attempt to develop in technical students to comprehend different topics relative to varied scientific and social myriad happenings in the world thus bridging the gap from the scientific- technical culture from the liberal arts culture.

Content: Passages from News Papers, magazines and short comprehensions from GRE packages

3. Effective Composition: Liberal space has been devoted to written composition and an overall initiative will be taken to show the students that most effective writing-scientific or literary-adapts certain principles of rhetoric which can be learnt and put into practice through artistic writing.

Content: Discussions on varied topics in tutorials, excerpts from magazines and newspapers.

4. Pronunciation Skill: One of the important aspects in communication and personality impression of the students. This will be enhanced through the aid of language lab and the instructors own drilling exercises. So that availing such a skill can create great space for themselves and for job in this age of globalisation, where overall developed personality is more easily absorbed.

Content: With the help of language lab and instructors drilling exercises.

INTRODUCTION TO MANUFACTURING PROCESSES

1. **Introduction to Materials and Manufacturing:** Introduction to engineering materials such as metals and alloys and their applications. Art of manufacturing; Classification of manufacturing processes, Guide to processing of metals and alloys.
2. **Machining Processes and Machine Tools:** Classification of machining processes and machine tools; Construction and working of lathe, Drilling machine, Shaper, Slotter and Planer, Boring Machine, Milling Machine, Grinding Machine, Brief introduction of Newer Machining Processes such as EDM, ECM, USM, LBM, WJM etc.
3. **Casting Processes:** Elements of Sand Mould, Method of preparation of Sand Mould, Introduction of casting defects.
4. **Press Working Operations:** Classification of press working operations, Construction of Power Presses, Press working terminology, Types of dies and their operations.
5. **Fabrication Processes:** Classification of welding operations, Types of joints and welding positions. Brief description of Arc, Resistance and Gas welding techniques. Brazing and Soldering.
6. **Modern Trends in Manufacturing:** Automation, Concept of CAD, CAM and CIM; Concept of Micro manufacturing and nano-technology.

ENGINEERING GRAPHICS

General: Importance, significance and scope of engineering graphics, dimensioning, scales, different types of projections, orthographic projections,

Projection of Points and lines in different quadrants, traces, inclinations, and true lengths of the lines, projections on auxiliary planes, shortest distance, intersecting and non-intersecting lines.

Planes other than reference planes: Perpendicular and oblique planes, their traces, inclinations etc. projections of points and lines lying in the planes, conversion of oblique plane into auxiliary plane and solution of related problems.

Projections of plane figures: Different cases of plane figures (of different shapes) making different angles with one or both reference planes and lines lying in the plane figures making different given angles (with one or both reference planes). Obtaining true shape of the plane figure by projection.

Projection of solids: Simple cases when solid is placed in different positions, axis, faces and lines lying in the faces of the solid making given angles.

Development of Surfaces: Development of simple objects with or without sectioning.

Basic Concepts: IS drawing conventions, line symbols, Kinds of line, drawing sheet layout, rules of printing, preferred scales.

Projections: Perspective, orthographic, isometric and oblique projections, sketching of orthographic views from pictorial views, precedence of lines.

Shape Description (internal): Importance of sectioning, principles of sectioning, types of sections, cutting plane representation, section lines, and conventional practices.

Size Description: Dimensioning, size and location dimensioning, Principles and conventions of dimensioning, dimensioning exercises.

Screwed Fasteners: Introduction, Screw Thread nomenclature, Forms of Screw Threads, Thread series, Multi-start threads, Right hand and left hand threads, Representation of threads, Bolted Joints, Locking arrangements for nuts, foundation bolts.

Computer Graphics: Basic Concepts and use. Methods of constructing objects in computer aided design softwares.

References:

1. N. Sidheswar, P. Kannaiah, V. V. S. Shastry, "Machine Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 1988

2. Bhatt, N. D., 'Elementary Engineering Drawing', Charotar Book Stall, Anand, 1998.

3. Laxminarayanan, V, and Vaish Wanar, R. S., 'Engineering Graphics', Jain Brothers, New Delhi, 1998.

4. French and Vireck, The fundamental of Engineering Drawing and Graphic Technology', McGraw Hill, 4th Edition, 1978.

5. IS 696 (1972); Code of practice for general engineering drawing', BIS, New Delhi.

6. P. S. Gill, ' A Text book of Machine Drawing', Katson Publishing House, Ludhiana, 1980.

7. Giesecke, Mitchell, Spener, Hill and Dygon, ' Technical Drawing', McMillan &Co., 7th Ed, 1980.

SEMESTER-II

PHYSICS II

1. Electrostatics
Background of vector calculus, Quantization and conservation of charge, Coulomb's law (vector form) and superposition principle, concept of electric field lines, flux of E-field, Gauss flux law (Integral and differential form). Simple cases of charge distributions. Energy of charge distribution, Energy as an integral over the field of uniformly charged spherical surface and volume.

2. Electric Current
Current Density Vector, Equation of Continuity, Ohm and Joule's Laws (Integral and differential forms).

3. Magneto statics
Ampere's Law, Biot Savart's Law, Law of Force in magnetic Field on currents and Charged Particles. Magnetic Field due to a Straight Infinite Wire. Magnetic Field due to Circular Loop and Solenoid at Axial points, Variation of Magnetic field with distance along the axis of Helmholtz galvanometer. Vector potential and its Evaluation for Uniform magnetic field and for Straight Infinite Wire. Divergence and curl of **B**. Distant Field due to Loop of Current. Magnetic Moment. Magnetic materials and magnetization. Magnetic Current Field **H**, Curl of **H** and calculation of **H**

5. Time Varying Fields
Displacement Current, Curl H, Faraday's Law(Integral and Differential forms). Self and Mutual Inductances. Energy of Coupled Circuits and Current Distribution. Energy as an Integral over the Magnetic field. Energy of a Solenoid.

6. Electromagnetic Waves in Free-Space
Maxwell equations. Plane Polarized Plane Wave Solution. Characteristics of these Electromagnetic waves. Poynting's Theorem.

7. Atomic & Nuclear Physics
X-rays-Characteristic and continuous X-ray spectra, Mosley's law, X-ray absorption X-ray diffraction, Bragg's law, Laue Spots Bragg's Spectrometer. Compton effect.

8. **Magnetic Properties of Materials-** Ferro, Para, Dia, Antiferro and Ferri Magnetic Materials. Hysteresis curve and their uses. Larmor's Theory and Diamagnetic Susceptibility. Langevin's Theory and Curie-Weiss Law. Magnetic Circuits.

9. Quantum Concepts -Particle nature of radiation, Wave nature of Particles. De-Broglie Waves, Davission-Germer experiment, Wave Packets, Phase velocity and group velocity, Heisenberg's Uncertainty Principle and its applications, one-dimensional Schrodinger's wave equation and concept of probabilities, amplitude, application to one-dimensional potential well.

10. Particle Physics- Classification of elementary Particles

References

1. Electricity & Magnetism-Brijlal & Subramanium
2. Electricity & Magnetism-K.K.Tiwari
3. Introduction to Electrodynamics-David J.Griffiths
4. Modern Physics-Beiser
5. Engineering Physics-A.S.Vasudeva
6. Physics for Engineers-M.R.Srinivasan
7. Quantum Mechanics- Gasirowicz

List of Experiments

Minimum ten experiment to be completed out of the following-

1. To determine the specific resistance of wire by Carry-Foster's Bridge.
2. To determine the reduction factor of Helmholtz Galvanometer.
3. To determine the E.C.E. of copper using voltameter..
4. To convert a galvanometer into a voltmeter of 3 volts.
5. To convert a galvanometer into an ammeter of 200 milliamperes.
6. To determine the variation of magnetic field along the axis of current carrying coil.
7. To determine e/m by magnetic focussing.
8. To Verify Stefan's law.
9. To study the non-Ohmic behavior of the filament of an electric bulb.
10. To compare the illuminating power of two electric bulbs by photometer.
11. To find the resistance of a galvanometer using P.O.Box.
12. To find the internal resistance of a cell using P.O.Box.
13. To find the current sensitivity of a galvanometer using P.O.Box.
14. To calibrate a moving coil galvanometer using P.O.Box.
15. To calibrate an ammeter and voltmeter using Potentiometer

MATHEMATICS-II

Linear vector spaces, Linear transformation and matrices, Determinants, Linear simultaneous algebraic equations, Special matrices, Quadratic forms, Diagonalisation and canonical forms, First order ODE, IVP/BVP, Existence and uniqueness questions, System of linear equations, Higher order ODE, Solutions of homogeneous and non-homogeneous ODE, Variation of parameters, Undetermined coefficients, Laplace transforms and application to solutions of ODE, Series solutions, Strum-Liouville problem, Orthogonal polynomials, Fourier series, Fourier integrals, Generalized Fourier series.

References:

1. E. Kreyszig, Advanced Engineering Mathematics, 8th Edition, Wiley Eastern
2. Jain and Iyengar, Advanced Engineering Mathematics, Narosa Pub. House
3. Jaggi and Mathur, Higher Engineering Mathematics, Khanna Publishers.
4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers.
5. Hoffman and Kunj, Linear Algebra, Prentice Hall
6. Bali and Iyengar,' Engineering Mathematics, Khanna Publishers

COMPUTER PROGRAMMING

Writing a Simple Program: Learning the form of a C program, Declaring variables, designing program flow and control, defining and using functions, using standard terminal I/O functions.

Fundamental Data Types and Storage Classes: Character types, Integer, short, long, unsigned, single and double-precision floating point, storage classes, automatic, register, static and external.

Operators and Expressions: Using numeric and relational operators, mixed operands and type conversion, Logical operators, Bit operations, Operator precedence and associativity.

Conditional Program Execution: Applying if and switch statements, nesting if and else, restrictions on switch values, use of break and default with switch.

Program Loops and Iteration: Uses of while, do and for loops, multiple loop variables, assignment operators, using break and continue.

Modular Programming: Passing arguments by value, scope rules and global variables, separate compilation, and linkage, building your own modules.

Arrays: Array notation and representation, manipulating array elements, using multidimensional arrays, arrays of unknown or varying size.

Structures: Purpose and usage of structures, declaring structures, assigning of structures.

Pointers to Objects: Pointer and address arithmetic, pointer operations and declarations, using pointers as function arguments, Dynamic memory allocation, defining and using stacks and linked lists.

Unions: Components in overlapping memory, declaring and using unions .h vs. private .c files, Hiding private variables and functions.

Controlling Devices: Bit access and masking, pointing to hardware structures.

Operating System Interaction: Reading command line arguments, creating and accessing files, file opening modes, formatted disk I/O.

The Standard C Preprocessor: Defining and calling macros, utilizing conditional compilation, passing values to the compiler.

The Standard C Library: Input/Output : fopen, fread, etc, string handling functions, Math functions : log, sin, alike' Other Standard C functions.

References:

1. Herbert Schield, Complete reference in C,' TMH.
2. Yashwant Kanetkar,' Let US C", BPB.
3. Balaguruswamy, 'Programming in ANSI C,' TMH.
4. Yashwant Kanetkar, Pointers in C.

CHEMISTRY

Chemical Bonding
Valence bond theory, molecular orbital theories of bonding in metals and semi-conductors (Band theory), imperfection in solids.

Polymers
Classification of polymers, types of polymerisation and their principles, structure property relationship, polymer materials of industrial importance, biopolymers.

Phase rule
Derivation of the phase rule, application of phase rule to one component system.

Chemical kinetics
Reaction rates, order and molecularity of reactions, factors influencing reaction rates, complicating factors in reaction kinetics- opposing reactions, consecutive reactions, side reactions and surface reactions.

Water Chemistry
Sources and nature of impurities, characteristics of natural water, water treatment processes, boiler feed water.

Fuels
Classification, calorific value, analysis of solid fuels, carbonisation of coal, gaseous fuels including LPG and natural gases, liquid fuels and its properties, power alcohol, knocking and octane, rating, anti-knocking agents, diesel as a fuel, cetane number.

Corrosion
Theories of corrosion, types of corrosion and its protective measures, detailed account of paints, varnishes and resins.

Lubricants
Definition, functions, mechanisms and classification of lubricants, properties and testing of lubricating oils.

References

1. S.Chawla, A Text Book of Engineering Chemistry, Dhanpat Rai & Co., New Delhi, 2004.

2. J.N.Gurtu and N.Singhal, Engineering Chemistry: Theory & Practices, Pragati Prakashan, Meerut, 2004.

3. Jain & Jain, Engineering Chemistrty, Dhanpat Rai & Co., New Delhi, 2000.

ENGINEERING MECHANICS

INTRODUCTION:

Idealisation of Mechanics, concept of Rigid Body, External Forces (Body forces & surface forces), Laws of Mechanics.

FORCE SYSTEMS AND EQUILIBRIUM

Introduction to vector, Statically Equivalent Force systems (Planar and Spatial), Free Body Diagram, Equations of equilibrium and their applications to various system of forces.

STRUCTURES AND MACHINES

Plane Trusses, Space Trusses, Method of Joints, Method of Section, Graphical Method, Method of tension coefficients, Frames and Machines.

DISTRIBUTED FORCES AND MOMENT OF INERTIA

Centroid of Composite figures, Area Moment of Inertia, Mass Moment of Inertia, Principle axes and Principle Moment of Inertia.

FRICTION

Introduction to friction, Laws of friction, wedge, screw, belt, rolling friction.

BEAMS

Different support & load conditions, SFD, BMD

KINEMATICS AND KINETICS OF RIGID BODIES

Velocity and acceleration, Rotation of Rigid bodies, Rolling motion, Plane motion of rigid bodies, Effective Forces on a rigid body, D'Alembert's Principle, Force, Mass and Acceleration, Work and Energy, Impulse and Momentum.

THREE DIMENSIONAL DYNAMICS OF RIGID BODIES

Introduction, Kinematics and Kinetics, General Motion

References

1. Engineering Mechanics (Statics and Dynamics) J.L. Meriam and L. G. Kraige.
2. Mechanics for Engineers- (Statics and Dynamics) F.B. Beer & E.R. Johnston.
3. Engineering Mechanics- I.M. Shames
4. Engineering Mechanics- S. Timoshenko & T. Yong
5. Engineering Mechanics- Singer
6. Engineering Mechanics- Statics Vol-I & Dynamics Vol-II by V.S. Mokashi. (Tata McGraw-Hill)
7. Engg. Mechanics-Statics & Dynamics by Dr. A.K. Tayal, Umesh Publication, Delhi.

SEMESTER- III

MATHEMATICS-III

First order PDE, Complete general and particular solutions, Second order linear PDE, Interior and exterior BVP, Functions of a complex variable, The complex plane, Analytic functions, Elementary functions, Multivalued functions, Singularities, Complex integration, Conformal mapping, Probability theory, Axiomatic definition of probability, Conditional probability, Random variables Distribution function, Expectation, Moments, Moment generation function, Special types of Probability distributions, Normal approximation to Binomial distribution.

References:

1. E. Kreyszig, Advanced Engineering Mathematics, 8th Edition, Wiley Eastern
2. Jain and Iyengar, Advanced Engineering Mathematics, Narosa Pub. House
3. Jaggi and Mathur, Higher Engineering Mathematics, Khanna Publishers.
4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers.
5. J.N. Kapur, Mathematical Statistics, S.Chand & Co.
6. Zill and Cullen, Advanced Engineering Mathematics, C.B.S.Publishers

ENVIRONMENT AND ECOLOGY

Introduction and scope

Conservation of natural resources i.e. forest resource, water resource, mineral resource, energy resource, land resource etc. Role of individual for resource conservation and sustainable development.

Ecosystem and its basic concept, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Examples of ecosystems.

Biodiversity and its conservation: Introduction - Definition: genetic, species and ecosystem diversity, National and global scenario.

Environmental Pollution, Definition, Causes, effects and control measures of:Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards

Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust Case studies, Wasteland reclamation, Consumerism and waste products, Environmental Management through Acts.

