UNIVERSITY OF KERALA

B.TECH. DEGREE COURSE

2008 SCHEME

CHEMICAL ENGINEERING

I to VIII SEMESTERS:
REGULATION, SCHEME AND SYLLABUS

UNIVERSITY OF KERALA

B. Tech. Degree Course – 2008 Scheme

REGULATIONS

1. Conditions for Admission

Candidates for admission to the B.Tech degree course shall be required to have passed the Higher Secondary Examination, Kerala or 12th Standard V.H.S.E., C.B.S.E., I.S.C. or any examination accepted by the university as equivalent thereto obtaining not less than 50% in Mathematics and 50% in Mathematics, Physics and Chemistry/ Bio- technology/ Computer Science/ Biology put together, or a diploma in Engineering awarded by the Board of Technical Education, Kerala or an examination recognized as equivalent thereto after undergoing an institutional course of at least three years securing a minimum of 50 % marks in the final diploma examination subject to the usual concessions allowed for backward classes and other communities as specified from time to time.

2. Duration of the course

i) The course for the B.Tech Degree shall extend over a period of four academic years comprising of eight semesters. The first and second semester shall be combined and each semester from third semester onwards shall cover the groups of subjects as given in the curriculum and scheme of examination
ii) Each semester shall ordinarily comprise of not less than 400 working periods each of 60 minutes duration
iii) A candidate who could not complete the programme and pass all examinations within Ten (10) years since his first admission to the B.Tech programme will not be allowed to continue and he has to quit the Programme. However he can be readmitted to the first year of the programme if he/she satisfies the eligibility norms applicable to the regular candidates prevailing at the time of readmission.

3. Eligibility for the Degree

Candidates for admission to the degree of bachelor of technology shall be required to have undergone the prescribed course of study in an institution maintained by or affiliated to the University of Kerala for a period of not less than four academic years and to have passed all the examinations specified in the scheme of study

4. Subjects of Study

The subjects of study shall be in accordance with the scheme and syllabi prescribed

5. Evaluation

Candidates in each semester will be evaluated both by continuous assessment and end semester University examination. The individual maximum marks allotted for continuous assessment and University examination for each subject is as prescribed by the scheme of study.

5.1 Continuous Assessment (C.A)

The marks awarded for the continuous assessment will be on the basis of the day-to-day work, periodic tests (minimum two in a semester) and assignments (minimum of three – one each from each module). The faculty member concerned will do the continuous assessment for each semester. The C.A. marks for the individual subjects shall be computed by giving weight age to the following parameters.

Subject	**Attendance**	**Tests**	**Assignments/ Class Work**
Theory Subjects	20%	50%	30%
Drawing	20%	40%	40%
Practical	20%	40%	40%
Project Work	Work Assessed by Guide – 50% Assessed by a three member committee out of which one member is the guide – 50%		

The C.A. marks for the attendance (20%) for each theory, practical and drawing shall be awarded in full only if the candidate has secured 90% attendance or above in the subject. Proportionate reduction shall be made in the case of subjects in which he/she gets below 90% of the attendance for a subject. The CA marks obtained by the student for all subjects in a semester is to be published at least 5 days before the commencement of the University examinations. Anomalies if any may be scrutinized by the department committee and the final CA marks are forwarded to the university within the stipulated time.

5.2. End Semester University Examinations

i) There will be University examinations at the end of the first academic year and at the end of every semester from third semester onwards in subjects as prescribed under the respective scheme of examinations. Semester classes shall be completed at least 10 working days before the commencement of the University examination.

ii) The examination will be held twice in an year – April/May session (for even semester) and October/November session (for odd semester). The combined 1st and 2nd semester is reckoned as equivalent to an even semester for the purpose of conduct of examination and the University examination will be held during April/May. However VII and VIII Semester examination will be conducted in both the sessions. This schedule will not be changed

iii) A student will be permitted to appear for the university examination only if he/she satisfies the following requirements

a. He/she must secure not less than 75% attendance in the total number of working periods during the first year and in each semester thereafter and shall be physically present for a minimum of 60% of the total working periods. In addition, he/she also shall be physically present in at least 50% of total working periods for each subject
b. He must earn a progress certificate from the head of the institution of having satisfactorily completed the course of study in the semester as prescribed by these regulations
c. It shall be open to the Vice-Chancellor to grant condonation of shortage of attendance on the recommendation of the head of the institution in accordance with the following norms
d. The attendance shall not be less than 60% of the total working periods
e. He/she shall be physically present for a minimum of 50% of the total working periods
f. The shortage shall not be condoned more than twice during the entire course
g. The condonation shall be granted subject to the rules and procedures prescribed by the university from time to time.
h. The condonation for combined 1st and 2nd semesters will be reckoned as a single condonation for attendance purposes.

iv) A student who is not permitted to appear for the University examinations for a particular semester due to the shortage of attendance and not permitted by the authorities for condonation of shortage of attendance shall repeat the semester when it is offered again. This provision is allowed only once for a semester.

v) The university will conduct examinations for all subjects (Theory, Drawing & Practical)

vi) The scheme of valuation will be decided by the chief examiner for theory / drawing subjects

vii) For practical examinations, the examiners together will decide the marks to be awarded. The student shall produce the certified record of the work done in the laboratory during the examination. The evaluation of the candidate should be as per the guidelines given in the syllabus for the practical subject.

6. Letter Grades

For each subject in a semester, based on the total marks obtained by the student in the University examination and Continuous assessment put together a letter grade (S,A+, A, B+, B, C+, C, D, E and F) will be awarded. ***All letter grades except 'F' will be awarded if the marks for the University examination is 40 % or above and the total mark (C.A marks + University Exam mark) is 50 % or above***. No absolute mark will be indicated in the grade card. Letter grade corresponding to total marks (C.A marks+ University Exam mark) and the corresponding grade point in a ten-point scale is described below.

% of Total marks ***(C.A marks + University Exam mark)***	**Letter Grade**	**Grade Point (G.P)**	**Remarks**
90 % and above	S	10	Excellent
85 % and above but less than 90%	A+	9	
80 % and above but less than 85%	A	8.5	
75 % and above but less than 80%	B+	8	
70 % and above but less than 75%	B	7.5	
65 % and above but less than 70%	C+	7	
60 % and above but less than 65%	C	6.5	
55 % and above but less than 60%	D	6	
50 % and above but less than 55%	E	5.5	
Below 50% (C.A + U.E) or below 40 % for U.E only	F	0	Failed

7. Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA)

Grade point average is the semester wise average points obtained by each student in a 10-point scale. GPA for a particular semester is calculated as per the calculation shown below.

$$\boldsymbol{GPA = \frac{\sum Credit \times \text{GP obtained for the subject}}{\sum \text{credit for subject}}}$$

Cumulative Grade point Average (CGPA) is the average grade points obtained by the students till the end of any particular semester. CGPA is calculated in a 10-point scale as shown below.

$$\mathbf{CGPA = \frac{\sum Credits\ for\ semester \times GPA\ obtained\ for\ the\ semester}{\sum credits\ for\ the\ semester}}$$

GPA and CGPA shall be rounded to two decimal points. The Grade card issued to the students shall contain subject number and subject name, credits for the subject, letter grades obtained, GPA for the semester and CGPA up to that particular semester. In addition to the grade cards for each semester all successful candidate shall also be issued a consolidated statement grades. On specific request from a candidate and after remitting the prescribed fees the University shall issue detailed mark to the individual candidate.