.Human Population and the Environment: Environment and human health, Role of Information Technology in Environment and human health, Case studies

Field Work

Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain
Visit to a local polluted site- Urban/Rural/Industrial/Agricultural
Report submission on field visit

MATERIAL SCIENCE AND ENGINEERING

- **Structure and properties, relationship of Engineering Materials**
- **Structure of Crystalline Solids:** Crystal structures and Systems, Unit Cells, Metallic Crystal Structures, Crystallographic directions and Planes, Density Computations.
- **Characterization of Materials:** Crystallography, Reciprocal Lattice, Stereographic projections, Diffraction methods, Electron microscopy, Metallography, Thermal analysis.
- **Imperfections in Crystals:** Point defects, Dislocations, Interfacial Defects, Bulk defects.
- **Diffusion:** Mechanisms, steady state and non steady state Diffusion, factors influencing diffusion.
- **Multiphase Structures, Phase Transformations:** Unary, Binary, Equilibrium Phase Diagrams, Eutectic, Eutectoid Peritectic and Peritectoid Reactions, Iron Carbon Diagram.
- **Mechanical Behaviour of Materials:** Elastic and Plastic properties, Creep, Fracture, Heat treatment of steels.
- **Ceramic Materials:** Ceramic Structures, Properties.
- **Electric and Electronic materials:** Electrical Conduction, Classification of semiconductor materials, Materials and Technology for integrated circuits, Photonic materials, super conductivity and special super-conducting materials, Ferrites. Quartz crystal, Dielectric materials. Piezoelectric and Ferro-electric materials, Electromechanical materials, Mechanism of polarization, Its measurements.
- **Magnetic Properties for Applications;** Diamagnetism, Paramagnetism, ferromagnetism, Antiferromagnetism, Ferrimagnetism, Soft and hard magnetic materials magnetic storage.
- **Optical properties:** Optical properties of Metals and Nonmetals, Luminescence, photoconductivity, Optical Fibers in communications.

1. Callister W. D., Jr., Material Science and Engineering An Introduction, John Wiley & Sons, Inc., 6th Ed., 2003.
2. Raghavan V., Material Science and Engineering, Prentice- Hall of India Private Limited, New Delhi, 5th ed., 2004.

ENGINEERING THERMODYNAMICS

1.Basic Concepts and Definitions: Definition, Areas of Application of thermodynamics, Thermodynamic System, Surroundings and universe, Types of Systems, Phases, Macroscopic and Microscopic point of view, Concept of Continuum, Density, pressure, Thermodynamic equilibrium, Property, Path, Process, Quasi-static process, Reversible and irreversible processes, Energy and its types, Thermodynamic media, Thermodynamic devices.

2.Heat and Work: Work, Power, Forms of work, heat, sign convention of various energies.

3. Temperature and Zeroth law of Thermodynamics: Concept of temperature, Zeroth law of thermodynamics, Measurement of temperature, Temperature Scale, Various thermometers, International temperature scale.

4.Ideal and Real Gases: Concept of ideal and real gases, gas laws, Characteristic equation of gas, Avagadro hypothesis and universal gas constant, Specific heat, Vander Waals equation of state, Compressibility and law of corresponding states, Deviation of real gases from ideal gases, PVT surface of ideal gas.

5. First Law of Thermodynamics: Definition and proof for non-flow and cyclic processes, Internal energy and enthalpy. Application of first law for closed system, Flow Process and control Volume, Flow work, First law of thermodynamics applied to open system for steady and unsteady flow process, Mechanical work in a flow system, continuity equation, Throttling process, Joule-Thomson coefficient, Application of Steady and unsteady flow energy equation.

6.Second Law of Thermodynamics: Limitation of First law and essence of Second law, Thermal reservoirs, Heat engines and thermal efficiency, Heat pump and coefficient of performance, Available and unavailable energy, Statement of Second law, Carnot Cycle, irreversibility, Corollaries of Second law.

7.Entropy and Third Law of Thermodynamics: Clausius inequality, Entropy, Entropy related corollaries, Entropy generation in a closed and an open system, Temperature entropy-diagram, Application of entropy principle, First and Second law combined Equations, Entropy change for an ideal gas, Physical interpretation of entropy, Isentropic efficiencies, Third law of Thermodynamics.

8. Properties of Steam and Applications: Pure Substance, Phase transformation, P-V-T surface for pure substance, Quality of Steam, Properties of Steam, Steam property diagrams, Application of first and second law involving steam as working fluid, Methods of determination of dryness fraction.

9. General Thermodynamic Relation. Helmholtz and Gibbs free energy, Coefficient of volume expansion and isothermal compressibility, Differential relation for U, H, G and F, Maxwell Relations, Generalized Relation for C_p, C_v, K and β, various Tds equations, Clapeyron equation.

10. Availability, Energy and Irreversibility: High and low grade energy, Aspects of energy concepts, Availability of Heat, quality of energy, Availability of closed and open system,

closed and open system energy balance, Irreversibility for closed and open system, Exergetic (or Second law) efficiency, Effectiveness.

11. Non-Reactive gas mixture: PVT relationship for mixtures of ideal gases, properties of mixture of ideal gases, entropy change due to mixing, mixture of perfect gases at different temperature and pressure.

12. Gas Power cycle: Air standard cycle, some definition of piston-cylinder arrangement, Carnot, Otto, Diesel, Dual and Brayton cycle.

13. Vapour Power cycle: Carnot and Rankine cycle, Effect of operating parameters on Rankine cycle, means for improving efficiency of Rankine cycle

14. Refrigeration cycle: Definitions of refrigeration, Reverse Carnot cycle, Vapor compression and vapor absorption cycle, Gas refrigeration.

15. Reactive Mixtures: Chemical reaction, classification of fuels, Stoichiometric equation, flue gas analysis, maximum air required for complete combustion of fuel, heating values of fuel, enthalpy of formation and heat of reaction, adiabatic combustion (flame) temperature.

Refereneces:

1. Moran, M.J. and Shapiro, H.N., Fundamentals of Engineering thermodynamics, 4th edition, John Wiley & Sons Inc, New York, 2000.
2. Van Wylen, G.J. and Sountag, R.E., Fundamentals of Thermodynamics, John Wiley & Sons Inc, New York, 2000.
3. Holman, J.P., Thermodynamics, 4th ed., McGraw-Hill book Co. New York.
4. Spalding, D.B. and Cole, E.H. Engineering Thermodynamics, Edward Arnold.
5. Reynolds, W.C., Thermodynamics, McGraw-Hill Book Co. New York.
6. Nag P.K. Engineering Thermodynamics, 2nd edition, 1995, Tata McGraw Hill Publishing co. Ltd, New Delhi.

FLUID FLOW OPERATIONS

I Introduction :

Fluid and continuum, Physical properties of fluids, Rheology of fluids.

II Kinematics of Fluid flow :

Types of fluid flows: Continuum & free molecular flows. Steady and unsteady, uniform and non-uniform, laminar and turbulent flows, rotational and irrotational flows, compressible and incompressible flows, subsonic, sonic and supersonic flows, sub-critical, critical and supercritical flows, one, two and three dimensional flows, streamlines, continuity equation for 3D and 1D flows, circulation, stream function and velocity potential, source, sink, doublet and half-body.

III Fluid Statics :

Pressure-density-height relationship, manometers, pressure transducers, pressure on plane and curved surfaces, centre of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to linear acceleration and uniform rotation about an axis.

IV Dynamics of Fluid Flow :

Euler's Equation of motion along a streamline and its integration, Bernoulli's equation and its applications- Pitot tube, notches, weirs, orifice meter, venturimeter

and bend meter, Hot-wire anemometer and LDA, notches and weirs, momentum equation and its application to pipe bends.

V Dimensional Analysis and Hydraulic Similitude :

Dimensional analysis, Buckingham's Pi theorem, important dimensionless numbers and their significance, geometric, kinematic and dynamic similarity, model studies.

VI Laminar and Turbulent Flow :

Equation of motion for laminar flow through pipes, Stokes' law, transition from laminar to turbulent flow, turbulent flow, types of turbulent flow, isotropic, homogenous turbulence, scale and intensity of turbulence, measurement of turbulence, eddy viscosity, mixing length concept and velocity distribution in turbulent flow over smooth and rough surfaces, resistance to flow, minor losses, pipe in series and parallel, power transmission through a pipe, water hammer.

VII Boundary Layer Analysis :

Boundary layer thickness, boundary layer over a flat plate, laminar boundary layer, application of momentum equation, turbulent boundary layer, laminar sub-layer, separation and its control, Drag and lift, drag on a sphere, a two dimensional cylinder, and an aerofoil, Magnus effect.

VIII Introduction to compressible flow:

Thermodynamic processes, continuity equation, work done in an isothermal process and adiabatic process, sonic velocity, Mach number, Mach Line, Mach angle and Mach cone, properties at a stagnation point, flow through a convergent nozzle and De Laval nozzle, Normal and oblique shocks, Fanno and Rayleigh lines.

Refrences :

1. Som, S.K. & Biswas G, Introduction to fluid mechanics & Fluid Machines, TMH, 2000, 2nd edition.
2. S.K.Agarwal, Fluid Mechanics & Machinery, TMH, New Delhi.
3. Garde, R.J., 'Fluid Mechanics through Problems', New Age International Pvt. Ltd, New Delhi, 2nd Edition.
4. Hunter Rouse, 'Elementary Mechanics of Fluids', John Wiley & Sons. Onc. 1946.
5. I.H.Shames, 'Mechanics of Fluids', McGraw Hill, Int. Student, Education, 1988.
6. Jagdish Lal, Fluid Mechanics, Metropolitan Book Company Ltd., Delhi.
7. Vijay Gupta and S.K.Gupta, ' Fluid Mechanics and its Applications', Wiley Eastern Ltd, 1984.
8. Modi, P.N., and Seth, S.H., 'Hydraulics and Fluid Machines', Standard Book House, 1989.

FLUID FLOW OPERATIONS LAB

1. To verify the momentum equation using the experimental set-up on diffusion of submerged air jet.
2. To determine the coefficient of discharge of an orifice of a given shape. Also to determine the coefficient of velocity and the coefficient of contraction of the orifice mouth piece.
3. To calibrate an orifice meter, venturimeter, and bend meter and study the variation of the co-efficient of discharge with the Reynolds number.

4. To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number.
5. To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile.
6. To study the variation of friction factor, 'f' for turbulent flow in commercial pipes.
7. To study the boundary layer velocity profile over a flat plate and to determine the boundary layer thickness.

CHEMICAL PROCESS PRINCIPLES

1. STOICHIOMETRY:

Introduction- Units and Dimensions - stochiometric principles-composition relations, density and specific gravity.

2. IDEAL GASES AND VAPOR PRESSURE:

Behaviors of Ideal gases -kinetic theory of gases - application of ideal gas law- gaseous mixtures - volume changes with change in composition. Vapor pressure- effect of Temperature on vapor pressure, vapor pressure plots, vapor pressure of immiscible liquids-solutions.

3. HUMIDITY AND SOLUBILITY:

Humidity - saturation - vaporization - condensation - wet and dry bulb thermometry Solubility and Crystallization-Dissolution -solubility of gases.

4. MATERIAL BALANCE:

Material Balance-Process involving chemical reaction-Combustion of Coal, fuel gases and sulphur-Recycling operations - by passing streams - Degree of conversion

5. ENERGY BALANCE:

Thermo chemistry- Hess's law of summation- heat of formation, reaction, combustion and mixing - mean specific heat -Theoretical flame Temperature.

TEXTBOOKS:

1. O.A.Hougen, K. M. Watson and R. A. Ragatz, "Chemical Process Principles", Vol-I, CBS Publishers and Distributors, New Delhi, 1995.
2. D. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", 5th Edn., Prentice Hall of India Ltd.,N.Delhi,1994.
3. B.I.Bhatt and S.M.Vora, "Stoichiometry", Tata McGraw Hill Publishers Ltd., New Delhi, 1996.
4. V.Venkataramani and N.Anantharaman, "Process Calculations", Prentice Hall of India Ltd.,N.Delhi,2003.

SEMESTER - IV

COMPUTATIONAL AND STATISTICAL TECHNIQUES

Introduction: Errors in Numerical Computation, Mathematical Preliminaries, Errors and their analysis.

Algebraic and Transcendental Equations: Bisection method, Iteration method, Method of false position, Rate of convergence, Method for Complex Root, Muller's Method, Quotient difference method, Newton-Raphson Method.

Interpolation: Introduction, Errors in Polynomial Interpolation, Finite Difference, Decision of Errors, Newton's Formulae for Interpolation, Gauss, Stirling, Bessel's Everett's Formulae, Interpolation by Unevenly spaced points, Lagrange Interpolation Formula, Divided Difference, Newton's General Interpolation Formula.

Curve Fitting, Cubic Splines and Approximation: Introduction, Method of least square curve fitting procedures, Fitting a straight line, Curve fitting by sum of exponentials, Data fitting with cubic splines, Approximations of Functions.

Numerical Integration & Differentiations: Introduction, Numerical differentiation, numerical integration, Trapezoidal Rule. Simpson 1/3 rule, Simpson 3/8 rule, Booles and Weddles Rule, Euler ' Maclariaun Formula, Gaussian Formula, Numerical Evaluation of Singular Integrals.

Statistical Computation: Frequency Chart, Regression Analysis, Least Square fit, Linear and non-linear regression, multiple regression, statistical quality control methods.

Books:

1. Gerald and Wheatley, 'Applied numerical analysis', Addison Wesley.
2. Flowers, 'Numerical Methods in C++', Oxford University Press.
3. Balaguruswamy, 'Numerical Methods'. TMH.
4. Jain, Iyengar, Jain, 'Numerical Methods for Scientific & Engineering Computation', New Age International

FLUID PARTICLE MECHANICS AND MECHANICAL OPERATIONS

1. Properties of Particulate Solid:

2. Handling of Particulate Solid:

Transportation, conveying and storage of particulate solids

3. Mechanical Separation:

Size separation, filtration

4. Size Reduction:

Crushing and Grinding

5. Size Enlargement:

6. Crystallization

7. Mixing of solids & Pastes

HEAT TRANFER OPERATIONS

1.Introduction to Heat Transfer:
Concept of the mechanism of heat flow: conduction, convection and radiation; effect of temperature on thermal conductivity of materials; introduction to combined heat transfer mechanism.

2.Conduction:
One-dimensional general differential heat conduction equation in rectangular, cylindrical and spherical coordinate system; initial and boundary conditions.

3.Steady state one dimensional heat conduction:
Composite system in rectangular, cylindrical and spherical coordinates without energy generation; thermal resistance concept; analogy between heat and electrical flow; thermal contact resistance; critical thickness of insulation.
Fins of uniform cross sectional area; error of measurement of temperature in thermometer wells, volumetric internal energy generation, solution of 2D steady state problems using relaxation method.

4.Transient Conduction:
Transient heat conduction with known temperature distribution within the system; lumped heat analysis of transient heat conduction problem, time constant of thermocouples.

5. Convective Heat Transfer
Newton's Law of Cooling, Types of convective heat transfer, Laminar and Turbulent flows, Hydrodynamic and thermal boundary layers, Navier Stokes Equation, Non-dimensional numbers, Buckingham Pi Theorem.

6. Forced Convection:
Basic concept; hydrodynamic boundary layer; thermal boundary layer; flow over a flat plate; flow across a single cylinder and a sphere; flow inside tubes; empirical heat transfer relations; relation between fluid friction and heat transfer; liquid metal heat transfer.

7. Natural Convection:
Physical mechanism of natural convection; buoyant force; empirical heat transfer relations natural convection over vertical planes and a cylinder, horizontal planes and cylinders, and a sphere.

8. Thermal Radiation:
Basic radiation concept; radiation properties of surfaces; black body radiation laws; Kirchoff's Law, Plank Law and Wein's Displacement Law, view factor concept; view factor determination; black body radiation exchange; radiation exchange between diffuse non black bodies in an enclosure; radiation shields; solar radiations.

9. Heat Exchangers:
Type of heat exchangers; fouling factor; overall heat transfer coefficient; logarithmic mean temperature difference (LMTD) method; effectiveness-NTU method; compact heat exchangers.

10. Condensation and boiling:
Introduction to condensation phenomena; heat transfer relations for laminar film condensation over vertical surfaces and a horizontal tube; pool boiling.

REFERENCES

1. Elements of Heat Transfer by Bayazitouglu and Ozisik, McGraw Hill Book Company.
2. Heat Transfer By J.P.Holman, McGraw Hill Book Company.
3. Principles of Heat Transfer by F. Kreith, and S.B. Marks, A.B.Pvt. Ltd.
4. Fundamentals of Heat Transfer by F.P Incorpera and P.D.Dewitt, John Wiley and Sons, V Ed.

MASS TRANSFER-I

1. DIFFUSION:

Ficks law, Diffusion in fluids: Molecular and eddy diffusion measurement and calculation of diffusivities. Ordinary diffusion in multi-component gaseous mixtures. Diffusion in solids.

2. INTERPHASE MASS TRANSFER:

Inter-phase mass transfer: Mass transfer coefficients. Theories of mass transfer. Analogies between momentum heat and mass transfer.