8. Minimum for a pass

a) A candidate shall be declared to have passed a semester examination in full in the first appearance if he/she secures not less than 5.5 GPA with a minimum of 'E' grade for the all individual subject in that semester.

b) A candidate shall be declared to have passed in an individual subject of a semester examination if he/she secures grade 'E' or above.

c) A candidate who does not secure a full pass in a semester examination as per clause (a) above will have to pass in all the subjects of the semester examination as per clause (b) above before he is declared to have passed in that semester examination in full.

9. Improvement of Grades

i) A candidate shall be allowed to re-appear for a maximum of two subjects of a semester examination in order to improve the marks and hence the grades already obtained subject to the following conditions

a) The candidate shall be permitted to improve the examination only along with next available chance.
b) The candidate shall not be allowed to appear for an improvement examination for the subjects of the VII & VIII semesters
c) The grades obtained by the candidate for each subject in the improvement chance he has appeared for or the already existing grades – whichever is better will be reckoned as the grades secured.
d) First & Second semester will be counted as a single chance and they can improve a maximum of three subjects

ii) A candidate shall be allowed to repeat the course work in one or more semesters in order to better the C.A. marks already obtained, subject to the following conditions
a) He/she shall repeat the course work in a particular semester only once and that too at the earliest opportunity offered to him/her.
b) He/she shall not combine this course work with his/her regular course work
c) He/she shall not be allowed to repeat the course work of any semester if he has already passed that semester examination in full
d) The C.A marks obtained by the repetition of the course work will be considered for all purposes

iii) A candidate shall be allowed to withdraw from the whole examination of a semester in accordance with the rules for cancellation of examination of the University of Kerala.

10. Classification of Successful candidates

i) A candidate who qualifies for the degree passing all the subjects of the eight semesters within five academic years (ten consecutive semesters after the commencement of his/her course of study) and secures not less than 8 CGPA up to and including eighth semester (overall CGPA) shall be declared to have passed the B.Tech degree examination in FIRST CLASS WITH DISTINCTION
ii) A candidate who qualifies for the degree passing all the subjects of the eight semesters within five academic years (ten consecutive semesters after the commencement of his/her course of study) and secures less than 8 CGPA but not less than 6.5 CGPA up to and including eighth semester shall be declared to have passed the B.Tech degree examination in FIRST CLASS.
iii) All other successful candidates shall be declared to have passed the B.Tech Degree examination in SECOND CLASS
iv) Successful candidates who complete the examination in four academic years (Eight consecutive semesters after the commencement of the course of study shall be ranked

branch-wise on the basis of the CGPA in all eight semesters put together. In the case of a tie in the CGPA the total marks of the students who have got same CGPA shall be considered for finalizing the rank. Students who pass the examination in supplementary examination are also covered under this clause

11. Educational Tour

a) The students may undertake one educational tour preferably after fourth semester of the course and submit a tour report
b) The tour may be conducted during the vacation / holidays taking not more than 5 working days, combined with the vacation / holidays if required. Total number of Tour days shall not exceed 15 days.
c) The tour period shall be considered as part of the working periods of a semester

12. Revision of Regulations

The university may from time to time revise, amend or change the regulations, curriculum, scheme of examinations and syllabi. These changes unless specified otherwise, will have effect from the beginning of the academic year / semester following the notification of the University

UNIVERSITY OF KERALA
CHEMICAL ENGINEERING
SCHEME OF STUDIES AND EXAMINATION FOR B.TECH DEGREE
I to VIII SEMESTERS 2008 SCHEME

Combined I & II SEMESTERS (Common for all branches)

Course No.	Name of Subject	Weekly load, hours			Max. sessional marks	Uni. Exam Dur. (Hrs)	Uni. Exam max marks	Credits
		L	T	D/P				
08.101	Engineering Mathematics	2	1	0	50	3	100	6
08.102	Engineering Physics	2	1	0	50	3	100	6
08.103	Engineering Chemistry	2	1	0	50	3	100	6
08.104	Engineering Graphics	1	0	2	50	3	100	6
08.105	Engineering Mechanics	2	1	0	50	3	100	6
08.106	Basic Civil Engineering	2	1	0	50	3	100	6
08.107	Basic Mechanical Engineering	2	1	0	50	3	100	6
08.108	Basic Electrical and Electronics Engineering	2	1	0	50	3	100	6
08.109	Basic Communication and Information Engineering	2	1	0	50	3	100	6
08.110	Engineering Workshops	0	0	2	50	3	100	4
	TOTAL	17	8	4	500		1000	58

The subject 08.109 will be handled by the Department of Electronics and Communication Engineering,

SEMESTER III

Course No.	Name of Subject	Weekly load, hours			Max. sessional marks	Uni. Exam Dur. (Hrs)	Uni. Exam max marks	Credits
		L	T	D/P				
08.301	Engineering Mathematics II (CMPUNERFHBTA)	3	1	0	50	3	100	4
08.302	Physical & Analytical Chemistry (H)	3	1	0	50	3	100	4
08.303	Process Calculations(H)	3	1	0	50	3	100	4
08.304	Machine Drawing (H)	0	0	3	50	3	100	3
08.305	Computer Programming in C++(H)	2	2	0	50	3	100	4
08.306	Particle Technology (H)	3	1	0	50	3	100	4
08.307	Chemistry Lab I (H)	0	0	3	50	4	100	3
08.308	Chemical & Instrumental Analysis Lab(H)	0	0	3	50	4	100	3
	TOTAL	14	6	9	400	26	800	29

SEMESTER IV

Course No.	Name of Subject	Weekly load, hours			Max. sessional marks	Uni. Exam Dur. (Hrs)	Uni. Exam max marks	Credits
		L	T	D/P				
08.401	Engineering Mathematics III (CMPUNERFHB)	3	1	0	50	3	100	4
08.402	Humanities (CTAFRHB)	2	1	0	50	3	100	3
08.403	Organic Chemistry(H)	3	1	0	50	3	100	4
08.404	Fluid Flow Operations I(H)	3	1	0	50	3	100	4
08.405	Electrical Technology(H)	3	1	0	50	3	100	4
08.406	Heat Transfer Operations I(H)	3	1	0	50	3	100	4
08.407	Chemistry Lab II(H)	0	0	3	50	4	100	3
08.408	Electrical Lab(H)	0	0	3	50	4	100	3
	TOTAL	17	6	6	400	26	800	29

SEMESTER V

Course No.	Name of Subject	Weekly load, hours			Max. sessional marks	Uni. Exam Dur. (Hrs)	Uni. Exam max marks	Credits
		L	T	D/P				
08.501	Engineering Mathematics IV (E,R,H,B,F)	3	1	0	50	3	100	4
08.502	Fluid Flow Operations II(H)	2	1	0	50	3	100	4
08.503	Heat Transfer Operations II(H)	3	1	0	50	3	100	4
08.504	Industrial Management(H)	2	1	0	50	3	100	3
08.505	Mass Transfer Operations I(H)	3	1	0	50	3	100	4
08.506	Chemical Engineering Thermodynamics(H)	3	1	0	50	3	100	4
08.507	Particle Technology and Mineral Processing Lab(H)	0	0	3	50	4	100	3
08.508	Fluid Mechanics Lab(H)	0	0	3	50	3	100	3
	TOTAL	17	6	6	400	25	800	29