3. MASS TRANSFER EQUIPMENT:

Batch and continuous Stage wise contactors-Differential contactors.

4. ABSORPTION:

Theories of gas absorption-Design of absorption towers. Absorption with chemical reactions.

5. ADSORPTION:

Types of adsorption, nature of adsorbants-Adsorption isotherms-Operation of adsorption columns-Batch and continuous operations-Design of adsorbers, Ion exchange

6. HUMIDIFICATION OPERATIONS:

Psychrometery, Evaporative Cooling, Air conditioning and Refrigeration

REFERENCES:

1. R.E.Treybal, "Mass Transfer Operations", 3rd Edn., McGraw Hill Book Co., New York, 1980.
2. W.L. McCabe, J.C. Smith and P. Harriot, "Unit Operations of Chemical Engineering", 5th Edn., McGraw Hill Book Co., New York, 1993.
3. J.M. Coulson and J.F. Richardson, "Chemical Engineering", Vol. I, II, III, Pergamon Press, New York, 1977.

ORAGANIC AND PHYSICAL CHEMISTRY

1. REACTIONS AND REAGENTS:

Basic ideas relating to addition, substitutions, elimination, oxidation and reduction reactions - Electrophilic and Nucleophilic. Organometallic compounds- Grignard reagent - Synthesis of different types of compounds like alcohol ,aldehyde, acid ,amine and organometallic. Acetoacetic ester - tautomerism- Base hydrolysis - Acid hydrolysis - Malonic ester - cyano acetic esters- synthesis of dicarboxylic acids and Unsaturated acids.

2. CARBOHYDRATES:

Carbohydrates - Classification - Reactions of Glucose and fructose- Inter conversion - Ascending and descending of series. Structure of glucose and fructose. Industrial uses of cellulose and starch .

3. ALICYCYCLIC COMPOUNDS, AROMATIC COMPOUNDS, FATS AND OILS:

Alicyclic Compounds- Nomenclature - synthesis of alicyclic compounds using carbon - acroyloin condensation - Diels Alder reaction Freunds's synthesis - Bayer's strain theory postulates, drawbacks- theory of strainless rings- conformations of cyclohexane. Coal tar distillation, separation of benzene, toluene, phenol and naphthalene- Aromaticity exhibited by these compounds. Fats and oils - Saponification- hydrogenation of oils

4. AMINO ACIDS, PROTEINS AND DYES:

Amino acids and proteins- classification - synthesis of amino acids - reactions of carboxyl group and amino group -peptide linkage-end group analysis-colour reaction of proteins-denaturation. Dyes-colors and constitution - chromophores and auxochromes- Quinine theory and electron theory of dyes- preparation-colour and application of azodyes-acidic. basic, mordant, direct azodyes-Triphenylmethane dyes - malachite green, crystal violet, Rosaniline, prosaniline mordant dyes- application. vat dyes-indigo-synthesis and application.

5 HETEROCYCLIC COMPOUNDS AND NATURAL PRODUCTS:

Heterocyclic compounds-synthesis and reaction of pyrrole ,furan ,thiophene, pyridine, quinine, isoquinoline and anisole. Alkaloids-Isolation from natural products-colour reaction-structural elucidation of nicotine. Terpenoids- Isolation - Isoprene rule-structural elucidation of citral.

7. REACTION KINETICS:

Law of Mass action. Rate order and molecularity of chemical reactions. Methods for their evaluation. Calculation of rate constants. Consecutive - Parallel and opposing reactions. Chain reactions. Energy of activation - Theories on reaction rates. Heterogeneous reactions - zero order reactions - Catalysis - Theory and applications - Inhibitors - Promotors - enzyme catalysis.

8. PHASE EQUILIBRIA:

Phase rule: Application - to one components system (water, sulphur and carbon dioxide), Two component systems (Eutetic, Intermediate compound formation and solid solutions) and simple three component systems. Solutions: Ideal and non-ideal solutions solubility of gases in liquids. Henry's law. Completely miscible liquids - Raoult's law - vapour pressure and boiling point diagrams. Partially miscible liquids - Critical solution temperature -completely immiscible liquids - Nerns: distribution law - Dilute solution and their colligative properties. Molecular weight determination using these properties.

9. ELECTRICAL CONDUCTANCE:

Electrolytes - strong electrolytes and weak electrolytes - Arrhenius theory of electrolytic dissociation. Debye - Huckell Onsager theory; Ostwald's dilution law - solubility of electrolytes and solubility product - common ion action - acids, bases - definitions) based on proton transference, dissociation constant, amphoteric electrolyte - pH -Buffer solutions. Salts - water of crystallisation, double salts, complex ions and salts, introduction to co-ordination theory - hydrolysis.

10. ELECTRODE POTENTIAL:

Electrode potential-Hydrogen electrode, reference electrodes, electrochemical series, Faraday's laws of electrolysis. Decomposition potential, over voltage, definitions of current density, current concentration, current efficiency, energy consumption; electrical conductance, oxidation - reduction redox couple; e.m.f. and energy relations. Conductometry, Potentiometry - Their applications.

REFERENCES:

1. K. J. Laidler, "Chemical Kinetics", 3rd Edn., Harper & Row Publishers,1987.I.L. Finar, "Organic Chemistry", (Vol. I & II) 5th Edn., ELBS, London 1975.
2. Morrison and Boyd, " A Text Book of Organic Chemistry", 5th and 6th Edn., Prentice Hall of India, 1996.
3. B. R. Puri and SL. R. Sharma, "Principles of Physical Chemistry", Shoban Lal Nagin Chand & Co.
4. P.L. Soni, "Text Book of Physical Chemistry ", S. Chand & Co., New Delhi.

CHEMICAL TECHNOLOGY-I

1. ALKALIES:

Chlor-alkali Industries: Manufacture of Soda ash, Manufacture of caustic soda and chlorine - common salt.

2. ACIDS:

Sulphur and Sulphuric acid: Mining of sulphur and manufacture of sulphuric acid. Manufacture of hydrochloric acid .

3. CEMENT AND GLASS

Cement: Types and Manufacture of Portland cement, Glass: Manufacture of glasses and special glasses. Ceramics: Refractories.

4. GASES, WATER AND PAINTS:

Industrial Gases: Carbon dioxide, Nitrogen, Hydrogen, Oxygen and Acetylene - Water Treatment: Industrial and Municipal water treatment-Manufacture of paints - Pigments.

5. FERTILISERS:

Nitrogen Fertilizers: Synthetic ammonia, nitric acid, Urea, Ammonium Chloride, CAN, Ammonium Sulphate - Phosphorous Fertilizers: Phosphate rock, phosphoric acid, Super phosphate and Triple Super phosphate, MAP, DAP. Potassium Fertilizers: Potassium chloride and Potassium sulphate.

REFERENCES:

1. G.T.Austin, "Shreve's Chemical Process Industries", 5th Edn., McGraw Hill Book Co., New York, 1984.
2. R.Gopal Rao and M.Sittig,"Dryden's Outlines of Chemical Technology", 3rd Edn.,Affiliated East-West Publishers,1997.
3. S.D. Shukla and G.N. Pandey, "Text book of Chemical Technology", Vol. I, 1977.

SEMESTER V

CHEMICAL REACTION ENGINEERING -I

1. BASICS OF KINETICS:

Introduction - Kinetics of homogeneous reactions: Concentration dependent & Temperature dependent term of rate equation. Searching for a mechanism. Interpretation of Batch Reactor data.

2. REACTOR DESIGN:

Introduction to Reactor Design, Single Ideal Reactors.

3. DESIGN OF REACTOR FOR MULTIPLE REACTIONS:

Design for single and multiple Reactions. Size comparison of single reactors for single reactions. Multiple Reactor system for single reactions. Reactions in parallel, reactions in series and series - parallel reactions of first order. Recycle reactor, auto catalytic reactions.

4. HEAT EFFECTS:

Temperature and pressure effects on single and multiple reactions.

5. FLOW BEHAVIOR OF REACTORS:

Non - ideal flow: Residence time distribution studies: C,E,F and I curves, conversion calculations directly from tracer studies. Models for non-ideal flow-dispersion and tanks in series multi-parameter models.

REFERENCES :

1. O. Levenspiel, "Chemical Reaction Engineering", 2nd Edn., Wiley Easter Ltd., New York, 1972.
2. J.M.Smith, "Chemical Engineering Kinetics", 2nd Edn., McCraw Hill, New York, 1971.

CHEMICAL ENGINEERING THERMODYNAMICS

1. Vapour liquid equilibrium at low, moderate and high pressures, Compressibility factor.
2. Refrigeration cycle and liquefaction: Definitions of refrigeration, Reverse Carnot cycle, Vapor compression and vapor absorption cycle, Gas refrigeration.
3. Thermodynamics of solutions: ideal and non-ideal solution, Concept of Fugacity and Fugacity coefficient, Fugacity and Activity Coefficient Modes, Solid-liquid equilibrium, solubility of gases in liquids, Liquid-liquid equilibrium
4. Phase Equilibrium, Pure component and mixtures, Latent Heat correlation Van Laar, Margules' equation Gibbs'-Duhem equation, consistency tests, multi-component

phase equilibrium, partially miscible and immiscible systems, Azeotropes, retrograde condensation thermodynamic diagram

5. Chemical reaction equilibrium, heat effects, industrial reactions (NH_3 synthesis etc), free energy calculations, Homogeneous and heterogeneous reaction systems, Multiple reactions, Work of separation, Evaluation of Properties,
6. Reactive Mixtures: Chemical reaction, classification of fuels, Stoichiometric equation, flue gas analysis, maximum air required for complete combustion of fuel, heating values of fuel, enthalpy of formation and heat of reaction, adiabatic combustion (flame) temperature.
7. Thermodynamic analysis of processes, Electrochemical cells
8. Introduction to molecular thermodynamics

REFERENCES:

1. J. M. Smith and Van Ness, "Introduction to Chemical Engineering Thermodynamics", McGraw Hill, New York, 1994.
2. S. Sundaram, " Chemical Engineering Thermodynamics", Ahuja Publishers, New Delhi, 1998.
3. B.F. Dodge, "Chemical Engineering Thermodynamics", McGraw Hill, New York, 1971.

MASS TRANSFER -II

1. DISTILLATION:

Vapour Liquid Equilibrium Data. Methods of distillation-batch, continuous, flash, steam, vacuum and molecular distillations.

2. CONTINUOUS FRACTIONATION:

Stage - wise and continuous contact operations. Design calculations. Reboiers and condensors.

3. MULTICOMPONENT DISTILLATION:

Azeotropic distillation and extractive distillation. Multicomponent flash and differential distillation. Continuous fractionation.

4. LIQUID-LIQUID EXTRACTION:

Liquid - Liquid Equilibrium data. Batch and continuous operations. Design of extraction towers.

5. LEACHING:

Solid - Liquid extraction. Batch and continuous operations. Equipments.

REFERENCES:

1. R.E.Treybal, "Mass Transfer Operations", 3rd Edn., McGraw Hill Book Co., New York, 1980.
2. W.L.McCabe, J.C.Smith and P.Harriot, "Unit Operations of Chemical Engineering", 5th Edn., McGraw Hill Book Co., New York, 1993.
3. C. J. Geankopolis, "Transport Processes in Chemical Operations", 3rd Edn. Prentice Hall of India, New Delhi, 1996.
4. M. Coulson and J: F. Richardson, "Chemical Engineering", Vol - II, 3rd Edn. Pergamon Press, New York, 1987.

PROCESS DYNAMICS AND CONTROL

1.FIRST ORDER SYSTEMS

Linear open loop systems - First order and Linearised first order systems - Responce to various disturbances.

2. HIGHER ORDER SYSTEMS:

First order in series - Higher order systems - Response to various disturbances.

3. BLOCK DIAGRAM:

Controls - Block Diagram - closed loop transfer function -Transient response- Simple alarm Modes of control and controller characteristics.

4. STABILITY ANALYSIS:

Stability - Routh analysis - Frequency response - Control system design - Controller tuning.

5. SPECIAL CONTROLS:

Cascade - feed forward and ratio control - dead time compensation - Internal Model Control - Control valves - Process identification.

REFERENCES:

1. S. Sundaram and T. K. Radhakrishnan, "Process Dynamics and Control", Ahuja Publishers, 2003.
2. D. P. Coughnowr, "Process Systems Analysis and Control", McGraw Hill, New York,1991.
3. C. A. Smith and A. B. Corripio, "Principles and Practice of Automatic Process Control", Wiley, New York, 1989.
4. P.Harriot, "Process Control", Tata McGraw Hill, New Delhi, 1984.
5. D.P. Eckman, "Industrial Instrumentation", Wiley Eastern Ltd., New York 1990.
6. D.P. Eckman, "Automatic Process Control", Wiley Eastern Ltd., New Delhi.

CHEMICAL TECHNOLOGY- II

1. NATURAL PRODUCTS PROCESSING:

Production of pulp, paper and rayon. Manufacture of sugar, starch and starch derivatives. Gasification of coal and chemicals from coal.

2. INDUSTRIAL MICROBIAL PROCESSES AND EDIBLE OILS:

Fermentation processes for the production of ethyl alcohol, citric acid and antibiotics. Refining of edible oils and fats, fatty acids. Soaps and detergents.

3. PETROLEUM REFINING AND PETROCHEMICAL PRECURSORS:

Petroleum refining to produce naphtha, fuel hydrocarbons and lubricants. Processes for the production of petrochemical precursors: ethylene, propylene, butadiene, acetylene, synthetic gas, benzene, toluene and xylene. (Cracking, Catalytic reforming and separation of products)

4. POLYMER BASED INDUSTRIES AND THEIR CHARACTERISTICS:

Plastics: Production of thermoplastic and thermosetting resins such as polyethylene, polypropylene, phenolic resins and epoxy resins; Polymers and their applications in engineering practice.

5. FIBRE FORMING AND ELASTOMERIC POLYMERS:

Synthetic fibres: polyamides, polyesters and acrylics from monomers. Processes for the production of natural and synthetic rubbers.

REFERENCE:

1. G.T. Austin, " Shreve's Chemical Process Industries", 5th Edn., Mcgraw Hill Book Co., NewYork, 1984.
2. R. Gopal Rao and M. Sittig, " Dryden's Outline of Chemical Technology",3rd Edn., Affiliated East-West Publishers, 1990.
3. S.D.Shukla and G.N. Pandey, "Text book of Chemical Technology", Vol. I, 1977.

PRINCIPLES OF MANAGEMENT

Concept:

Definition of management, evolution of management thought, systems approach, process of decision making.

Functions of Management.

Planning, types of plans, major steps in managerial planning, Organizing, nature and purpose, process of organization, basic departmentation. Coordination, nature purpose and process of

coordination. Supervision, Leadership: purpose, functions, types. Communication, process of communication, effective communication, barriers to communication.
Motivation: what is motivation, factors involved, theories, and motives in organization. Controlling-Nature and purpose.
Management of change: forces of change, strategies of change, resistance to change.

Human Elements in management

Factors in individual behaviour, Perception, Learning, Personality development, Interpersonal relationship & group behaviour, Conflict management Stress management, sources of stress,von sequences ,strategies of stress management.

Reference Books.

1. Koontz, H & Weihrich, H. Management: A Global Perspective 10th ed., Tata McGraw Hill, New Delhi.
2. Robbins, S. P. Organizational Behaviour, 6th ed. Prentice Hall, New Delhi.
3. Prasad, L M" Principles and Practices of Management", 5th Ed., Sultan Chand & Sons, New Delhi, 1999.

SEMESTER -VI

PROCESS EQUIPMENT DESIGN

1. **SIMPLE STRESS & STRAIN**
   Stress, Strain, Hook's Law, Elastic Constants, Strain Energy, Statically Indeterminate problems, Thermal Effects, Impact Loading
2. **ANALYSIS OF STRESS & STRAIN (Plane Stress and Plane Strain)**
   Stress at a Point, Variation of Stress, Stress Transformation (2-D), Analysis of Strain, Strain-displacement relations, Strain transformation, Strain Measurements, Constitutive equations
3. **SIMPLE BENDING & SHEAR STRESS**
   Introduction, Pure Bending, Normal stresses in beams, Combined Bending and Direct Stress, Composite Beams, Shear Stress, Shear Centre, Strain energy in bending
4. **TORSION**
   Introduction, Torsion of Circular Shaft, Power Transmitted by a Shaft, Compound Shaft,Tapered Shaft, Strain Energy in Torsion, Combined Bending and Twisting, Torsion of Thin Walled Tubes, Open and Closed Coiled Springs
5. **THIN & THICK CYLINDERS & SPHERES**
   Introduction, Thin Walled Shells, Thick Shells, Compound Cylindrical Shell
6. **DESIGN OF PIPE FITTINGS AND JOINTS:**
   Design and schematic of simple bolts and screws. Riveted joints. Design & Drawing of shafts and couplings.
7. **DESIGN OF REACTION VESSEL AND STORAGE TANK:**
   Design and schematic of storage tank, (vertical and horizontal) supports, agitating vessel.
8. **DESIGN OF PRESSURE VESSELS:**
   Design of cylindrical vessels and different end closures subjected to internal pressure, Stress analysis of support and pressure vessels, Design of supports and various heads, Design of vertical pressure vessels considering the wind factors, seismic factor, etc. Design of cylindrical vessels operating under external pressure. Design and selection of standard flanges, gaskets and flange facings and their selection. Design of high-pressure vessels and reactors.
9. **DRAWING AND DESIGN OF PHASE SEPARATION EQUIPMENTS:**
   Drawing of physical separation equipments such as hydro-cyclones, packed towers, plate columns, electro static precipitators. Design of physical separation equipment such as cyclones, centrifuges, thickeners filtration equipment KO drum.
10. **DESIGN OF HEAT TRANSFER EQUIPMENTS:**
    Design and Drawing of Heat Transfer Equipments such as heat exchangers with and without phase change, evaporators, crystallizes.
11. **DESIGN OF MASS TRANSFER EQUIPMENTS:**
    Design and Drawing of mass transfer equipments such as distillation columns, absorption columns, extraction columns, dryers and cooling towers.

1. L. E. Brownell and E.H. Young, "Process Equipment Design - Vessel Design", Wiley Eastern Edn. New York, 1968.
2. R. H. Perry, 'Chemical Engineers' Handbook, 7th Edn., McGraw Hill , N York, 1998.
3. M. V. Joshi, "Process Equipment Design and Drawing", Mac Millan Press, New Delhi, 1996.
4. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol-VI, Pergam Press, New York, 1987.
5. JF Harvey, Theory and Design of Pressure Vessels, 2"' Edition, Van Nostrand Reinhold, 1991.
6. IS 2825 Code, Design of Pressure Vessels.
7. R. Smith, "Chemical Process Design", McGraw Hill Book Co., New York 1997.

NEW SEPARATION PROCESSES

1. THERMAL SEPARATION :

Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures. Equipments design and Applications. Zone Melting: Equilibrium diagrams. Controlling factors. Apparatus and Applications.

2. ADSORPTION TECHNIQUE:

Types and choice of adsorbents. Normal Adsorption techniques, chromatographic techniques. Equipment and commercial processes, Recent advances and economics, Molecular Sieves.

3. MEMBRANE SEPARATION PROCESS :

Types and choice of membranes, their merits, commercial, pilot plant and laboratory membrane permeators .Dialysis ,Reverse Osmosis, Ultra Filtration and Economics of Membrane operations, Pervaporation .

4. IONIC SEPARATION :

Controlling factors, Applications, Equipments for Electrophoresis, Dielectrophoresis, Electro Dialysis and Ion - Exchange, Commercial processes.

5. OTHER TECHNIQUES :

Adductive Crystallization: Molecular addition compounds, Clathrate compounds and Adducts, Equipments, Applications, Economics and Commercial processes. Foam Separation: Surface Adsorption, Nature of foams. Apparatus, Applications and Controlling factors.

REFERENCES:

1. H. M. Schoen, " New Chemical Engineering Separation Techniques", Inter Science Publications New York 1972.
2. C. Loeb and R. E. Lacey, "Industrial Processing with Membranes", Wiley Inter Science, 1972.
3. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol.II, 4th Edn., Butterworth - Heinemann London 1991.
4. R.H. Perry and D.W. Green, "Perry's Chemical Engineers Hand book", 6th Edn.,McGraw Hill. New York., 1990.

TRANSPORT PHENOMENA

1. LAMINAR FLOW:

Velocity distribution in Laminar flow - Shell momentum balances - Flow through tubes, surfaces. Flow of non - Newtonian fluids.

2. EQUATION OF MOTION:

Equation of change for isothermal process - One dimensional equation of motion and continuity - Euler and Navier - Stokes equation. Dimensional analysis of equation of change.

3. TURBULENT FLOW:

Velocity distribution in turbulent flow - Semi empirical expressions for Reynolds stress. Interphase transport in isothermal system - Ergun's equation.

4. HEAT TRANSFER ANALYSIS:

Temperature distribution in solids and fluids in laminar flow - Equations of change for multi component systems.

5. MASS TRANSFER ANALYSIS:

Concentration distribution in solids and in fluids laminar flow - Equations of change for multi component systems.

REFERENCES:

1. J.L. Stuart., 'Transport Phenomena", John Wiley, New York, 1982.
2. R. B. Bird, W. Stewart and E. N. Lightfoot, "Transport Phenomena", Wiley, New York, 1960.
3. C. J. Geankopolis, "Transport Processes in Chemical Operations", 3rd Edn., Prentice Hall of India, New Delhi, 1996.

ENVIRONMENTAL POLLUTION MONITORING AND CONTROL

Introduction
Ecology & Environment, Biodiversity, Interaction of man and environment, Overall picture of environmental pollution, Ambient air and water quality criteria, Standards and Acts-Indian, EPA& EURO, Effects and control of noise, thermal and radioactive pollution.

Air Pollution
Types of pollutants – Natural and man made air pollutants, Dispersion of pollutant in the atmosphere, Gaussian dispersion model, Meteorological factors, Stability and inversion of atmosphere, Plume behaviour, Control of air pollution from stationary and mobile sources, Methods of measuring and sampling of gaseous and particulate pollutants in ambient air and industrial waste gases, measurement of smoke density and visibility. Control of gaseous pollutants - SOx, NOx, H_2S, VOCS, Auto exhaust.
Stack design, Classification, selection and design of equipment's like cyclones, electrostatic precipitators, bag filters, wet scrubbers, settling chambers.

Water Pollution
Waste water characteristics – Physical and chemical composition, Biochemical oxygen demand (BOD), Pathogenic bacteria and chemical toxicity. Types of pollutants in waste water of chemical industries, Methods of sampling, preservation of samples and analysis. Methods for the treatment of liquid wastes to control pollution, Classification viz. physical, chemical and biological methods, Selection and design of equipment like hydrocyclone, settling tanks, filters, ion- exchange.

Solid Wastes Management
Characterisation of solid wastes, Problems of collection and handling, Various processing techniques used in solid waste management such as compaction, incineration, Composting, landfills and biological processing, Solid waste as resource material.
Pollution abatement in important chemical industries like fertiliser, petroleum refineries and petrochemicals, Pulp and Paper, Pharmaceuticals, Tannery, Sugar, Distillery, food processing, cement and electroplating.

REFERENCES:

1. Howard S. Peavy, D. R. Rowe & C. Tchobonoglous "Environmental Engineering", McGraw Hill (1984).
2. Metcalf & Eddy, "Waste Water Engineering Treatment, Disposal & Reuse", Tata McGraw Hill(2003).
3. Werner Strauss, 'Air Pollution Control: Measuring and monitoring air pollutant' Wiley (1978).
4. Werner Strauss, 'Air Pollution Control part II' Wiley (1978).
5. Pandey G. N. and Carney G. C., "Environmental Engineering ". Tata McGraw Hill (1991).

CHEMICAL REACTION ENGINEERING – II

1. MODES OF CONTACTING DIFFERENT PHASES:
Self mixing of single fluids, mixing of two miscible fluids. Introduction. Design for Heterogeneous Reacting Systems.

2. DESIGN OF REACTOR FOR NON-CATALYTIC REACTIONS:
Fluid-Particle Systems: Models for non-catalytic heterogeneous reactions, their limitations, selection and their applications to design.

3. DESIGN OF SLURRY REACTOR :
Fluid-Fluid Reactions: Rate equations for instantaneous, fast, intermediate, slow, and infinitely slow reactions. Slurry reaction kinetics. Application to design.

4. CHARACTERISTICS OF CATALYST:
Catalysis; Introduction. Physical and Chemical Adsorption catalysts. Preparation and properties. Promoters, inhibitors. Poisons. Surface area by BET method. Pore size distribution, mechanism of catalyst deactivation.

5. KINETICS OF HETEROGENEOUS CHEMICAL REACTION :
Kinetics and Mechanism of Heterogeneous Catalytic Reactions, Various models, Evaluation and elimination of internal and external diffusion resistances, effectiveness factor, Solid catalyzed reactions, heat effects, controlling resistances, rates of chemisorptions, adsorption isotherms, rates of adsorption and desorption.

REFERENCES:

1. O. Levenspiel, "Chemical Reaction Engineering", 3rd Edn., Wiley Asian New York, 1990.

2. J.M. Smith, "Chemical kinetics",2nd Ed., McGraw Hill, NewYork,1971.

SEMESTER - VII

PLANT DESIGN AND ECONOMICS

Material and fabrication selection, Design strategy and optimum equipment design, Economic design criteria, Cost and Asset Accounting, Cost estimation, Interest and Investment cost, Taxes and Insurance, Depreciation, Profitability.
Alternative investments and replacement, Illustrative case studies.

Text Book:

1. M.S. Peters and K.D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", McGraw Hill, 1991.

SEMESTER -VIII

HAZARDS AND SAFETY IN CHEMICAL INDUSTRIES

1. INTRODUCTION TO CONSEQUENCE ANALYSIS - DISPERSION AND TOXIC MODELS: Risk analysis introduction - Rapid risk analysis - Comprehensive risk analysis - Failure types and release rate calculations - Emission and dispersion - Dispersion models for dense gas - Plume dispersion - Jet dispersion - Toxic dispersion model Evaluation of risk contours.

2. CONSEQUENCE ANALYSIS - FIRE AND EXPLOSION MODELS: Radiation - Tank on fire - Flame length - Radiation intensity calculation and its effect on plant, people & properly, UCVCE - Explosion due to - Deflatration -Detonation - TNT, TNO & DSM model - Over pressure - Effects of explosion -Risk contour - Flash fire - Jet fire - Pool fire - BLEVE - Fire ball.

3. RISK MANAGEMENT:
Overall risk analysis - Generation of Meteorological data - Ignition data -Population data - Overall risk contours for different failure scenarios - Disaster management plan - Emergency Planning - on site & offsite emergency planning - Risk management & IS0 14000- EMS models- Case studies-Marketing terminal, gas processing complex, refinery.

4. PAST ACCIDENT ANALYSIS:
Hazard identification -Safety Audits-Checklists- What if Analysis-Vulnerability models - Event tree and Fault tree Analysis - Past accident analysis Flixborough -Mexico - Bhopal - Vizak 3 miles - island chemoobyl, feyzih disasters, seveso accident analysis.

5. HAZOPS
HAZOPS- Principles - Risk ranking - Guide word - Parameter - Deviation - • Consequences - Recommendations - Coarse HAZOP study - Case studies Pumping system - Reactor System - Mass transfer system.

REFERENCES:

1. K. V. Raghavan and A. A Khan, "Methodologis in Hazard Identification and Risk Assessment", Manual by CLRI, 1990.
2. V. C. Marshal, "Major Chemical Hazards", Ellis Hawood Ltd., Chichester,United Kingdom.1987.
3. Kletz, "Risk Analysis Hazops " Institute of Engineers, U.K, 1990.
4. Frank P. Less, "Loss Prevention in Process Industries", Vol. I, II & III Butterworth, London,1980.
5. " A Guide to Hazard Operability Studies", Chemical Industry Safety and Council, 1977.

LIST OF PROFESSIONAL ELECTIVES

Subjects

1. APPLIED MATHEMATICS IN CHEMICAL ENGINEERING
2. ADVANCES IN HEAT TRANSFER
3. INTRODUCTION TO PFD-P & ID
4. BIOCHEMICAL ENGINEERING
5. ELECTROCHEMICAL ENGINEERING
6. FLUIDIZATION ENGINEERING
7. INDUSTRIAL CATALYSIS
8. ENZYME ENGINEERING
9. PROCESS DYNAMICS AND CONTROL-II
10. FOOD TECHNOLOGY AND ENGINEERING
11. FERTILIZER TECHNOLOGY
12. OIL AND FAT TECHNOLOGY
13. CERAMIC TECHNOLOGY
14. POLYMER TECHNOLOGY
15. BIOTECHNOLOGY
16. ENERGY CONSERVATION
17. PILOT PLANTS, MODELS AND SCALE-UP METHODS IN CHEMICAL ENGINEERING
18. INSTRUMENTATION AND MEASUREMENTS
19. TWO-PHASE FLOW AND HEAT TRANSFER
20. PETROCHEMICAL TECHNOLOGY
21. MANUFACTURING AND MAINTENANCE OF PROCESS EQUIPMENTS
22. MODELLING & SIMULATION IN ENGINEERING
23. COMPUTER-AIDED PROCESS CONTROL

APPLIED MATHEMATICS IN CHEMICAL ENGINEERING

1. Design of Engineering Experiments:

Application of mathematical methods to solve chemical engineering problems. Treatment of experimental data and interpretation of results. Use of .different types of graph paper. Curve fitting methods and empirical laws

2. Formulation of Physical Problems:

The mathematical statement of the problem, introduction. Representation of problem, Simple problems formulation on solvent extraction in single and multistage. Radial heat transfer through a cylindrical conductor. Salt accumulation in stirred tank .Summary of the method of formulation.

3. Linear and non-linear Algebraic Equations:

Numerical solutions of linear and non -linear algebraic equations in Chemical engineering, Interpolation and extrapolation.

4. Numerical solution of Ordinary Differential Equations:

Numerical solution of initial value and boundary value, ordinary different equation problems in chemical engineering.

5. Numerical Solutions of Partial Differential Equations:

Finite differences, Orthogonal Collocation technique, Finite Element Method, Numerical solution of partial differential equations in chemical engineering- elliptic, parabolic and hyperbolic equations.

REFERENCES:

1. S.K.Gupta, "Numerical Techniques for Engineers", Wiley Eastern Ltd.,NewYork,1995.
2. H.S. Mickley, T. K. Sherwood rod C.E. Reid, "Applied Mathematic in Chemical Engineering", II Edn., Tata McGraw Hill, New Delhi, 1978.
3. O.F.Hanna and O.C. Sandall, "Computational Methods in Chemical Engineering", Prentice-Hall, 1995.
4. W.F.Ramirez, "Computational Methods for process Simulation",Butterwortlia, 1989.
5. V. Q. Jenson and G. V. Jeffreys, "Mathematical Methods in Chemical Engineering" 2nd. Edn., 1977.

ADVANCES IN HEAT TRANSFER

1. TRANSIENT HEAT CONDUCTION :

Transient heat condition, Extended surfaces and generalized expressions for fins or spines. Effectiveness of fins. Numerical solution for one dimensional and two dimensional steady state heat conduction problems. Relationship between thermal and electrical conductivity. Temperature- time response of thermocouples, transient heat conduction charts.

2. CONVECTION - THEORY AND PRACTICE :

Convective heat transfer-theories and practices, energy equation for thermal boundary layer over a flat plate. Momentum and heat exchange in turbulent fluid flow (Eddy viscosity and eddy thermal diffusivity). Reynolds analogy between heat and momentum transfer, empirical equations for forced convection based on experimental results.

3. HEAT TRANSFER WITH PHASE CHANGE :

Heat transfer with change of phase. Phenomena of Boiling and condensation. Regimes of pool boiling and heat transfer during boiling. Drop wise and film wise condensation, effect of turbulence and high velocity on film wise condensation.

4. ADVANCES IN HEAT EXCHANGER DESIGN :

Advances in design of heat exchangers. Regenerators and recuperators. Shell and tube heat exchangers with multiple shell and tube passes, Use of charts for calculating L.M.T.D. correction factors, Efficiency of heat exchangers and number of transfer units, (N.T.U.) Illustrative examples, Compact heat exchangers.

6. HEAT TRANSFER IN PACKED & FLUIDIZED BEDS AND NUCLEAR REACTORS :

Heat transfer in liquid metals. Heat transfer in packed and fluidized beds - Basic fundamentals and factors affecting the rate of Heat Transfer in these beds. Heat transfer in nuclear reactors.

REFERENCES:

1. James G. Knudsen and Donald L. Katz, "Fluid Dynamics and Heat Transfer ", McGraw Hill Book Company, 1958.
2. Antony F. Mills, "Heat Transfer", Richard D. Irwin. Inc., 1992, Homewood, IL60430 and Boston, MA021 163.
3. W. M. Rohsenow and H. Y. Choi, "Heat Mass and Momentum Transfer" PrenticeHall, Inc., 1961.
4. W.H. Mc Adams," Heat Transmissroa", McGraw Hill. New York. 1954.