SEMESTER VI

Course No.	Name of Subject	Weekly load, hours			Max. sessional marks	Uni. Exam Dur. (Hrs)	Uni. Exam max marks	Credits
		L	T	D/P				
08.601	Mass Transfer Operations II(H)	3	1	0	50	3	100	4
08.602	Chemical Reaction Engineering I(H)	3	1	0	50	3	100	4
08.603	Chemical Technology I(H)	3	1	0	50	3	100	4
08.604	Process Dynamics and Control (H)	3	1	0	50	3	100	4
08.605	Numerical Methods for Process Engineers (B,H)	2	2	0	50	3	100	4
08.606	Elective I (Separate list provided)	2	1	0	50	3	100	3
08.607	Mass Transfer Operations Lab (H)	0	0	3	50	4	100	3
08.608	Heat Transfer Operations Lab(H)	0	0	3	50	4	100	3
	TOTAL	16	7	6	400	26	800	29

SEMESTER VII

Course No.	Name of Subject	Weekly load, hours			Max. sessional marks	Uni. Exam Dur. (Hrs)	Uni. Exam max marks	Credits
		L	T	D/P				
08.701	Chemical Engineering Design I(H)	3	2	0	50	4	100	5
08.702	Chemical Technology II (H)	3	1	0	50	3	100	4
08.703	Chemical Reaction Engineering II(H)	3	1	0	50	3	100	4
08.704	Elective II(Separate list provided)	3	1	0	50	3	100	4
08.705	Elective III(Separate list provided)	3	1	0	50	3	100	4
08.706	Mini Project, Seminar & Industrial Training	0	0	2	150	0	0	2
08.707	Software Lab (H)	0	0	3	50	3	100	3
08.708	Reaction Engineering and Process Control Lab (H)	0	0	3	50	4	100	3
	TOTAL	15	6	8	500	23	700	29

SEMESTER VIII

Course No.	Name of Subject	Weekly load, hours			Max. sessional marks	Uni. Exam Dur. (Hrs)	Uni. Exam max marks	Credits
		L	T	D/P				
08.801	Transport Phenomena (H)	3	2	0	50	3	100	5
08.802	Chemical Engineering Design II(H)	2	2	0	50	4	100	4
08.803	Environmental Pollution: Control, Design and Modeling (H)	3	1	0	50	3	100	4
08.804	Process Instrumentation (H)	3	1	0	50	3	100	4
08.805	Elective IV(Separate list provided)	2	2	0	50	3	100	4
08.806	Elective V(Separate list provided)	2	2	0	50	3	100	4
08.807	Project and Comprehensive Viva-Voce	0	0	4	100	0	100	4
	TOTAL	15	10	4	400	19	700	29

Elective I - 08.606 (H)

EL1(A) Colloid and Interface Science(H)
EL1(B) Fertilizer Technology(H)
EL1(C) Fuel Cell Technology(H)
EL1(D) Operations Research(H)
EL1(E) Electrochemical Technology(H)
EL1(F) Energy Engineering(H)
EL1(G) Technical English Communication Skills (B,H,E)
EL1(H) Nano-Engineering of materials (H)

Elective II - 08.704 (H)

EL2(A) Biochemical Engineering(H)
EL2(B) Polymer Technology(H)
EL2(C) Process Modelling & Simulation(H)
EL2(D) New Separation Processes(H)
EL2(E) Food Technology & Engineering(H)
EL2(F) Production of Particulate System(H)
EL2(G) Process Plant Safety and Hazard Assessment(H)

Elective III - 08.705 (H)

EL3(A) Bioprocess Engineering(H)
EL3(B) Computational Fluid Dynamics(H)
EL3(C) Process Optimization (H)
EL3(D) Water And Waste Water Engineering(H)
EL3(E) Petroleum Refinery Engineering(H)
EL3(F) Rubber Technology (H)
EL3(G) Total Quality Management (H)

Elective IV - 08.805 (H)

EL4(A) Drugs and Pharmaceutical Technology(H)
EL4(B) Entrepreneurship Development(H)
EL4(C) Surface Coatings(H)
EL4(D) Engineering of catalysts and catalytic processes(H)
EL4(E) Material Science(H)
EL4(F) Process Utilities and Pipeline Design(H)
EL4(G) Advanced Process Control(H)
EL4(H) Economics and Management for Process Engineers(H)

Elective V - 08.806 (H)

EL5(A) Bioinformatics(H)
EL5(B) Corrosion Engineering(H)
EL5(C) Solid Waste Management and Engineering(H)
EL5(D) Composite Technology(H)
EL5(E) Project Engineering(H)
EL5(F) Mathematical Methods in Chemical Engineering(H)
EL5(G) Process Engineering Principles in Electronic and Ceramic material fabrication(H)

08. 101 ENGINEERING MATHEMATICS I
Credits: 6 L/T/P:2/1/0

MODULE- 1

Applications of differentiation: – Definition of Hyperbolic functions and their derivatives- Successive differentiation- Leibnitz' Theorem (without proof)- Curvature- Radius of curvature- centre of curvature- Evolute (Cartesian ,polar and parametric forms)
Partial differentiation and applications:- Partial derivatives- Euler's theorem on homogeneous functions- Total derivatives- Jacobians- Errors and approximations- Taylor's series (one and two variables) - Maxima and minima of functions of two variables - Lagrange's method- Leibnitz rule on differentiation under integral sign.
Vector differentiation and applications :- Scalar and vector functions- differentiation of vector functions-Velocity and acceleration- Scalar and vector fields- Operator ∇ - Gradient- Physical interpretation of gradient- Directional derivative- Divergence- Curl- Identities involving ∇ (no proof) - Irrotational and solenoidal fields – Scalar potential.

MODULE-II

Laplace transforms:- Transforms of elementary functions - shifting property- Inverse transforms- Transforms of derivatives and integrals- Transform functions multiplied by t and divided by t - Convolution theorem(without proof)-Transforms of unit step function, unit impulse function and periodic functions-second shifting theorem- Solution of ordinary differential equations with constant coefficients using Laplace transforms.
Differential Equations and Applications:- Linear differential equations with constant coefficients- Method of variation of parameters - Cauchy and Legendre equations – Simultaneous linear equations with constant coefficients- Application to orthogonal trajectories (Cartesian form only).

MODULE-III

Matrices:-Rank of a matrix- Elementary transformations- Equivalent matrices- Inverse of a matrix by gauss-Jordan method- Echelon form and normal form- Linear dependence and independence of vectors- Consistency- Solution of a system linear equations-Non homogeneous and homogeneous equations- Eigen values and Eigen vectors – Properties of Eigen values and Eigen vectors- Cayley Hamilton theorem(no proof)- Diagonalisation- Quadratic forms- Reduction to canonical forms-Nature of quadratic forms-Definiteness, rank, signature and index.

REFERENCES

1. **Kreyszig,** *Advanced Engineering Mathematics*, 8th edition, Wiley Eastern.
2. **Peter O' Neil** , *Advanced Engineering Mathematics,* Thomson
3. **B.S.Grewal**, *Higher Engineering Mathematics,* Khanna Publishers
4. **B.V.Ramana,** *Higher Engineering Mathematics,* Tata Mc Graw Hill, 2006
5. **Michel D Greenberg,** *Advanced Engineering Mathematics,*,Pearson International
6. **Sureshan J, Nazarudeen and Royson**, *Engineering Mathematics I*, Zenith Publications

08.102 ENGINEERING PHYSICS
Credits: 6 L/T/P:2/1/0

MODULE-I

Oscillations and Waves

Basic ideas of harmonic oscillations – Differential equation of a SHM and its solution. Theory of damped harmonic oscillations. Quality factor. Theory of forced harmonic oscillations and resonance. Types of waves. One dimensional waves – Differential Equation. Harmonic waves. Three dimensional waves - Differential Equation and solution. Plane waves and spherical waves. Energy in wave motion. Velocity of transverse waves along a stretched string.