INTRODUCTION TO PFD-P & ID

1. PROCESS FLOW DIAGRAM :

Types of flow sheets - Flow sheet presentation - flow sheet symbols - line symbols and designation ion- Process flow diagram - synthesis of steady state flow sheet-flow sheeting using ASPEN PLUS, DESIGN- II AND PDS software.

2. PIPING AND INSTRUMENTATION DIAGRAM EVALUATION AND PREPARATION :

P& I D Symbols - Line numbering - Line Schedule - P & ID development - typical Stages of P & ID - P &ID for rotating equipment and static pressure vessels. Process vessels, P & I D using PDS.

3. CONTROL SYSTEMS AND INTERLOCKS FOR PROCESS OPERATION :

Introduction and description - Need of interlock - Types of interlocks - Interlock for rotating and static equipments, Distributes digital control system, programmable logic controller.

4. INSTRUMENT LINE DIAGRAM & INSTRUMENT DATA MANAGER :

Line diagram symbols - Logic gates, Representation of line diagram. - IDM.

5. APPLICATION OF P & ID's :

Applications of P&ID in design stage - Construction stage - Commissioning stage -Operating stage - Revamping stage, - Applications of P & ID in Hazards and Risk analysis.

REFERENCES :

1. Ernest E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants", Vol –1, Gulf Publishing Company, Houston, 1989.
2. Max. S. Peters and K. D. Timmerhaus, " Plant Design and Economics for Chemical Engineers", McGraw Hill, Inc. New York, 1991.
3. Anil Kumar , "Chemical Process Synthesis and Engineering Design", Tata McGraw Hill Publishing Company Limited, New Delhi - 1981.
4. A. N. Westerberg, et al., "Process Flowsheeting", Cambridge University Press,1979. ISA Hand book ISA Publications, 1995.

BIOCHEMICAL ENGINEERING

1. INTRODUCTION TO BIOSCIENCE:

Types of Micro-organisms: Structure and function of microbial cells. Fundamental of microbial growth, batch and continuous culture. Isolation and purification, Enzymes from cells, Assay of Enzymes.

2. FUNCTIONING OF CELLS AND FUNDAMENTAL MOLECULAR BIOLOGY:

Metabolism and bio-energetics. Photosynthesis, carbon metabolism, EMP pathway tricarbocyclic cycle and electron transport chain, aerobic and anacrobic meta(pathways. Synthesis and regulation of biomolecules, fundamentals of micro genetics, role of RNA and DNA.

3. ENZYME TECHNOLOGY AND KINETICS:

Applied Enzyme catalysis , Applications of enzymes in industry and medicine, Immobilization of enzymes. Kinetics of enzyme catalytic reactions involving isolated enzymes. Reversible inhibition.

4. REACTIONS CATALYSED BY ENZYMES, REACTORS, ANALYSIS:

Reactor Design and Analysis for soluble enzyme systems. Cofactor regeneration . Membrane reactor. Effect of mass transfer in immobilised enzyme particle systems. Reactors for immobilised enzyme systems.

5. BIO REACTORS , EFFECT OF TRANSPORT PROCESSES:

Introduction to Bioreactor design: Continuously Stirred aerated tank bioreactors. Mixing power correlation. Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power consumption. Multiphase bioreactors and their applications. Downstream processing and product recovery in bioprocesses.

REFERENCES:

1. J. E. Bailey and D. F. Oilis. " Biochemical Engineering Fundamentals", 2nd Edn., McGraw Hill, New York, 1986.
2. Trevan, Boffey, Goulding and Stanbury," Biotechnology", Tata McGraw Hill Publishing Co., New Delhi, 1987.
3. M. L. ShulerandF. Kaigi, "Bio Process Engmeering : Basic concepts", 1st Edn., Prentice Hall, Englewood Cliffs, New Jersey 07632, 1992.

ELECTRO CHEMICAL ENGINEERING

1. INTRODUCTION TO ELECTROCHEMICAL ENGINEERING:

Introduction. Methods of measurement - Steady state techniques. Non-steady state techniques. Eliminating IR Drop.

2. ELECTROCHEMICAL TRANSFER PROCESS:

Electrochemical Transfer Processes. Mass Transport, Charge Transport and Heat Transfer.

3. ELECTROCHEMICAL REACTION ENGINEERING:

Electrochemical Reaction Engineering. Electrochemical Thermodynamics and Electrode kinetics . Kinetics in Electrochemical Reactors.

4. DESIGN AND MODELING IN ELECTROCHEMICAL PROCESSES:

Optimization and Factorial Design of Experiments. Experimental Modeling of Industrial Processes.

5. SEPARATION PROCESSES IN ELECTROCHEMICAL CELLS:

Separation Systems in Electrochemical Cells. Materials and corrosion.

REFERENCES:

1. Ewald Heitz and Gerhard Kreysa, "Principles of Electrochemical Engineering 1986.
2. T.Z.Fahidy,"Principles of Electrochemical Reactor Analysis", Elsevier 1985.
3. D.J.Pickett,"Electrochemical Reactor Design", Elsevir, 1977.

FLUIDIZATION ENGINEERING

1. INTRODUCTION AND APPLICATIONS:

Introduction to Fluidized bed systems. Fundamentals of fluidization. Industrial applications of fluidized beds - Physical operations. Synthesis reaction, cracking and reforming of hydrocarbons. Gasification, Carbonization, Gas - solid reactions ,calcining and clinkering.

2. GROSS BEHAVIOR OF FLUIDIZED BED:

Gross behavior of fluidized bed. Minimum and terminal velocities in fluidized beds, Types of fluidization. Design of distributors. Voidage in fluidized beds. TDH, variation in size distribution with height, viscosity and fluidity of fluidized beds. Power consumption.

3. ANALYSIS OF BUBBLE AND EMULSION PHASE:

Davidson's model. Frequency measurements, bubbles in ordinary bubbling bed model for bubble phase . emulsion phase: Experimental findings. Turn over rate of solids. Bubbling bed model for emulsion phase Interchange co-efficient.

4. FLOW PATTERN OF GAS AND HEAT & MASS TRANSFER IN FLUIDIZED BEDS:

Flow pattern of gas through fluidized beds. Experimental findings. The bubbling bed model for Gas inter change Interpretation of Gas mixing data. Heat and Mass Transfer between fluid and solid: Experiment findings on Heat and Mass Transfer. Heat and Mass Transfer rates from bubbling bed model.

5. HEAT TRANSFER BETWEEN FLUIDIZED BEDS AND SURFACE:

Heat transfer between fluidized beds and surfaces: Experiment finding, theories of bed heat transfer, comparison of theories. Entrainment of or above TDH, model for Entrainment and application of the entrainment model to elutriation.

TEXTBOOK:

1. D.Kunii and O.Levenspiel ,'Fluidization Engineering " 2nd. Edn.,]ohn Wiley& Sons, 1992

INDUSTRIAL CATALYSIS

1. INTRODUCTION TO CATALYSIS:

General properties of homogeneous and heterogeneous catalysis.

2. GEOMETRIC AND ELECTRONIC FACTORS IN CATALYSIS:

Adsorption and reaction kinetics in catalytic (heterogeneous) system.

3. CATALYST PREPARATION:

Preparation and evaluation of industrial catalysts.

4. KINETICS OF HETEROGONOUS REACTIONS:

Reaction engineering applied to catalytic homogeneous and heterogeneous chemical reactions.

5. CATALYST POISONING;

Catalyst poisoning and deterioration (sintering) origination of catalyst.

REFERENCE:

1. J. M. Smith, "Chemical Engineering Kinetics", 3rd Edn., 1983.
2. G. Bond, "Heterogeneous Catalysis-Principles and Applications", 2nd Edn., Oxford Univ. Press, 1986.
3. I. Mukhlyonov "Catalyst Technology", Mir Publishers, Moscow, 1976.
4. C.C. Thomas, "Catalytic Processes with Proven Catalysis", Academic Press.

ENZYME ENGINEERING

1. INTRODUCTION TO BIOCHEMISTRY , FUNCTION AND APPLICATIONS:

Nature and function of enzyme. Coenzyme/ Cofactor. Classification of enzymes. Assay methods and units. Examples of applications of enzymes in industry. analytical techniques medicine and Pharmaceuticals.

2. KINETICS AND MECHANISM OF ENZYME CATALYSIS:

Enzyme catalysis and controlling factors. Kinetics of enzyme catalyzed reactions in solution. Immobilized enzyme reaction kinetics. Effect of mass transfer resistance.

3. ENZYME PRODUCTION ON LARGE SCALE TECHNOLOGY:

Isolation and purification of enzyme, protein , protein fractionalization methods.

4. IMMOBILIZATION TECHNOLOGY AND DEVELOPMENTS:

Immobilization technique for enzymes . Characteristics and uses for immobilized enzyme systems.

5. INDUSTRIAL BIOREACTORS UTILIZING ISOLATED ENZYMES AND BIOSENSORS DEVELOPMENT AND APPLICATIONS:

Reactor design and analysis for immobilized enzyme reactors. Applications in biosensors . Some modern developments for enzyme in organic synthesis.

REFERENCES:

1. A. Wiseman, "Hand book of Enzyme Biotechnology", Ellis-Horwood,1983.
2. E.K.Pye and L.B.Wingard, "Enzyme Engineering II", Plenum Press, 1974.
3. I.E. Bailey and D. F. Ollis, "Biochemical Engineering Fundamentals" 2nd Edn., McGraw -Hill Publishing Company New York, 1986.

PROCESS DYNAMICS AND CONTROL- II

1. FREQUENCY RESPONSE:

Review of control system design in Laplace, time, and frequency domains, controller design using Laplace, time and frequency response-Analysis of some common loops.

2. DESIGN OF CONTROLLERS FOR DIFFICULT & COMPLEX DYNAMICS:

Inverse response systems - controller design - design of inverse response compensator. Time delay systems - controller design - Smith predictor method. Dynamics and Control of complex processes. Theoretical analysis of complex processes like jacketed kettle, absorber and heat exchanger.

3. MULTIVARIABLE SYSTEMS:

Feed forward control ,cascade and ratio control - Introduction to stage space methods-Design of controllers using state-space methods - Introduction to multiloop systems- Relative gain analysis.

4. CONTROLLERS DESIGN AND ART OF PROCESS CONTROL:

Degrees of freedom analysis - Introduction to distillation system - Controller design for mutliloop systems. Interaction and pairing of control loops. The art of process control.

5. DESIGN OF DIGITAL CONTROLLERS:

Supervisory control systems-Digital computer control - sampling & filtering of continuous measurements. Developments of discrete time models - Dynamic response of discrete time systems. Analysis of sampled data control System-Design of digital controllers

REFERENCES:

1. D. R. Coughanowr, "Process System Analysis and Control", 2nd Edn. McGraw Hill, 1991.
2. G Stephanopopulas, "Chemical Process Control", Prentice-Hall India, 1984.
3. D. E.Seborg, T.F. Edgar and D.A. Mellichamp, "Process Dynamics Control", John Wiley and Sons, 1989.
4. Ogunnaike and W.H.Ray, "Process Dynamics, Modeling and Control" Oxford Press. 1994.

FOOD TECHNOLOGY AND ENGINEERING

1. FOOD PROCESS ENGINEERING -FUNDAMENTALS:

Fundamentals of food process engineering, application of quantitative methods of material and energy balance in food engineering practice.

2. UNIT OPERATIONS IN FOOD INDUSTRIES:

Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations in food processing.

3. FOOD CANNING TECHNOLOGY:

Fundamentals of food canning technology. Heat sterilization of canned food, containers - metal, glass and flexible packaging. Canning procedures for fruits, vegetables, meats, poultry marine products.

4. MECHANICAL OPERATIONS IN FOOD PROCESSING:

Conversion operations, Size reduction and screening of solids, mixing and emulsification and membrane separation , centrifugation , extraction.

5. FOOD BIOTECHNOLOGY:

Food Biotechnology, Dairy and cereal products, Beverages and food ingredients, High fructose corn syrup, Single Cell protein.

REFERENCES:

1. R.T. Toledo, "Fundamentals of food process engineering " ,AVI publishing Co., 1980.
2. J. M. Jackson and B. M. Shinn, "Fundamentals of Food Canning Technology" AVI Publishing Co.,1978.
3. J. G. Berman, J. R. Butters, N. D. Cowell and A.E.V.Lilley, "Food engineering operations", 2nd., Edn., Applied Science, 1976.
4. R. Angold, G.Beech and J.Taggart, " Food Biotechnology", Cambridge University Press 1989
5. Briggs and Galloway, "Nutrition and Physical Fitness", 11th Edn., Holt Rinehart Winston, 1984.

FERTILIZER TECHNOLOGY

1. INTRODUCTION TO CHEMICAL FERTILIZERS:

Chemical inorganic Fertilizers and Organic manures. Types of fertilizer-,Mixed, complex and granulated, plant nutrients.

2. PROCESSES FOR RAW MATERIALS:

Processes for manufacture of ammonia, nitric acid , phosphoric acid and

3. NITROGENOUS AND POTASSIC FERTILIZERS:

Processes for urea and di -ammonium phosphite. Recovery of Potassium salts, processes for ammonia chloride and ammonium phosphate.

4. COMPLEX FERTILIZERS:

Processes for nitro - Phosphorous and complex NPK fertilizers ,liquid fertilizers.

5. PHOSPHATIC FERTILIZERS AND INDIAN FERTILIZER INDUSTRY:

Single and Triple super phosphate, bio-fertilizer. Fertilizer Industry in India.

REFERENCES:

1. Strelizoff, "Technology and Manufacture of Ammonia", 2nd. Edn.,Wiley, 1981.
2. L. J. Carpentire, "New Developments in Phosphate Fertilizer Technology", Elsevier, 1971.
3. M. E. Pozin, "Fertilizer Manufacture", MIR Publishers, Moscow, 1986.
4. "Handbook on Fertilizer Technology", Fertilizer Association of India, near JNU, New Delhi 1992.
5. A. V. Slack, "Phosphoric Acid", 2nd Edn., Marcell Dekkar, 1968.

OIL AND FAT TECHNOLOGY

1.INDUSTRIAL OILS AND FATS:RAW MATERIAL PROPERTIES:

Sources,composition,properties,classification and analysis of oils and fats.

2.RECOVERY AND REFINING OF OILS FROM RAW MATERIALS:

Extraction of oils, Mechanical and solvent extraction methods. Refining and hydrogenation of oils, Edible oil processing.

3.MANUFACTURE OF FATTY ACIDS,GLYCERIN AND SOAP:

Fat splitting and hydrolysis. Manufacture of glycerine and fatty acids. Soap manufacture.

4.TECHNOLOGY OF OIL BASED DETERGENTS:

Oil based raw material for detergents. Detergents manufacturing processes. Oleo-Chemicals for other applications.

5.MODERN DEVELOPMENT IN DETERGENTS:

Indian oils, fats and detergents industries.Alpha Olefin from natural oils and conversion to sulphonate.Fatty alchohols and thier sulphates form natural oils.

TEXT BOOKS:

1. D.Swern, "Baileys Industrial Oils and Fat Products",4th Edn., Vol. I & II, Wiley, 1982.
2. Edgar Woollatt, "The Manufacture of Soaps, Other Detergents and Glycerine", 1st Edn., Ellis Horwood,1985.

CERAMIC TECHNOLOGY

1. INTRODUCTION TO CERAMICS:

Importance of ceramics and lines of ceramic development, structure and properties of ceramics, electronic configuration of atoms, Bonding, Physical, Thermal, Electrical, Magnetic and Optical properties of ceramics, Mechanical properties and their measurements.

2. CERAMIC PROCESSING:

Processing of ceramics, powder processing, powder sizing and preconsolidation, shape forming processes. Pressing, casting, plastic forming and other forming processes. Densitification and theory of sintering.

3. CERAMIC FORMATION:

Drying ceramic ware. Internal flow of moisture, surface solid state reactions, setting methods, finishing fired ware.

4. APPLICATION OF CERAMICS:

Fine ceramics-Bodies for electrical and electronics uses. Refractories and Insulators. Heavy refractories,Insulating firebrick, pure oxide refractories, non-oxide refractory bodies, Refractory plastics, concrete and mortar, insulating materials.

5. TYPES OF CERAMICS:

Ceramics building materials, building brick, sand-lime brick, lime, portland cement, high alumina cement, gypsum plaster, oxychloride, silicate and phosphate cements, Glass compositions, mechanism of melting and glass products.

REFERENCES:

1. F.Singer and S.S.Singer,"Industrial Ceramics",Chapman and Hall Co., London,1982.
2. David W., Richardson and Basel," Moder Ceramic Engineering, Properties, Processing and use in design",Macell Dekkar,Inc,Newyork,1962.

3. F.H.Norton,"Elements of ceramics",2nd Edn.,Addison-Wesley Publishing Co., London,1974.
4. Enginnering application of Ceramic Materials Source Books of American Society for materials.

POLYMER TECHNOLOGY

1. CHARACTERISTICS AND ANALYSIS OF POLYMERS:

The science of large molecules. Theory of polymer solutions. Measurement of molecular weight and size. Analyzing and testing of polymers.

2. POLYMER MATERIAL STRUCTURE AND PROPERTIES:

Deformation, flow and melt characteristics. Morphology and other in crystalline polymers. Rheology and mechanical properties of polymers. Polymer structure and physical properties.

3. POLYMER SYNTHESIS AND REACTION ENGINEERING:

Condensation polymerization, Addition polymerization, Ionic and Coordination polymerization, copolymerisation, polymerization conditions and polymer reactions.

4. INDUTRIAL POLYMERS, MANUFACTURING PROCESSES AND APPLICATIONS:

Hydrocarbon plastics and elastomers, other carbon chain polymers, Heterochain thermoplastics, Thermosetting resins

5. PROCESSING OF POLYMERS: PLASTICS, FIBERS AND ELASTOMERS:

Polymers developed for synthetic plastics, fibers and elastomer applications. Plastics technology. Fiber technology and Elastomer Technology.

REFERENCES:

1. F.W. Billmeyer, "Text Book of Polymer Sciences", 3rd Edn., Wiley Inter Science, 1984.
2. F. Rodriguez, "Principles of polymer systems",4th Edn., Taylor and Francis, Washington, 1996.
3. "Encyclopedia of Polymers Science and Technology", John Wiley-Inter Science.

BIO-TECHNOLOGY

1. RATES AND PATTERNS OF CHANGES IN CELL CULTURES:

Kinetics of substrate utilization, biomass and product formation in cellular cultures. Stoichiometry of growth and product formation.

2. PHYSICAL PARAMETERS IN BIOREACTORS AND DOWNSTREAM SEPARATIONS:

Transport phenomena and modeling in Bioprocesses. Product Recovery operations. .

3. SENSORS,MONITORING AND CONTROL SYSTEMS IN BIOPROCESSES:

Instrumentation and process control in bioprocesses.

4. BIOCHEMICAL REACTION ENGINEERING AND BIOREACTOR DESIGN:

Design and analysis of Bioreactors. Dynamic models and stability, non-ideal mixing, residence time. Sterilization reactors. Immobilised bio-catalysts and multiphase bio reactors.

5. FERMENTATION TECHNOLOGY AND r-DNA TECHNOLOGY:

Bio-process Technology and Genetic Engineering.

TEXT BOOKS:

1. J.E. Bailey and D.F. Ollis, "Biochemical Engineering Fundamentals", 2nd Edn., McGraw Hill, New York,1986.
2. M.D. Trevan, S. boffly, K.H. Golding and P.stanbury, "Biotechnology", Tata McGraw publishing Company, New Delhi 1987.
3. R. Lovitt and M. Jones, "Biochemical Reaction Engineering in Chemical Engineering", Vol. III, 3rd Edn., Edited by J.F. Richardson and Peacock, Pergamon, London, 1994.
4. Smith "Biotechnology" cambridge University, 2nd Edn., 1990.

ENERGY CONSERVATION

1.Introduction: The energy crisis and options: the energy conservation option, energy intensity of developed and developing economies, energy auditing – basic requirements, scope and purpose, process energy and gross energy requirements.

2.Efficient energy conversion: efficient combustion, waste as a fuel, combined cycles for efficient power generation, combined heat and power plants, combined cooling and power plants.

3. Energy recovery: insulation: insulating materials, economic thickness of insulation; heat recovery heat exchangers: recuperative heat exchangers, run-around coil systems, regenerative heat exchangers; heat pumps; and heat-pipes.

4. Process integration: basic concepts of pinch technology, stream networks, significance of the pinch, design of energy recovery system.

5. Energy conservation in buildings: degree-days, steady state loads and comfort. Conditioning the air for process requirements and human comfort, thermal performance monitoring, efficient lighting systems, solar passive features.

6. Economics of energy saving schemes and case studies.

REFERENCES :

1. Eastop and Croft, 'Energy efficiency', Longman Scientific and Technical, 1990.
2. Gordon A Payne, 'Managing energy in commerce and industry', Butterworths, 1984.

PILOT PLANTS, MODELS AND SCALE-UP METHODS IN CHEMICAL ENGINEERING

1. INTRODUCTION TO PILOT PLANTS AND MODELS:

Introduction to pilot plants and Models, Process Development, Process study, the principle of similarity and similarity criteria, dimensional analysis and its application in scaling-up or scaling-down the chemical process plant.

2. MATHEMATICAL EQUATIONS;

Mathematical Equations representing the Mechanical, Thermal, Diffusional and chemical processes and derivation of the dimensionless groups from these differential equations. Rate of chemical reaction of Homogeneous and Heterogeneous chemical reactions.

3. THE REGIME CONCEPT:

The Regime Concept, Laupichleir's study of catalytic water gas reaction, chemical dynamic and mixed regime, Effect of temperature on physical and chemical reactions. Similarly criteria for the principle types of regime and scale equations.

4. SCALE UP OF HEAT TRANSFER EQUIPMENTS:

Scale-up methods for Heat-Transfer equipment e.g.-Heat Exchangers, Steam or vapour Heaters, Evaporators, Condensers and Coolers.

5. SCALE-UP OF MISCELLANEOUS EQUIPMENT:

Scale-up methods for mixing equipment and other miscellaneous equipment used in chemical process industries.

REFERENCES:

1. R.E. Johnstone and M.W. Thring, "Pilot Plants, Models and Scale-up methods in Chemical Engineering ",McGraw Hill Book Company, New York,1957.
2. Bisio & Kabel, "Scale-up in Chemical Industry".
3. D.G. Jordan, "Chemical Process Development", Vol. 1 & II, Interscience Publishers, 1988.

INSTRUMENTATION AND MEASURMENTS

1. CONCEPTS AND INSTRUMENTATION OF OPTICAL METHODS:

Introduction to optical methods and various Instruments. Visible and UV Spectrophotometer. IR Spectrophotometer, Fluorescence.

2. NUCLEAR MAGNETIC RESONANCE (NMR) AND X-RAY ANALYSIS:

Introduction-Instrumentation-analysis, X-ray methods

3. ELECTRO CHEMICAL ANALYSIS:

Electro chemical Methods of analysis.pH and conductometric titration

4. THERMAL ANALYSIS:

Thermo analytical methods. Differential scanning. Calorimeter. Thermogravimetric analyser. Thermo mechanical analysers.

5. CHROMATOGRAPHY:

Chromatography-various types. Construction and working. Analysis of sample.

REFERENCES:

1. C.W. Ewing, "Instrumental methods of chemical analysis", 4th edn., McGraw Hill, 1985.
2. H. H. Willard, L.L. Merit, and J.A. Deunm, "Instrumental Methods of Analysis", 5th Edn.

TWO PHASE FLOW AND HEAT TRANSFER

Introduction to two phase flow, simple momentum and energy balances and their related empirical correlations, basic equation for two phase flow modelling, annular two phase flow, introduction to two phase heat transfer, nucleate boiling heat transfer, forced convection boiling, burnout, heat transfer in condensation, measurement technique in two phase flow, introduction to two phase flow problems in process industry.

REFERENCES :

1. Jean J. Ginoux, Two phase flow and heat transfer.
2. Bergles, Collier & Hewitt, Two phase flow and heat transfer in the power and process industries.

PETROCHEMICAL TECHNOLOGY

1. PRIMARY PROCESSING OF CRUDE OIL :

Classification of crude oil, Atmospheric distillation .Vacuum distillation of residue-products and distillation practice.

2. SECONDARY PROCESSING OF CRUDE OIL :

FCCU, Hydro cracking, Visbreaking, Thermal cracking. Coking, Reforming, Alkylation, Polymerization and Isomerisation process.

3. TREATMENT-TECHNIQUES :

Treatment techniques for removal of objectionable gases. Odours, to improve performance, .Storage stability. Extraction of aromatics, Olefins and recovery operations from petroleum products.

4. PETROCHEMICALS :

Chemicals from methane and synthetic gas: Ammonia, Methanol and Hydrogen Cyanide, Chemicals from olefins; Ethviene derivatives, Propylene derivatives and Butylene derivatives, Aromatics, intermediates for synthetic fibers. Plastics and rubber.

5. ENVIRONMENTAL AND SAFETY ASPECTS IN REFINERY AND PETROCHEMICALS :

Waste water and effluent gases treatment from alkylation units and petrochemical units, safely aspects in the above industries.

REFERENCES :

1. W.L. Nelson, "Petroleum Refinery Engineering", 4th Edn., McGraw Hill , New York 1985.
2. B. K. Bhaskara Rao, "Modern Petroleum Refining Processes", 2nd Edn., Oxford and IBH Publishing Company, New Delhi, 1990. Khanna Publishers.
3. G. D. Hobson and W. Pohl., " Modern Petroleum Technology", Gulf Publishers 2nd. Edn., 1990.
4. R. A. Meyers, "Handbook of Petroleum Refining Processes", McGraw Hill , 1st Edn., 1980.
5. F. Hatch md Sumi Malar, "From Hydrocarbons to Petrochemicals", Gulf Publishing Company, 1st Ed. 1981.

MANUFACTURING AND MAINTENANCE OF PROCESS EQUIPMENTS

Manufacturing:

Manufacturing methods of process equipments

Bulk Metal Deforming: Elastic and Plastic deformation, Yield and Flow, Classification of Deforming Processes,

Drawing: Classification, Process Geometry, Geometrical Relationship; Analysis of Wire/ Sheet/Tube Drawing- Stresses, Load and Power, Maximum Reduction Possible. *Extrusion*: Classification, Process Geometry, Geometrical Relationship; Analysis of Extrusion-Stresses, Load and Power, Maximum Reduction Possible; Working and Application of Indirect Extrusion, Hydrostatic Extrusion, Pipe and Tube Extrusion, Defects in Extruded Parts.

Forging: Classification, Strip and Disc Forging- Process Geometry, Geometrical Relationship, Analysis- Pressure Distribution, Forging Load and Power; Defects in Forged Products.

Sheet metal working: Roll of sheet components, *Bending:* Classification, Process Geometry, Geometrical Relationship, Analysis- Bend Allowance, Spring Back and Bending Force; Other Bending Related Operation- *Deep Drawing*: Process Geometry, Measures of Drawing, Forces and Power, Blank Size Determination, Redrawing and Defects in Deep Drawing.

Cutting Operations: Fundamentals of Shearing, Blanking and Piercing –Clearance, Cutting Foces; Other Sheet Metal Cutting Operations, Concept of Nesting.

Unconventional Deforming: Explosive Deforming, Electro-Hydraulic Deforming, and Electro-Magnetic Deforming; Laser bending; Concept of Micro-Deforming.

JOINING PROCESSES

Classification of Welding Processes;

Arc Welding- Principle of Arc, Metal Transfer, Arc Characteristics; Working and Applications of SMAW, GTAW, GMAW, SAW, FSW and AITW;

Resistance Welding- Spot, Seam, Projection and Flash Butt;

Gas Welding: Oxy Acetylene and Oxy Hydrogen;

Thermit Welding; Solid State Welding Processes, Fusion Welding Pool and Welding Defects.

Allied Processes- Brazing and Soldering, Surfacing and Spraying, Electro-Plating and Electro-Forming, Deposition Processes-PVD and CVD.

UNCONVENTIONAL WELDING: Principle of Working and Applications of Beam Welding Processes- LBW and EBW, Ultra-Sonic Welding and Under Water Welding; Concept of Micro-Welding

Maintenance:
Types of maintenance such as Preventive maintenance, predictive maintenance, schedule maintenance, Corrective maintenance, Failure-finding maintenance, etc.
Monitoring of processing equipments for degradation such as Erosion, corrosion, and erosion-corrosion. Protection of equipment against such degradation.

REFERENCES :

1. **Groover, M.P.,** Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley Student Edition, John Wiley and Sons, 2005.
2. **Ghosh, A., and Mallik, A.K.,** Manufacturing Science, EWP Pvt. Ltd., New Delhi.
3. **Juin, V.K.,** Advance Machining Processes, Allied Publisher, Bombay.

MODELLING & SIMULATION IN ENGINEERING

Fundamental aspect of modeling:
Technical and Commercial aspects, types of modeling- Analytical, experimental, mechanistic, numerical, AI based and stochastic.
Model testing, Principles of simulation, Discrete event simulation. Applications in design and manufacturing.

COMPUTER-AIDED PROCESS CONTROL

Hardware, Analog and digital interfacing, Sensors and transducers, System software: Realtime programming, Application software: data logging, filtering, Digital Control: *Z*-transforms, discrete time dynamics systems, adaptive control, introduction to MIMO control systems.

ANNEXURE-3

Scheme of Syllabi for III[rd] and IV[th] Semester of

B.Tech. Programme

in

BIOTECHNOLOGY

Applied Mechanics Department
Motilal Nehru National Institute of Technology
(Deemed University) Allahabad-211 004.

Department of Applied Mechanics
Course Structure for B.Tech. in Bio-Technology
(Semester III[rd] & IV[th] only), *

SEMESTER-III						SEMESTER-IV					
S.N.	Subject	L	T	P	Cr	S.N.	Subject	L	T	P	Cr
BT301	Bio-Chemistry	3	1	2	5	BT401	Biophysics and Structural Biology	3	1	2	5
BT302	Microbiology	3	1	2	5	BT402	Immunology	3	1	2	5
BT303	Genetics	3	1	2	5	BT403	Genetic Engineering	3	1	2	5
CE301	Environment and Ecology	3	1	0	4	BT404	Transport Process	3	1	0	4
AM 301	Material Science and Engineering	3	0	2	4	BT405	Biochemical Engineering	3	1	2	5
BT304	Cell and Molecular Biology	3	1	2	5	BT406	Thermodynamics of Biological system	3	1	0	4
		18	5	10	28			18	6	8	28

*1. Course structure for I[st] & II[nd] semester is common for all B. Tech. programme.
2. Course structure for V[th] to VIII[th] semester to be submitted later.

SEMESTER- III rd

BT 301: BIOCHEMISTRY

Biochemistry of Carbohydrates and Lipids:

Metabolic Pathways - Biosynthesis of Glucose, Glycogen and Starch, Carbohydrate Metabolism - Glycolysis, Citric Acid Cycle (TCA Cycle) and Oxidative Phosphorylation, Metabolic Pathways - Biosynthesis of Saturated and Unsaturated Fatty Acids, Cholesterol, Phospholipids and Sphingolipids, Lipid Metabolism - Catabolism of Fatty Acids, Metabolism of Triglycerol and Cholesterol, Metabolism of Glyco-conjugates - Proteoglycans, Glycoproteins and Glyco-Lipids.

Biochemistry of Proteins and Nucleic Acids :

Metabolic Pathways - Biosynthesis of Amino Acids, Peptides and Proteins, Protein Metabolism - Catabolism of Carbon skeletons of Amino Acids - Oxidative Deamination and Oxidative Decarboxylation, Nitrogen Excretion and Urea Cycle, Metabolic pathways - Biosynthesis of Purines, Pyrimidines, Nucleotides and Nucleic Acids (DNA and RNA), Nucleic Acid Metabolism - Degradation of Nucleotides and Nucleic Acids and Genetic Disorders.

Biochemistry of Photosynthesis:
Plant photosynthesis : Oxygenic and Anoxygenic Photosynthesis, Photosynthetic reaction Centers, Chlorophylls as trappers of Solar Energy Hill Reaction - Photosynthesis I and Photosynthesis II, Dark Reaction Cyclic and Non-cyclic Photo Phosphorylation, Bacterial photosynthesis.