Electromagnetic Theory

Del operator – grad, div, curl and their physical significance. Concept of displacement current. Deduction of Maxwell's equations. Prediction of electromagnetic waves. Transverse nature of electromagnetic waves. **E** and **H** are at right angles. Poynting's theorem (qualitative only)

Physics of Solids

Space lattice. Unit cell and lattice parameters. Crystal systems. Co-ordination number and packing factor with reference to simple cubic, body centered cubic and face centered cubic crystals. Directions and planes. Miller indices. Interplanar spacing in terms of Miller indices. Super conductivity - Meissner effect. Type-I and Type-II superconductors. BCS theory (qualitative). High temperature superconductors. Applications of superconductors. Introduction to new materials (qualitative) -Metallic glasses, Nano materials, Shape memory alloys, Bio materials.

MODULE- II

Interference of Light

Concept of temporal and spatial coherence. Interference in thin films and wedge shaped films. Newton's rings. Michelson's interferometer. Determination of wave length and thickness. Interference filters. Antireflection coating.

Diffraction of Light

Fresnel and Fraunhofer diffraction. Fraunhofer diffraction at a single slit. Fraunhofer diffraction at a circular aperture (qualitative). Rayleigh's criterion for resolution. Resolving power of telescope and microscope. Plane transmission grating. Resolving power of grating. Grating equation. X-ray diffraction. Bragg's law.

Polarization of Light

Types of polarized light. Double refraction. Nicol Prism. Retardation plates. Theory of plane, circular and elliptically polarized light. Production and analysis of circularly and elliptically polarized light. Polaroids. Induced birefringence. Photo elasticity – isoclinic and isochromatic fringes – photo elastic bench

Special Theory of Relativity

Michelson-Morley experiment. Einstein's postulates. Lorentz transformation equations (no derivation). Simultaneity. Length contraction. Time dilation. Velocity addition. Relativistic mass. Mass energy relation. Mass less particle.

MODULE – III

Quantum Mechanics

Dual nature of matter. Wave function. Uncertainty principle. Energy and momentum operators. Eigen values and functions. Expectation values. Time Dependent and Time Independent Schrodinger equations. Particle in one dimensional box. Tunnelling (qualitative).

Statistical Mechanics

Macrostates and Microstates. Phase space. Basic postulates of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Distribution equations in the three cases (no derivation). Bosons and Fermions. Density of states. Derivation of Planck's formula. Free electrons in a metal as a Fermi gas. Fermi energy.

Laser

Einstein's coefficients. Population inversion and stimulated emission. Optical resonant cavity. Ruby Laser, Helium-Neon Laser, Carbon dioxide Laser (qualitative). Semiconductor Laser (qualitative). Holography. Fiber Optics - Numerical Aperture and acceptance angle. Types of optical fibers. Applications.

REFERENCES

1. **Sears and Zemansky,** *University Physics, XI Edn, Pearson*
2. **Frank and Leno,** *Introduction to Optics, III Edn., Pearson*
3. **J.C. Upadhyaya,** *Mechanics., Ram Prasad and Sons*
4. **David J Griffiths,** *Introduction to Electrodynamics, III Edn , Pearson*
5. **M Ali Omar,** *Elementary Solid State Physics, Pearson*
6. **S O Pillai,** *Solid State Physics., New Age International Publishers*
7. **John R Taylor, Chris D Zafiratos & Michael A Dubson,** *Modern Physics for Scientists and Engineers. II Edn, Prentice Hall of India*
8. **Eugene Hecht,** *Optics, IV Edn, Pearson*
9. **Robert Resnick,** *Introduction to Special Relativity, John Willey and Sons*
10. **Richard L Libboff,** *Introduction to Quantum Mechanics, IV Edn, Pearson*
11. **Donald A Mcquarrie,** *Statistical Mechanics, Vivo Books*
12. **Mark Ratner and Daniel Ratner,** *Nanotechnology,* Pearson Prentice Hall Prof.
13. **T.A. Hassan et al,** *A Text Book of Engineering Physics*, *Aswathy Publishers, Trivandrum*
14. **B. Premlet,** *Advanced Engineering Physics, Phasor Books, Kollam.*

LIST OF DEMONSTRATION EXPERIMENTS

1. Newton's Rings – Determination of wave length.
2. Air Wedge – Diameter of a thin wire
3. Spectrometer – Plane transmission grating – wavelength of light.
4. Spectrometer – Refractive indices of calcite for the ordinary and extraordinary rays.
5. Laser – Diffraction at a narrow slit.
6. Laser – Diffraction at a straight wire or circular aperture.
7. Michelson's interferometer – Wavelength of light.
8. Michelson's interferometer – Thickness of thin transparent film.
9. Polarization by reflection – Brewster's law.
10. Computer stimulation – superposition of waves.
11. Computer stimulation – study of **E** & **H**. (Gauss' law & Ampere's law)

*University examination is for a maximum of **100 marks**, in **3 hour** duration. The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of* **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.

08.103 ENGINEERING CHEMISTRY
Credits: 06 L/T/P: 2/1/0

MODULE 1

Electrochemistry - Electrodes- Electrode potential- Origin of electrode potential- Helmoltz double layer- Nernst equation and application- Reference electrodes- Standard hydrogen electrode- Saturated calomel electrode- Quinhydron electrode-Determination of PH using these electrodes- Concentration cells- Fuel cells- Secondary cells- Lead acid cell- Nickel cadmium cell- Lithium-ion cell. - Coductometric and Potentiometric titrations (acid base, oxidation reduction and precipitation titrations). **(12 hrs)**

Corrosion and its control- Theories of corrosion (chemical corrosion and electrochemical corrosion) - Galvanic series- Types of corrosion (Concentration cell corrosion, Stress corrosion, galvanic corrosion) - Factors affecting corrosion (nature of metal and nature of environment) and different methods of corrosion control (corrosion inhibitors, cathodic protection). **(5hrs)**

Protective coatings- Metallic coatings- Chemical conversion coatings- paint **(4hrs)**

Nano- materials- Introduction-Classification-preparation (laser abrasion technique and sputtering technique)- Chemical method (reduction)-Properties and Applications of nano-materials-Nano tubes-Nano wires. **(4hrs)**

MODULE-2

Water treatment- Types of hardness- Degree of hardness- Related problems- Estimation of hardness- by EDTA method- Sludge and scales in boilers- Priming and foaming- Boiler corrosion-Water softening methods, Lime-soda process, Ion exchange methods-Internal treatments (colloidal, carbonate, phosphate and calgon conditioning)- Domestic water treatment-Methods of disinfection of water-Desalination process (Reverse osmosis, electro dialysis-Distillation).

(12hrs)

Environmental damages and prevention- Air pollution- CFCs and ozone depletion-Alternative refrigerants-Green house effect-Water pollution- BOD and COD- Waste water treatment- Aerobic - Anaerobic and USAB processes.

(3hrs)

Thermal methods of analysis-Basic principles involved in Thermo-gravimetry, Differential thermal analysis and applications.

(2hrs)

Spectroscopy- Molecular energy levels-Types of molecular spectra- Electronic spectra (Classification of electronic transitions- Beer Lamberts law, Vibrational spectra (mechanism of interaction and application), Rotational spectra (Determination of bond length and application). NMR spectra (Basic principle, chemical shift, spin-spin splitting)

(6hrs)

Chromatography- General principles- High performance liquid chromatography- Gas chromatography. **(2hrs)**

MODULE 3

Polymers- Classifications- Mechanism of polymerization (Addition, free radical, cationic, anionic and coordination polymerization)- Thermoplastics and thermosetting plastics-Compounding of plastics-Moulding techniques of plastics (Compression, Injection, Transfer and Extrusion moulding)-Preparation, properties and uses of PVC, PVA, PMMA, Nylon, PET, Bakelite, Urea formaldehyde resin- Silicon polymers- Biodegradable plastics. Elastomers-structure of natural rubber- vulcanization- synthetic rubbers (Buna-S, Butyl rubber and Neoprene) **(12hrs)**

Organo electronic compounds -Super conducting and conducting organic materials like Polyaniline, polyacetylene and [polypyrrol and its applications.

(2hrs)

Fuels- Calorific value- HCV and LCV-Experimental determination of calorific value-Theoretical calculation of calorific value by Dulongs formula - Bio fuels -Bio hydrogen and Bio-diesel

(5hrs)

Lubricants- Introduction-Mechanism of lubrication- solid and liquid lubricant- Properties of lubricants-Viscosity index- flash and fire point- cloud and pour point- aniline value.

(4hrs)

Cement- Manufacture of Portland cement- Theory of setting and hardening of cement

(2hrs)

LAB-EXPERIMENTS (DEMONSTRATION ONLY)

1. Estimation of total hardness in water using EDTA.
2. Estimation of chloride ions in domestic water.
3. Estimation of dissolved oxygen.
4. Estimation of COD in sewage water.
5. Estimation of available chlorine in bleaching powder.
6. Estimation of copper in brass.
7. Estimation of iron in a sample of hematite.
8. Determination of flash and fire point of a lubricating oil by Pensky Marten's apparatus.
9. Potentiometric titrations.
10. Preparation of buffers and standardisation of PH meter.
11. Determination of molarity of HCl solution PH-metrically.
12. Determinations of PH using glass electrode and quinhydron electrode.

REFERENCES

1. Willard H.A, Merrit L.L and Dean J.A, *Instrumental methods of analysis, CBS*
2. De A.K, *Environmental Chemistry, New Age International*
3. Klauhunde K.J, *Nanoscale materials in chemistry*
4. Gowariker B.R., *Polymer science, Wiley Intescience*
5. Gonser B.W, and Hausner H. H., *Modern materials, Academic Press*
6. Raghavan V, *Material Science and engineering. A first course, Prentice Hall of India*
7. Van Vlack L.H, *Elements of Material science and Engineering*, Dorling Kindersley (India) Pvt Ltd

8. Goodby J.W. *Chemistry of liquid crystals*
9. Glasstone S, *A text book of physical chemistry, Mc Graw Hill*
10. Jain P.C, *Engineering Chemistry,* Dhanpat Raj Publishing Co., India
11. Juhaina Ahad, *Engineering Chemistry*, Jai Publications, Kollam, India
12. Shashi Chawla, *A text book of Engineering Chemistry,* Dhanpat Raj Publishing Co., India
13. Gopalan R, Venkappayya D and S. Nagarajan S, *Engineering Chemistry, Vikas Publishing House Pvt. Ltd,.*
14. Kuriakose J.C and Rajaram J, *Chemistry of Engineering and Technology volume I & II, TMH*
15. Goyal R.N and Harmendra Goeal; *Engineering Chemistry*, Ane Books, Thiruvananthapuram

08.104 ENGINEERING GRAPHICS

Credits: 6 **L/T/D: 1/0/2**

INTRODUCTION: Introduction to technical drawing and its language. Lines, lettering, dimensioning, scaling of figures, symbols and drawing instruments. (1 sheet practice)

MODULE 1

PLAIN CURVES: Conic sections by eccentricity method. Construction of ellipse: (i) Arc of circles method (ii) Rectangle method (ii) Concentric circles method. Construction of parabola (i) Rectangle method (ii) Tangent method. Construction of hyperbola (i) Arc of circles method (ii) given ordinate, abscissa and the transverse axis (iii) given the asymptotes and a point on the curve. Construction of Tangent and Normal at any point on these curves

MISCELLANEOUS CURVES: Construction of Cycloid, Epicycloid and Hypocycloid, Involute of a circle. Archimedian spiral, Logarithmic spiral and Helix. Construction of Tangent and Normal at any point on these curves

PROJECTION OF POINTS AND LINES: Types of projections, Principles of Orthographic projection. Projections of points and lines. Determination of true length, inclination with planes of projection and traces of lines.

MODULE II

PROJECTION OF SOLIDS: Projection of simple solids such as prisms, pyramids, cone, cylinder, tetrahedron, octahedron, sphere and their auxiliary projections.

SECTIONS OF SOLIDS: Types of cutting planes, section of simple solids cut by parallel, perpendicular and inclined cutting planes. Their projections and true shape of cut sections.

DEVELOPMENT OF SURFACES: Development of surfaces of (i) simple solids like prisms, pyramids, cylinder and cone (ii) Cut regular solids.

MODULE III

ISOMETRIC PROJECTION: Isometric scale, Isometric view and projections of simple solids like prisms, pyramids, cylinder, cone sphere, frustum of solids and also their combinations.

INTERSECTION OF SURFACES: Intersection of surfaces of two solids as given below.

(i) Cylinder and cylinder
(ii) Prism and prism.
(iii) Cone and Cylinder

(Only cases where the axes are perpendicular to each other and intersecting with or without offset.)

PERSPECTIVE PROJECTION: Principles of perspective projection, definition of perspective terminology. Perspective
projection of simple solids like prisms and pyramids in simple positions.

CAD: Introduction to CAD systems, Benefits of CAD, Various Soft wares for CAD, Demonstration of any one CAD
software.

General Note:
(i) First angle projection to be followed
(ii) Question paper shall contain 3 questions from each module, except from CAD. Students are required to answer any
two questions from each module.
(iii) Distribution of marks
Module -I 2 x 16 = 32
Module -II 2 x 17 = 34
Module III 2 x 17 = 34

100

REFERENCES

1. Luzadder and Duff, *Fundamentals of Engineering Drawing*, Prentice Hall of India
2. N. D. Bhatt, *Engineering Drawing, Charotar Books*
3. K. Venugopal, *Engineering Drawing and Graphics, New Age International*
4. P.S. Gill; *Engineering Graphics, S.K. Kataria and Sons Publishers*
5. P.I. Varghese, *Engineering Graphics, VIP Publishers, Thrissur*
6. K.R. Gopalakrishnan*; Engineering Drawing* , Subash Publishers
7. Thamaraselvi; *Engineering Drawing*
8. K.C. John; *Engineering Graphics*, PHI
9. K.N. Anil Kumar; *Engineering Graphics,* Adhuth Narayanan Publishers

08.105 ENGINEERING MECHANICS
Credits: 6 L/T/P:2/1/0

MODULE I (20 HRS)

Idealizations of Mechanics- Elements of vector algebra
Statics of rigid bodies-Classification of force systems- principle of transmissibility of a force-composition and resolution- Resultant and Equilibrant of coplanar concurrent force systems-various analytical methods- - Lami's theorem, method of resolution- Conditions of equilibrium-Moment of a force, couple, properties of couple- Varignon's theorem- Resultant and equilibrant of coplanar non-concurrent force systems- Conditions of equilibrium. Equilibrium of rigid bodies-free body diagrams.(simple problems)
Types of supports - types of beams - types of loading- Support reactions of simply supported and overhanging beams under different types of loading.
Forces in space, equations of equilibrium, Vector approach.
Friction-Laws of friction-angle of friction- cone of friction- ladder friction- wedge friction.