Biochemistry of Metal Ions and Functions of Protein:
Metal ions in Biological Systems - Role of Iron, Zinc, Cobalt, Copper and Magnesium Haemoglobin - Oxygen transport, Chloroplast - Electron Transfer under Light, Vitamin - B_{12} - Oxidation - Reduction reactions, Transport across cell membranes, Functional Proteins like Enzymes and Hormones. Cofactors, Coenzymes and Prosthetic groups - its role in Biochemical Reaction

References

- Lehninger Principles of Biochemistry By David . L . Nelson and Michael. M. Cox
- Outlines of Biochemistry by E.E Conn and P.K.Stumpf
- Biochemistry by Stryer.L
- Harper's review of Biochemistry by by Martin. D. W, Mayes. P. A and Rodwell. V. M
- Practical of Biochemistry by Wilson & Walker

BIOCHEMISTRY LABORATORY

- Concepts of pH and buffers - application to enzyme reactions.
- Differential centrifugation and isolation of organelles and tests for organelle fractions.
- Estimation of carbohydrates.
- Estimation of proteins.
- Extraction of Lipids.
- Estimation of nucleic acids.
- Study of chromatographic techniques for separation of proteins and lipids.
- Enzyme assays based on UV-VIS spectroscopy.
- Enzyme inhibition studies.
- Electrophoresis of protein and Nucleic acids.
- Separation of proteins and DNA by electrophoresis – visualization of bands.

BT302: MICROBIOLOGY

Introduction to Microbiology:
Discovery of microorganism, Theory of spontaneous generation, Germ theory of diseases; Major contribution and events in the field of microbiology. Scope and relevance of Microbiology.

Classification and Identification of microorganisms:
Diversity classification of Woose et. al. Five kingdom system of Whittaker, taxonomic ranks, classification systems (phylogenetic, phenetic), numerical taxonomy, polyphasic taxonomy major characteristics used in taxonomy – morphological, physiological, ecological, biochemical, immunological, genetical and molecular. Identification of microorganisms - a general account. Fixation, principal dyes, simple staining, differential staining, staining of specific structures.

Major Groups of Microorganisms:
Characteristics of major groups of bacteria (archea, eubacteria). Characteristics of important groups of bacteria. Distribution, general characters, nutrition, reproduction, important uses, harmful effects.

Nutrition Of Microorganisms:
Nutrition of micro organisms; Macro and micronutrients, their sources and physiological functions; Growth factors and their functions in metabolism; Uptake of nutrients by cells, Transport of nutrients through the cytoplasmic membrane; Primary and secondary transports; Simple diffusion, Facilitated diffusion, Active transport, Group translocation, Iron transport, Ionophores,Siderophores.

Growth, Cultivation of Microorganisms and Control of Microorganisms :
Growth of microorganisms, Growth curve, Mathematics of growth, Measurement of microbial growth (cell numbers, cell mass), Growth yields and the effect of limiting factor, Continuous growth, Chemostat, Turbidostat, Balanced and unbalanced growth. Culture media, synthetic, complex media – selective, differential and enrichment and enriched media, importance and isolation of pure cultures – spread plate, pour plate and streak plate; colony characteristics.
Influence of environmental factors on growth – solutes, water activity, pH, temperature, oxygen, osmotic pressure, radiation.

Virology:
Viruses, General introduction, Types and Classification.Virus induced diseases.

Characteristics & mode of action of antimicrobial agent:
Control of microorganisms, Inhibition of growth and killing, sterilization and disinfectants. Classes of disinfectants - phenol and phenolics, alcohol, halogens (Cl_2, Chloramines, Br_2, I_2, tinctures of iodine, iodophores), surfactants (soaps and detergents), alkylating agents (formaldehyde, glutaraldehyde, - propiolactone and ethylene oxide), Heavy metals (Hg, Silver and copper containing compounds). Factors affecting sterilization and disinfection. Evaluation of disinfectants.

Microbiological Applications:
Microbiology in production and QC of food and pharmaceuticals, methods of sterilization, clean rooms, environment monitoring sterility tests, bioburden and microbial quality, Microbiological verification of water systems, cleaning and sanitization procedures. Developing standard operating procedures for microbiological system.

References:

- Microbiology Pelczar M.J. Chan ECS and Krieg NR, Tata McGraw Hill.
- General Microbiology by Roger Y.Stanier, Macmillan.
- Bergey's Manual of Systematic Bacteriology II edition.
- General Microbiology by Prescott and Dunn.
- Microbiology by T. D. Brocks.

MICROBIOLOGY LABORATORY.

- Sterilization techniques
- Preparation of culture media (a) Broth type of media (b) Agar.
- Culturing of microorganism (a) Broth, (b) pure culture techniques- streak plate, pour plate, isolation and preservation of bacterial culture.
- Identification of microorganisms- (a) Staining techniques, (b) Hanging drop, (c) Biochemical testing (d) Antibiotic sensitivity.
- Quantitation of microorganisms – (a) Counting microscopy (b) Turbidimetry (c) Total N or dry weight (d) Colony counter techniques.
- Environmental sample analysis.
- Isolation and characterization of plant pathogenic microbes.

BT303: GENETICS

Physical Basis of Heredity:
Basic law of inheritance, mono-hybrid, dihybrid and tri-hybrid ratios. Modification of Mendel's ratios due o gene interaction, Multiple alleles, Multiple factors of inheritance. Genes and environment interaction, Identification of the genetic materials – classical experiments. Hershey chase, Avery Mcleod etc.

Linkage, Recombination and Mapping:

Chromosomal inheritance, the concept of linkage and crossing over, recombinations. Three point test crosses and gene mapping, Mapping to genes by tetrad analysis by mitotic crossing over. Genetic Transfer- conjugation, transduction and transformation.

Chromosome Structure, Organisation, Aberrations and Extra Chromosomal Inheritance:

Organization of genetic material in prokaryotes, eukaryotes. Chromosome morphology, Classification, Karyotyping special chromosome, Chromosome aberrations, origins, types and cytogenetic effects. Euchromatin and Heterochromatin organizations, classifications of mutations, characters of mutants and its applications. Petite phenotypes in yeast, Unipair inheritance in algae. The maternal inheritance.

Sex Determination :

Mechanism of sex determination in animals and plants, Sex differentiation and developments in humans. Dosage compensation, Sex linked disorders in human beings.

References:

- Genetics, Goodenough U, Hold Saunders International 1985.. Principles of Genetics,
- Gardner EJ, Simmons MJ, Snustad DP, 1991.
- Genetics by Strickberger.
- Genetics by Gardener
- Gene VIII by B. Lewin

GENETICS LABORATORY

1. Monohybrid, dihybrid and trihybrid cross.
2. Test cross and back cross
3. Gene mapping by three point test cross
4. Genetic mapping by conjugation.
5. Study of chromosome morphology
6. Induction of mutation and isolation of mutants.
7. Study of genetic markers in bacteria.
8. Study of maternal inheritance.

CE301: ENVIRONMENT AND ECOLOGY

Introduction and scope:
Conservation of natural resources i.e. forest resource, water resource, mineral resource, energy resource, land resource etc. Role of individual for resource conservation and sustainable development.

Ecosystem and its basic concept:
Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Examples of ecosystems.

Biodiversity and its conservation:
Introduction - Definition: genetic, species and ecosystem diversity, National and global scenario.
Environmental Pollution, Definition, Causes, effects and control measures of:
Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards.

Sustainable development:
Urban problems related to energy, Water conservation, rain water harvesting, watershed management.

Environmental ethics:
Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust Case studies, Wasteland reclamation, Consumerism and waste products, Environmental Management through Acts.

Human Population and the Environment:
Environment and human health, Role of Information Technology in Environment and human health, Case studies.
Field Work:

- Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain.
- Visit to a local polluted site- Urban/Rural/Industrial/Agricultural.
- Report submission on field visit.

AM301: MATERIAL SCIENCE AND ENGINEERING

Structure and properties relationship of Engineering Materials.

Structure of Crystalline Solids:
Crystal structures and Systems, Unit Cells, Metallic Crystal Structures, Crystallographic directions and Planes, Density Computations.

Characterization of Materials:
Crystallography, Reciprocal Lattice, Stereographic projections, Diffraction methods, Electron microscopy, Metallography, Thermal analysis.

Imperfections in Crystals:
Point defects, Dislocations, Interfacial Defects, Bulk defects.

Diffusion:
Mechanisms, steady state and non steady state Diffusion, factors influencing diffusion

Multiphase Structures, Phase Transformations:
Unary, Binary, Equilibrium Phase Diagrams, Eutectic, Eutectoid, Peritectic and Peritectoid Reactions, Iron Carbon Diagram.

Mechanical Behaviour of Materials:
Elastic and Plastic properties, Creep, Fracture, Heat treatment of steels.

Ceramic Materials:
Ceramic Structures, Properties

Electric and Electronic materials:
Electrical Conduction, Classification of semiconductor materials, Materials and Technology for integrated circuits, Photonic materials, super conductivity and special super-conducting materials, Ferrites. Quartz crystal, Dielectric materials. Piezoelectric and Ferro-electric materials, Electromechanical materials, Mechanism of polarization, Its measurements

Magnetic Properties for Applications:
Diamagnetism, Paramagnetism, ferromagnetism, Antiferromagnetism, Ferrimagnetism, Soft and hard magnetic materials magnetic storage.

Optical properties:
Optical properties of Metals and Non metals, Luminescence, photoconductivity, Optical Fibers in communications

References:

- Callister J , "Material science for Engineers"
- Van Vlack, " Material Science"
- Raghavan V, " Material Science"
- Guy, " Physical Metallurgy"

MATERIAL SCIENCE AND ENGINEERING LABORATORY:

- Study of models of:

  (a) Unit Cells and crystal structures.
  (b) Dislocations
- Specimen preparation for micro structure examination involving:
  (a) cutting
  (b) grinding
  (c) polishing
  (d) etching
- Material identification of 20 common materials.
- Comparitive study of microstructure of different given specimen:
  (mild steel, grey cast iron, brass, copper, aluminium etc.)
- Heat treatment of steels such as annealing, normalising, quenching, case hardening and comparison of hardness before and after the treatment.
- Effect of surface imperfections on the strength of glasses.
- Determination of Hardness by Brinell Method.
- Creep of engineering materials.

BT304: CELL AND MOLECULAR BIOLOGY

The cell:
Definition and type of cell, Cellular compartmentalization. The Nucleus: Chromosomal DNA and its packaging, Global structure of chromosomes, Chromosome replication, Organization and evolution of the nuclear genome.

Cell Cycle and Division:
General strategy of the cell cycle, Mechanics of cell division, Early embryonic cell cycle, Cell-cycle control in yeasts and multicellular animals.

Cytoskeleton:
Nature of the cytoskeleton, Intermediate Filaments, microtubules, cilia and centrioles, actin filaments, actin-binding proteins, muscle.

Cell Junctions, Cell Adhesion, and the Extracellular Matrix:
Cell Junctions, Cell-Cell adhesion, extracellular matrix of animals, extracellular matrix receptors on animal cells- the Integrins, plant cell wall.

Cancer:
Cancer as a microevolutionary process, Tumour cells, Proto-oncogenes and viral oncogenes, Tumour suppressor genes.

DNA Structure, Replication & Repair:
Structure of DNA-Watson & Crick's model; Types of DNA-A-DNA, B-DNA, Z-DNA; Replication of DNA-semi conservative replication, enzymology of replication, continuous and discontinuous DNA synthesis, complex replication, apparatus, unidirectional replication, bi-directional replication, rolling circle replication; Denaturation and renaturation of DNA.
DNA damage and repair.

RNA Synthesis and Structure:
Transcription apparatus and proteins involved in transcription. Prokaryotic & Eukaryotic transcription. Types of RNA, Processing of RNA. RNA Splicing.

Protein Synthesis and Structure:
Ribosome- Structural features of prokaryotic and eukaryotic ribosome. Genetic code- Triplet code, cracking of genetic code, features of genetic code, Wobbles hypothesis. Translation in prokaryotes and eukaryotes- initiation, elongation and termination of polypeptide chain, post translation modification, protein folding.

Regulation of Gene Expression:

Regulation of Gene expression in bacteria- Operon concept, inducible and repressible operons, positive and negative regulations, inducer molecules, repressor molecules, co repressor molecules, Induction and catabolite repression of lac,trp and Ara operon in E.coli. Control of gene expression by sigma factor and micro RNA and posttranscriptional control. Absolute control by antisense RNA's; enhancers, upstream controlling elements, helix turn helix, zinc finger motifs, leucine zippers, homeotic genes.

References:

- Molecular biology of the gene-Watson, Hopkins, Roberts & co.
- Genes-Benjamin Lewin.
- Molecular biology-D. Freifielder
- Molecular biology-Weaver
- Developmental Biology, by Scott F. Gilbert (1997), Sinauer Associates, Inc.

CELL AND MOLECULAR BIOLOGY LABORATORY

- Microscopic visualization of chromosome by staining.
- Studies of mitosis and miosis of cell division.
- Isolation and visualisation of genomic DNA and plasmids on agarose gels.
- Estimation of DNA and RNA by spectrophotometric techniques.
- Restriction digestion and ligation of plasmids.
- Preparation of competent cells, Transformation, screening for recombinants.
- DNA denaturation and T_m calculation.
- Visualization of overexpressed protein bands.

SEMESTER- IVth

BT401: BIOPHYSICS AND STRUCTURAL BIOLOGY

Principles of protein structures:
Three dimensional conformations of proteins, Ramachandran plot, motifs, folds, mechanism of protein folding, fibrous proteins, membrane proteins and their structures.
Hydrogen bonding, hydrophobic interactions, ionic interactions, disulphide bonds and their role in protein structure. Secondary structural elements and organisation of tertiary structure. Helix-coil transition and zipper model.

Principles of Nucleic acid structures:
Nucleic acid structure and composition: A, B, and Z: forms of DNA, supercoiling of DNA, denaturation and renaturation kinetics, nucleotide sequence composition: unique, middle and highly repetitive DNA, Redundant DNA.

Methods of determination of biomolecular structures:
Macromolecular structure determination: Basic concepts and principles of X-ray diffraction, crystallography, spectroscopy –UV-Visible, fluorescence spectroscopy and NMR, circular dichroism, electron microscopy.

Biomolecular interactions:
Protein-Protein interactions, protein-carbohydrate interactions, Protein-DNA interactions, prediction and engineering of protein structures. General features and thermodynamic aspects of protein folding, Detection of folding intermediates, complex and folding kinetics. Ligand interactions, co-operative interactions.

Textbook:

1. Lehninger Principles of Biochemistry,
2. Kensal E van Holde, Principles of Physical Biochemistry

Reference books:

1. David Friefelder, Physical Biochemistry
2. Practical Biochemistry Principles and techniques : Wilson and Walker, Cambridge University Press.

BIOPHYSICS AND STRUCTURAL BIOLOGY LABORATORY.

- Determination of solvent exposure/accessibility of aromatic amino acids by UV-VIS and fluorescence Spectroscopy..
- Measurement of thermodynamic parameters of heat denaturation of proteins and nucleic acids.
- Measurement of the conformational stability of a protein.
- Estimation of secondary structure of proteins by CD.
- Modelling biomolecule and biomolecular processes by Computer Simulations and Graphics.

BT402: IMMUNOLOGY

The Immune system

The origin of Immunology: History and evolution of immune system; Innate immunity; Acquired immunity; Humoral and cell-mediated immunity; Passive transfer of immunity; Primary and secondary lymphoid organs; Structure and function of Antigen; Concept of Epitope, B cell and T cell: Biogenesis or Maturation; Macrophage and other Antigen Presenting Cells (APCs).

Molecular basis of Immunology:

Structure and function of Antibody; Concept of Isotype, Allotype and Idiotype; Molecular basis of antibody diversity: DNA rearrangements; variations arising out of V,D,J joining; somatic hypermutation; Class switching; Primary and secondary immune response; Polyclonal and monoclonal antibody; Complement; Antigen-antibody reaction, Basic concepts of Immunodiffusion, RIA and ELISA.

Major Histocompatibility Complex (MHC):

Antigen processing and presentation; synthesis of antibody and secretion; HLA; laws of graft rejection; graft versus host reaction; Development of Inbred mouse strain; Blood group classification and Rh factor, Cytokines and other co-stimulatory molecules.

Immune response and tolerance:

Regulation of immune response; Immune tolerance; T cell anergy and T cell elimination; Hypersensitivity; Autoimmunity with respect to Myasthenia gravis and Rheumatoid arthritis; AIDS and immunodeficiency; Tumour immunology; vaccines.

Textbook:

1. Roitt, Immunology, 6th ed 2001, Mosby Publications.

Reference books:

1. Essential Immunology, Roitt, I.M., 9th Ed. (1997), Blackwell Scientific, Oxford, UK
2. Immunology, Kuby, J. 3rd Ed. (1997), Freeman, W.H,Oxford,UK
3. Weir, Immunology, 8th ed, W.B. Saunders& Co.
4. K.A. Abbas, Immunology, 4th ed, W.B. Saunders& Co.