MODULE II (20 HRS)

Properties of surfaces- centroid of composite areas- Theorems of Pappus-Gouldinus- Moment of inertia of areas, Parallel and perpendicular axes theorems- Radius of Gyration- moment of inertia of composite areas.
Dynamics: Kinematics-Combined motion of translation and rotation-instantaneous centre, motion of link, motion of connecting rod and piston, wheel rolling without slipping.
Relative velocity - basic concepts-analysis of different types of problems
Kinetics- Newton's laws of translatory motion- D'Alembert's principle- Motion of lift- Motion of connected bodies.

MODULE III (20 HRS)

Work, Power and Energy - Work-Energy principle-Impulse, Momentum.
Collision of elastic bodies-Law of conservation of momentum-Direct and oblique impact between elastic bodies and impact with fixed plane.
Curvilinear motion- D'Alembert's principle in curvilinear motion- Mass moment of inertia of rings, solid discs and solid spheres (no derivations required)Angular momentum-Angular impulse.
Kinetics of rigid bodies under combined translatory and rotational motion – work – energy principle for rigid bodies.
Centrifugal and centripetal forces – motion of vehicles on curved paths in horizontal and vertical planes – super elevation – stability of vehicles moving in curved paths (qualitative ideas only).
Simple harmonic motion – vibration of mechanical systems - basic elements of a vibrating system – spring mass model – undamped free vibrations – angular free vibration – simple pendulum.

REFERENCES:

1. **Beer and Johnston,** *Vector Mechanics for Engineers – Statics and Dynamics*, Tata Mc-Graw Hill Publishing Company Limited, New Delhi, 2005.
2. **Irving. H. Shames,** *Engineering Mechanics*, Prentice Hall Book Company, 1966.
3. **Timoshenko S. and Young D. H.,** *Engineering Mechanics*, Mc-Graw Hill –International Edition
4. **Popov,** *Mechanics of Solids* Pearson Education,2007
5. **Kumar K.L,** *Engineering Mechanics*, Tata Mc-Graw Hill Publishing Company Limited, New Delhi, 1998.
6. **Rajasekaran S.and Sankarasubramanian G**., *Engineering Mechanics*, Vikas Publishing House Private Limited, New Delhi, 2003.
7. **Tayal A K,** *Engineering Mechanics- Statics and Dynamics*, Umesh Publications, Delhi,2004
8. **Benjamin J,** *Engineering Mechanics,* Pentex Book Publishers and Distributors, Kollam, 2008

Note

Question For University Examination:- Part A – 8 compulsory questions covering entire syllabus, 5 marks each. (5 x 8 = 40) Part B – Three questions of 10 marks from each module, out of which two should be answered (10 x 2 x 3 = 60).

08.106 BASIC CIVIL ENGINEERING

Credits: 6 L/T/P:2/1/0

MODULE I

Surveying: Object and Principles of Surveying.
Linear Measurements: Direct measurements - Tape & chain only - Ranging out survey lines- Taking measurements of sloping ground - Errors - Tape correction (problems).
Levelling: Levelling instruments - Level (Dumpy Level, Tilting Level) Levelling Staff. Measurements in levelling - Temporary adjustments of a level, holding the staff, reading the staff - Principles of leveling - recording measurements in the field book - reduction of level - height of collimation method only (simple examples).
Contour maps (Brief description only). Computation of areas - Mid ordinate rule, average ordinate rule, Trapezoidal rule, Simpson's rule (examples)- Introduction to Distomat, Total Station & GPS (Brief description only)

MODULE II

Building construction*:* Selection of site for buildings - types of buildings - Components of buildings.
Foundation: Different types - Spread footing, Isolated footing, Combined footing, Mat foundation¸ Pile foundation (description only).
Safe Bearing Capacity of Soil: Importance of determination of the Safe Bearing Capacity of Soil (brief description only).
Super structure: Masonry - stone masonry, brick masonry –Types- desirable qualities of stone and brick.
Partition: Materials used for making partition - plywood, particle boards & glass.
Doors, windows & ventilators : Types - materials used for the construction of doors and windows - wood, steel & Aluminium.
Plastering: Mortar – properties - Preparation of Cement mortar
Painting: Preparation of surfaces for painting - plastered, wood and steel surfaces- Types of paint - enamel, emulsion & distemper. Flooring: Types - mosaic tiles, ceramic tiles, marble, granite and synthetic materials. Roofing: Selection of type of roof -flat roof, sloping roof -Concrete roof, tiled roof. Selection of roof covering materials. GI Sheet , AC Sheet, PVC Sheet

MODULE III

Concrete: Ingredients- cement, aggregate, and water. Qualities of ingredients (brief description only).
Tests on Cement - consistency, initial and final setting times. Compressive strength -IS Specifications.
Aggregates – desirable qualities of fine and coarse aggregates
Plain Cement Concrete (PCC): preparation-proportioning-mixing of concrete.
Steel-common types used in construction- Mild Steel, HYSD Steel and their properties.
Reinforced Cement Concrete (RCC)-advantages of RCC over Plain Cement Concrete.

Elementary ideas on pre-cast and pre-stressed concrete constructions.
Building services – vertical transportation – stairs – types, escalators and elevators, ramps (brief description only). Plumbing services- brief description of water supply and sewage disposal arrangements for residential buildings.

REFERENCES

1. **Adler R.,** *Vertical Transportation for Buildings*, American Elsevier Publishing Company, New York.1970
2. **B.C Punmia**, *Surveying & Leveling, Vol*. – I, Laxmi publications(P) Ltd,N.Delhi, 2004
3. **Rangwala.,** *Building Materials,*Charotar publishing house, 2001
4. **Rangwala,** *Building Construction* , Charotar Publishing House., 2004
5. **S.K. Roy,** *Fundamentals of Surveying* Prentice-Hall of India, New Delhi.2004
6. **Rangwala.,***Water Supply and Sanitary Engineering*, Charotar Publishing House. 1990
7. **Moorthy,** *Building Construction*, Modern Publishing House distributor., 1957
8. **Jha and Sinha,** *Construction and Technology*
9. **Narayanan and Lalu Mangal,** *Introduction to Civil Engineering*, Phasor Books,Kollam.
10. **Santha Minu,** *Basic Civil Engineering*, Karunya Publications,Trivandrum

Note: *The question paper will consists of two parts. Part I and part II..*
Part I is Compulsory covering the entire syllabus, for 40 marks. It contains 8 questions of 5 marks each.
Part II is to cover 3 modules. There will be two questions (20 marks each) from each module out of which one from each module is to be answered. (20 X 3 = 60)

08.107 BASIC MECHANICAL ENGINEERING

Credits: 6 **L/T/P:2/1/0**

MODULE I

Thermodynamics : Basic concepts and definitions of Zeroth law, First law, Second law of thermodynamics- concept of reversibility and entropy. p-v and T-s diagrams
Air cycles: Carnot, Otto and Diesel cycles-Air standard efficiency (simple problems)
IC Engines: Working and comparison of two stroke and four stroke petrol and diesel engines - general description of various systems using block diagrams – air system, fuel system, ignition system and governing system. A brief description of CRDI, MPFI, GDI and Hybrid Vehicles
Steam boilers: Classification – Cochran boiler, Babcock and Wilcox boiler, Benson boiler-fluidized bed combustion.

MODULE II

Principles and fields of application of - compressors - reciprocating and centrifugal, blower, pumps- reciprocating, centrifugal and jet pumps, steam and hydraulic turbines- impulse and reaction, gas turbine cycles- open and closed
Elementary ideas of hydro electric, thermal and nuclear power plants
Refrigeration & Air Conditioning: Refrigerants, CFC free refrigerants. Vapor compression refrigeration system, Comfort and Industrial air conditioning-typical window air conditioning unit (general description only).

MODULE III

Mechanical Power transmission systems: Belt, rope and gear drives-types, comparison and fields of application-velocity ratio-slip (simple problems) friction disc, single plate clutch, gear trains (no derivations).
Manufacturing processes: Elementary ideas of casting, forging, rolling, welding, soldering and brazing
Machining processes- turning, taper turning, thread cutting, shaping, drilling, grinding, milling (simple sketches and short notes).
Non conventional machining - Electro discharge machining (EDM) and Electro chemical machining (ECM)
Principle, application and advantages of C N C machine

REFERENCES

1. **Spalding and Cole,** *Engineering Thermodynamic,* Arnold
2. **Gill, Smith and Zuirys,** *Fundamentals of IC Engine, Oxford*
3. **Amstead, Ostwald and Begeman,** *Manufacturing processes, Wiley*
4. **Crouse**, *Automobile Engineering, Mc Graw Hill*
5. **Roy and Choudhary,** *Elements of Mechanical Engineering*
6. **Hajra Choudhary,** *Workshop Technology*

7. **R K Bensal**, *Fluid mechanics and machines*
8. **J Benjamin**, *Basic Mechanical Engineering, Zenith Publications, Kollam*

Note: Lectures are to be supplemented by demonstration in laboratories.

Note: *The question paper will consist of two parts. Part I is to be compulsory for 40 marks. This may contain 10 questions of 4 marks each. Part II is to cover 3 modules. There can be 3 questions from each module (10 marks each) out of which 2 are to be answered.*

08.108 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

Credits: 6 **L/T/P:2/1/0**

MODULE I

Elementary concepts - Kirchoffs laws - Magnetic Circuits - MMF, field strength, flux density, reluctance – problems in series magnetic circuits. Review of electromagnetic induction - Faradays laws, Lenz's law - statically induced and dynamically induced emf - self and mutual induction - inductance.
Alternating current fundamentals - generation of alternating currents – waveforms - frequency - period - average and rms values - form factor. Phasor representation of alternating quantities - rectangular polar and exponential forms.
Analysis of simple ac circuits – concept of impedance and admittance - phasor representation - *j* notation - power and power factor in ac circuits - active and reactive components. Solution of RL, RC and RLC series circuits.
Three phase systems - generation of three phase voltage - star and delta connection - relation between phase and line values of voltage and current - phasor representation - three wire and four wire systems.
Measurement of power in three phase circuits (two wattmeter method). Measurement of energy – working of 1-phase energy meter.

MODULE II

Transformers - Principle of operation - EMF equation - constructional details of single phase and three phase transformers
Methods of bulk generation of electric power. Block schematic of layout of generating stations - hydroelectric, thermal and nuclear power plants. Renewable energy sources - solar, wind, tidal, wave and geothermal energy.
Bulk transmission of electric power - typical electrical power transmission scheme - need for high transmission voltage - substations - substation equipments. Primary and secondary transmission and distribution systems
Different methods of wiring for LT installations. Schematic layout of LT switchboards. Earthing of installations - necessity of earthing - plate and pipe earthing. Protective fuses, MCBs, ELCBs and switches.
Working of incandescent lamps, -fluorescent lamps, energy efficient lamps

MODULE III

Diodes - PN junction diodes,. V-I characteristics, dynamic & static resistance, principle of working and V-I characteristics of Zener diode, principle of Photo diode, Solar cell, & LED.

Rectifiers & power supplies - block diagram description of a dc power supply, circuit diagram & working of half-wave & full wave rectifier, final equations of Vrms, Vdc, ripple factor and peak inverse voltage in each case, principle of working of series inductor and shunt capacitor filters. Working of simple zener voltage regulator.

Power devices – V – I characteristics and applications of SCR and Triac Working principle of UPS and SMPS
Transducers – Resistance strain guage, thermistor, LVDT

REFERENCES

1. **Mitlle V.N,** *Basic Electrical Engineering*, Tata McGraw Hill, 1990.
2. **Kothari D.P and Nagrath I.J,** *Theory and Problems of Basic Electrical Engineering*, Prentice Hall of India, 2000.
3. **Thereja B.L,** *A Text Book of Electrical Technology*, Volume I, S Chand & Co, New Delhi, 1992.
4. **Francis M Fernandez,** *A Basic Course in Electrical Engineering*, Rajath Publishers, Ernakulam.
5. **Imthias Ahmed T.P, Premlet B,** *Introduction to Electrical Engineering*, Phaser Books, Kollam
6. **Gopakumar**, I*ntroduction To Electronics and Communications*, .Phasor Books, Kollam
7. **Millman and Halkias,** *Integrated Electronics: Analog and digital circuits and systems*, McGraw-Hill Book Co
8. **Edward Hughes,** *Electrical and Electronic Technology*, Pearson Education, 2002.
9. **Soni M.L, Guptha P.U, Bhatnagar U.S and Chakrabarthy A,** *A Text Book on Power System Engineering*, Dhanpath Raj and Sons, New Delhi 1997
10. **Bhargava N.N,** *Basic Electronics and Linear Circuits*, Tata McGraw Hill
11. **Rangan C.S., Sarma G.R., and Mani V.S.V,** *Instrumentation Devices and Systems*, Tata McGraw Hill, 1992.
12. **Muhammad H. Rashid,** *Power Electronic Circuits, Devices and Applications*, Pearson education, Asia 2003.

Note : *The question paper will consist of two parts. Part – A is to be compulsory for 40 marks (10 questions of 4 marks each). Part-B is to cover 3 modules for 60 marks. (50% choice- One out of two or two out of four from each module).*

08.109 BASIC COMMUNICATION AND INFORMATION ENGINEERING
Credits: 6 **L/T/P:2/1/0**

MODULE 1(Qualitative Treatment)

(a) Bipolar junction transistors: NPN & PNP transistors, structure, typical doping, working of NPN transistor, concepts of common base, common emitter and common collector configurations, current gain of each, input & output characteristics of common emitter configuration, comparison of three configurations with reference to voltage & current gain, input & output resistances and applications. (6 hrs)

(b) Field effect Transistors: basic principles of JFET, MESFET and MOSFET, comparison with BJT. (3 hrs)

(c) Amplifiers & Oscillators: circuit diagram & working of common emitter amplifier, function of each component in the circuit, need of proper biasing, frequency response, voltage gain and 3dB bandwidth, concepts of class A, B, AB and Class C power amplifiers, circuit diagram & working of push pull amplifiers, concepts of feedback, working principles of oscillators, circuit diagram & working of RC phase shift oscillator (7 hrs)

(d) Integrated circuits: advantages of ICs, analog and digital ICs, functional block diagram of operational amplifier, ideal operational amplifier,use as inverting amplifier, non inverting amplifier, summing amplifier, integrator and comparator.
(4 hrs)