IMMUNOLOGY LABORATORY:

- Cell counts with the hematocytometer - for cells and WBC counts, Dilutions and calculations.
- Preparation of Blood Smear.
- Microscopic study of blood cells.
- Enzyme linked immunosorbent assay (ELISA)
- Immunodiffusion test.
- Isolation of antibody from animal system.
- Haemmaglutination test
- Purification of lymphocytes from peripheral blood
- Blood typing and count.
- Estimation of haemoglobin.

BT403: GENETIC ENGINEERING

Recombinant DNA and Gene Cloning:
Plasmids, Bacteriophages and high capacity vectors.
Plasmids: Definition, types of plasmids, identification and classification of plasmids, purification of plasmids, Plasmid transfer and its mechanism.
Construction of Genomic and cDNA libraries, and their strategies and advantages of cDNA libraries, BAC Library.

Restriction Enzymes and Restriction Mapping:
Enzymes used in cloning – polymerases, lipases, restriction modification – DNA methylation of enzyme and modification of restriction site. Types of restriction enzymes and nomenclature of restriction enzymes. Restriction mapping.

Polymerase Chain Reaction (PCR) and its applications:
Principle of PCR, Design of primers, PCR methodology: RT-PCR, Multiplex PCR, Anchored PCR, Inverse PCR and PCR walking. Identification of PCR products, applications of PCR, Site directed mutagenesis, gene sequencing.

Molecular Markers:
Type of molecular markers, use of RFLP, RAPD, AFLP, STMS, DNA chips, SNPs and micro array. Different Blotting techniques: Southern, Northern, Western

Transposable elements:
Definition, Type of transposable elements, Type of transposition and excision, detection of transposition in plant and bacteria, applications of transposons.

Applications of Genetic Engineering:
Gene cloning in medicine, agriculture, transgenic animals and plants, molecular farming.

References:

- Genes to clone by T. A. Brown
- Genetic engineering by S. Mitra
- Principles of Gene Manipulation: An Introduction to Genetic Engineering Old RW, Primrose SB. Blackwell Science Publications.
- Genes by B. Lewin
- Molecular biology D. Freifielder.
- Molecular cloning by Sambrook et al.

GENETIC ENGINEERING LABORATORY.

- Isolation & visualization of Genomic DNA on agarose gels.
- Isolation & visualization of RNA.
- Isolation & visualization of plasmids on agarose gels.
- Restriction mapping of DNA fragments.
- Transformation, screening for recombinants.
- Blotting techniques – southern blotting.
- Amplification of DNA fragments by Polymerase chain reaction (PCR).

BT404: TRANPORT PROCESS

Basic concepts of Fluid Mechanics :

Dimensional Analysis: Buckingham Pi-theorem, Dimensionless groups, Conversion of equations. Basic equations of Fluid Flow, Hagen Poiseville equation, Bernoulli Equation, Fluid Friction. Friction in flow through packed beds, fundamentals of fluidisation.

Flow measurements and machineries:

Flow through pipes and open channels, Orifice and Venturi meters, Pitot Tube, Weirs, Rotameters and other types of meters, Transportation of fluids, Pipe Fittings and valves, Pumps – classification, centrifugal and positive displacement type - peristaltic. Blowers and Compressors (oil-free).

Heat transfer:

Classification of heat flow processes, conduction, Thermal conductivity. Heat flow in fluids by conduction and convection. Countercurrent and parallel flow. Enthalpy balance in heat exchange equipment. Individual heat transfer coefficients, overall coefficient, Heating and cooling of fluids, Heat transfer equipm ent. Unsteady state heat transfer, Radiation

Partial differential equations and its applications:

Introduction, linear and nonlinear equation of first order; examples; homogeneous linear equations with constant coefficients; nonlinear equation of second order, Separation of variables, formulation and solution of wave equation; one dimensional heat flow equation and solution; two dimensional heat flow equation and solution.

Mechanical Operations:

Principles of comminution, Types of comminuting equipment, Energy and power requirement, Crushers, Grinders, Mixing and Agitations, Power consumption in mixing, Mechanical separation, Screening, Types of screen, Filtration, Principle, Constant pressure and constant rate filtration, Settling classifiers, Floatation, Centrifugal Separations.

Textbook:

1. Unit Operations of Chemical Engineering: McCabe, Smith & Harriot, TMH, 5th edition

Reference books :

1. Geankopolis, Transport Processes & Unit operations: 3rd edition, PHI.
2. Coulson & Richardson, Chemical Engineering, Vol-I & II:, Butterworth Heinemann
3. D.Q. Kern, Heat Transfer, MGH
4. Badger, W.L., Banchero, J.T., Introduction to Chemical Engineering, MGH
5. Foust, A.S., Wenzel, L.A, et.al. Principles of Unit Operations, 2nd edition, JWS
6. Perry, Chilton & Green, Chemical Engineers' Handbook, MGH
7. E. Kreyszig, Advanced Engineering Mathematics, 5th Edn, Wily.
8. B. S. Grewal, Higher Engineering Mathematics, 1997
9. Gupta and Kapoor, Fundamental Concepts of Mathematical Statistics, S.Chand.
10. N.G.Das, Statistical Methods, M.Das & Co.
11. Sneddon, Elements of partial Differential Equation, MGH,1985

BT405: BIOCHEMICAL ENGINEERING

Kinetics of Microbial Growth and Product formation:
Growth curve in batch cultures. Simple unstructured Kinetic models for microbial growth, Monad model. Growth of filamentous organisms. Growth associated (primary) and non-growth associated (secondary) product formation kinetics. Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Introduction to structured models for growth and product formation.

Metabolic Stoichiometry and Energetics:
Stoichiometry of cell growth and product formation, elemental balances, Degrees of reduction of substrate and biomass, available electron balances, Yield coefficients of biomass and product formation, Maintenance coefficients. Kinetic Models for growth, substrate utilization and product formation; Oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

Fermentation Process:
Batch, Fed-batch,- semi-continuous and continuous Fermentation. Fermentation systems, dual and multiple fermentations. Comparison between batch and continuous fermentations.
Steady state, unsteady state continuous fermentation theories, examples of continuous fermentation. Practical problems with continuous operations.

Bioreactors:
Definitions, Classification of bioreactors, Types of reactors – batch, plug low reactor (PFR), continuous stirred rank reactors (CSTR), fluidized bed reactor bubble column, air lift fermenter etc. Description of a conventional bioreactor with all aspects. Design and construction criteria of a bioreactor. Alternate bioreactor configurations. Residence time disruptions, concentration, and temperature distributions. Models of non-ideal reactors. Imperfect mixing.

Aeration and Agitation in Fermentations:
Oxygen requirements of industrial fermentations. The balance between oxygen supply and demand. Determination of oxygen transfer rates, K_La values. Factors affecting K_La values in fermentation vessels. Mass transfer theories, bubble aeration and mechanical agitation. Correlations between mass transfer coefficients and operating variables. Other factors affecting the mass transfer coefficients.

Sterilization:
Sterilization methods, thermal death kinetics, design criterion, batch and continuous sterilization, and air sterilization

Multiphase Bioreactors:
Different types of reactors: Cell lift reactor, Multi purpose tower reactor, Liquid impelled loop reactor, Pumped tower loop reactor, Fluidized – bed reactor, Packed bed reactor, Bubble column reactors, Airlift reactors.

Animal and plant cell reactor technology:
Environmental requirements for animal cell cultivation, reactors for large-scale production using animal cells, plant cell cultivation.

References:

- Fundamentals of Biochemical Engineering Bailey & Ollis, McGraw Hill (2nd Ed.,)1986.
- Biochemical Engineering-F.C. Webb
- Chemical Engineering Vol-3 Coulson & Richardson
- Biotechnology and Biochemical Eng.- Atkinson & Mautiva
- Chemical Reaction Engineering-Octave Levenspiel
- Bioreaction Engineering-Kari Schugeri.

BT406: THERMODYNAMICS OF BIOLOGICAL SYSYTEM

Basic Concepts of Thermodynamics:

The Ideal Gas, Review of first and second laws of thermodynamics, PVT behaviour of Pure Substances, Virial Equation of State, , Application of the Virial Equations, Cubic Equations of State, Generalized Correlations for Gases and Liquids. The Nature of Equilibrium, the Phase Rule, Duhem's Theorem, Simple model's for Vapour/Liquid Equilibrium, Roult's Law, Henry's law, Modified Raoult's Law, Vapour Liquid Equilibrium

Thermodynamics and its Applications: The Chemical Potential and Phase Equilibria Fugacity and Fugacity Coefficient: for pure species and solution; Generalised correlations for Fugacity, the Ideal Solution, Property Changes and Heat Effects of Mixing Processes. The Vapour-Compression Cycle, the Choice of Refrigerant, Absorption, Refrigeration and liquefaction: Low temperature cycle: Linde and Claude.

Chemical Reaction Equilibria:
Equilibrium criteria for homogeneous chemical reactions, Evaluation of equilibrium constant and effect of pressure and temperature on equilibrium constant; Calculation of equilibrium conversions and yields for single and multiple chemical reactions.

Phase Equilibria:
Ideal and Non-ideal behaviour of systems in phase equilibrium, vapour-liquid and liquid-liquid equilibria, Prediction of equilibrium compositions from equations of state.

Biochemical Thermodynamics:
Bioenergetics, Energetics of Metabolic Pathways; Energy Coupling (ATP & NADH), Stoichiometry and energetic analysis of Cell Growth and Product Formation - elemental Balances, Degree of reduction concepts, available-electron balances, Yield coefficients, Oxygen consumption and heat evolution in aerobic cultures, Thermodynamic efficiency of growth, Thermodynamics of oxidation-reduction reactions, Energetics of Protein folding, enzyme -ligand binding.

Textbook:

1. Smith & Vanness, Thermodynamics for Chemical Engineers, MGH

Reference books:

1. Richardson, J.F., Peacock, D.G.Coulson & Richardson's Chemical Engineering- Volume 3 ed., First Indian ed. Asian Books Pvt. Ltd. 1998
2. Levenspiel.O., Chemical Reaction Engineering, Wiley Eastern Ltd.
3. Bailey & Olis,Biochemical Engg. Fudamentals, MGH, 1990
4. Physical Chemistry: Castellan, Narosa Publishing.
5. Physical Chemistry, ;Moore, PHI

ANNEXURE -4

Classification for Ph.D. students

The Ph.D. students of the Institute shall be classified as follows:

1. Full-time research students:

i. Institute research scholar (stipendiary)
ii. Sponsored candidates
iii. Self financed (Indian/Foreign/ Study Leave) candidates
iv. Indian Council for Cultural Relations (ICCR) and other agencies Awardees (Foreign Nationals).

2. Part –time research students:

i. Faculty/Staff and Project staff of MNNIT, Allahabad
ii. Sponsored candidates
iii. Self financed candidates
iv. Candidates registered under collaborative research programme between MNNIT and other University, R & D organisation in India or abroad.

1. Full-time research students:

i. Institute research scholar (stipendiary):

These full-time students will be eligible for the financial assistance in the form of the teaching or research assistantships (referred to as Institute Assistantships). Assistantships shall be awarded to Ph.D. students on a semester-to-semester basis for a period of up to six semesters, which is further extendable by two semesters at a time on the recommendation of DPGC and SPGC. This extension may be effected for a maximum of two times. Such a student is expected to devote at least eight hours per week towards job(s) assigned to him by the department, which may include class work, evaluation of students or any other job as assigned by the Department/Institute. The renewal of assistantship is dependent on the student's academic performance and his discharge of duties as assigned to him by the department being satisfactory.

A student on teaching/research assistantship is also reimbursed a contingency expense as per the approved terms and procedures to be notified from time to time by the Institute. The reimbursement is done twice annually during the period of assistantship.

ii. Sponsored candidates:

These full time students including QIP candidates usually receives financial support from Govt. /Semi Govt. schemes/Organisations such as CSIR, AICTE, UGC, DAE, DST, DBT, NBHM, etc. and recognized R&D organization for doing research work in the Institute. Candidates in service are to be released from the organisation for full time research work at the Institute and must furnish a sponsorship certificate from the employer. They shall not receive any financial support from the institute.

iii. **Self financed (Indian/Foreign/Study Leave) candidates:**

a. **Indian:** These students are admitted along with the regular research students through the usual admission procedure. They may not get financial support in any form from the Institute. These candidates shall be available full time in the Institute and may be using the facilities in the department as and when allowed.

b. **Foreign:** These students are admitted through Embassy of the respective governments after getting approval from the Ministry of External Affairs, from the Ministry of Home Affairs and approval of the Ministry of Human Resource and Development, Government of India.

c. **Study Leave:** This category refers to the students who are not sponsored but released from Governmental or educational Institutions on study leave or extraordinary leave for a period not less than the minimum specified period for doing research work at the Institute. However, a No Objection Certificate from employer should be produced at the time of joining.

iv. **Indian Council for Cultural Relations (ICCR) and other agencies Awardees (Foreign Nationals):** These students are sponsored by their Governments and awarded scholarship by Govt. of India, ICCR and other such agencies/organisation. They should apply for admission through Indian Embassy in their country.

2. Part-time research student:

i. **Institute Faculty/Staff and project staff of MNNIT.**

This category refers to the students who are permanent employees of the Institute and are admitted to the Ph.D. programme.

Project Staff are those candidates who are working on the various projects undertaken by the Institute and are admitted to the Ph.D. Programme.

ii. **Sponsored candidates**

a. Any candidate admitted under this category will be at par with Full-time Sponsored candidates for the payment of fees.

b. These candidates must fulfill one semester of residential requirement at the Institute. These candidates will have one supervisor from the Institute (Internal) and the other from their parent organization (External). While the requirement of Institute supervisor is a must, the external supervisor is optional depending on the availability.

Those candidates who are from such organisations/institutes where adequate laboratory facilities are not available (as assessed by the supervisor at MNNIT Allahabad), are required to spend a minimum of 60 days at MNNIT Allahabad, for completing research/laboratory work during the entire programme. These 60 days are additional than the residential requirement of one semester.

iii. Self-Financed candidates

Candidates admitted under this category will be at par with Full-time Self-Financed candidate for the payment of fees. However, for foreign candidates except the change in the tuition fee other components of the fee structure will be applicable. The candidates of this category will be governed by the **Clause 2. ii. (b) for Sponsored candidates**.

iv. Candidates registered under collaborative research programme between MNNIT and other University, R & D organisation in India or abroad.

Candidates working in approved Indian/ Foreign educational institutes or recognised R&D organisations, which are equipped with the necessary research and library facilities, may be considered for admission to the Ph.D. programme in engineering and management. The educational institutes located in India must be approved by AICTE. The students of this category will be governed by the **Clause 2. ii. (b) for Sponsored candidates.**

New Grading System for UG/PG programmes

Grades, Semester and Cumulative Performance Index

Grade and Grade Points- At the end of the semester/summer term, a student is awarded a letter grade in each course he/she is registered for, indicating his/her overall performance in that course. There are nine letter grades. The correspondence between grades and points (on a 10-point scale)/rating is given below:

Grade	Suggested Grade Point of UG/PG Courses	Grade Point (Presently operative)	Description
A^+	10	10	Outstanding
A	9	-	Excellent
B^+	8	8	Very Good
B	7	-	Good
C^+	6	6	Average
C	5	-	Below Average
D	4	4	Marginal
E	2	2	Poor
F	0	0	Very Poor

In addition, there are three letter grades, viz., **I, S** and **X,** which stand for **Incomplete, Satisfactory** and **Unsatisfactory,** respectively.

ANNEXURE-6

Rules for Issuance of Duplicate Degree

In case of loss of original degree by the student, the student will make an application to the Chairman, Senate, MNNIT, Allahabad for the issuance of Duplicate Degree along with following documents:

(1) Receipt of Rs. 500/- deposited in Account Section as fee for duplicate degree.
(2) Copy of FIR made in a police station that the degree of the student concerned is lost.
(3) An affidavit on a non-judicial stamp paper of Rs.10.00 in court of law.
(4) Copy of notification made in newspaper of repute that the degree of student is lost mentioning the city where the degree has been lost.

After receiving the application along with the above-mentioned documents the office of the Dean (Academic Affairs) will process the application and Duplicate Degree will be issued to the student. The Duplicate degree will bear an indication **'DUPLICATE'** on the top of the degree just below the name of the institute and will be issued under signature of the Chairman, Board of Governors and the Chairman, Senate, MNNIT, Allahabad.