(e) Digital ICs: logic gates, realization of logic functions, principle of combinational and sequential logic circuits, flip flop (JK), logic families: TTL and CMOS Logic (No internal diagram) (4 hrs)

(f) IC fabrication: purification of silicon, crystal growth, wafer preparation. unit process: oxidation, diffusion, ion implantation, epitaxy, deposition, photolithography.
(4 hrs)

MODULE II (Qualitative Treatment)

(a) Measurements: principle and block diagram of analog and digital multimeter, working principle of CRT, block diagram of CRO, measurements using CRO, principle of digital storage oscilloscope, principle and block diagram of function generator.
(5hrs)

(b) Radio communication: principle of AM & FM, wave forms, bandwidths, block diagrams of AM & FM transmitters, principle of AM &FM demodulation, comparison of AM & FM, principle & block diagram of super heterodyne receiver.
(4 hrs)

(c) Color television: TV Standards, interlaced scanning, block diagram of PAL TV transmitter & receiver, basic principles of cable TV, CCTV system, basic principles of HDTV, basic principles of LCD & Plasma displays. (5 hrs)

(d) Radar and navigation: principle of radar and radar equation, block schematics of pulsed radar, factors affecting range, applications of radar in measurements and navigation. (4 hrs)

(e) Satellite communication: microwave frequency bands, concept of geo-stationary satellite, frequency bands used, satellite transponder, block diagram of earth station transmitter & receiver, advantages of satellite communication, principle of Global Positioning System (GPS). (3 hrs)

(f) Optical communication: block diagram of the optical communication system, principle of light transmission through fiber, concepts of Single Mode and Multi Mode optical fiber, working principle of source (semiconductor Laser) & detector (PIN,APD), advantages of optical communication. (5 hrs)

MODULE 3 (Qualitative Treatment)

(a) Computer Architecture: functional units: basic concept of ALU- data path and control, memory hierarchy, caches, main memory, virtual memory, operating systems, microprocessors - functional block diagram of 8085 (9 hrs)

(b) Data communication: overview, analog and digital data transmission, transmission media, digitization of wave forms,
PCM, digital modulation techniques- ASK, PSK, FSK, basic concepts of error detection , parity checking. (6hrs)

(c) Mobile communication: basic principles of cellular communications, concepts of cells, frequency reuse, principle and block diagram of GSM,principle of CDMA, WLL & GPRS technologies. (4hrs)

(d) Internet Technology: concepts of networking: client - server computing, IP addresses, domain names, network interface unit - modem, switching technologies- circuit switching and packet switching, LAN,MAN,WAN &World wide web, network topologies, communication protocols- TCP/IP, Introduction to web languages-HTML,XML, internetworking concepts, network devices- basic principles of router, bridge, switch, network security- Firewall. (7 hrs)

REFERENCES

1. **Santiram Kal,** *Basic Electronics – Devices, Circuits and IT fundamentals*, PHI
2. **Louis.E.Frenzel,** *Principles of Electronic Communication Systems*, TMH
3. **William Stallings,** *Wireless Communications and Networks*, Pearson Education.
4. **Moris Mano M,** *Computer Architecture*, PHI
5. **Neil H E Weste and Kamran Eshraghian,** *Principles of CMOS VLSI design – A system perspective*, Pearson Education [Module 1(f)]
6. **David A. Bell**, *Electronic Instrumentation and Measurements*, PHI .[Module 2(a)]
7. **Bhargava N.N, Kulshreshtha D.C and Gupta S.C,** *Basic Electronics & Linear Circuits*, TMH
8. ITL Education Solution Ltd., *Introduction to Information Technology*, Pearson Education, 5th edition, 2008

9. **R.R. Gulati,** ***Monochrome*** *and Colour Television*, New Age International [Module 2 (c)]
10. **Gopakumar K,** *Introduction to Electronics & Communication* , 3rd edition, 2008,Phasor Publisher's,Kollam

This subject shall be handled by faculty of Dept. of Electronics and Communication in the Colleges.

Question Paper

The question paper shall consist of two parts. Part I is to cover the entire syllabus, and carries 40 marks. This shall contain 10 compulsory questions of 4 marks each. Part II is to cover 3 modules, and carries 60 marks. There shall be 3 questions from each module (10 marks each) out of which 2 are to be answered.

08.110 ENGINEERING WORKSHOPS

Credits: 4 **L/T/P: 0/0/2**

A.Carpentry:
Study of tools and joints. Practice in planning, chiseling, marking and sawing. Joints – Cross joint, T joint, Dove tail joint.

B. Fitting:
Study of tools, Practice in filing, cutting, drilling and tapping. Male and female joints, Stepped joints.

C. Sheet Metal Work:
Study of tools. Selection of different gauge GI sheets for jobs. Practice on riveted joints. Preparing tube joints, frustums, trays and containers.

D. Plumbing:
Study of tools. Details of plumbing work in domestic and industrial applications. Study of pipe joints, cutting, threading and laying of pipes with different fittings using PVC pipes. Use of special tools in plumbing work.

E: Foundry:
Study of tools. Preparation of sand, moulding practice and demonstration of casting.

F. Welding:
Study of welding machines. Straight line practices, Making of Butt joint, T joint and Lap joint.

G: Smithy:
Study of tools. Demonstration on forging of square prism, hexagonal bolt, T bolt and Eye bolt.

H: Machine Tools:
Study and demonstration on working of machine tools. Lathe and Drilling machine.

NOTE: *For the university examination the student shall be examined in sections A, B, C, D and E only.*

08. 301 ENGINEERING MATHEMATICS II (CMPUNERFHBTA)

Credits:4 **L/T/P:3/1/0**

Module I

Multiple Integrals: Double Integrals (Cartisian only).Change of order of integration. Area enclosed by plane curves.Triple integrals.Volume of solids.

Vector integration: Line and surface and volume integrals. Greens theorem in the plane.Stokes theorem and Gauss divergence theorem (no proof).

Module II

Fourier series: Fourier series of periodic functions of period 2π and $2l$. Dirichlet's condition for convergence. Odd and even functions. Half range expansions.

Fourier Transforms: Fourier integral theorem(no proof)-Fourier transforms- Fourier sine and cosine transforms , inverse Fourier transforms, properties

Module III

Partial differential equations: Formationof PDE. Solution of Lagranges linear equation. First order nonlinear equations-standard forms -Homogeneous PDE with constant coefficients.

Application of PDE: Derivation of one dimensional Wave and Heat equations. solution by seperation of variables. Boundary value problems in one dimensional Wave and Heat equations.

References

1. Kreyszig, Advanced Engineering Mathematics, 8th Wiley Eastern.
2. Peter O Neil, Advanced Engineering Mathematics.
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers.
4. B.V.Ramana, Higher Engineering Mathematics, Tata Mc Graw Hill.
5. Michel D Greenberg, Advanced Engineering Mathematics, Pearson

Examination Duration: 3 hours

Note: The question paper shall consists of two parts. **Part A** (40 marks) Ten compulsory questions of 4 marks each. **Part B** (60 marks) Student must answer one out of two from each module .Each question carries 20 marks.

08.302 PHYSICAL AND ANALYTICAL CHEMISTRY (H)

Credits:4 **L/T/P:3/1/0**

Module-I

Gaseous state: Kinetic theory of gases-Vander Waals equation-Critical constants- Liquifaction of gases.

Solutions: Raoults law- Ideal solutions-Partially miscible liquids- Phenol water system-Hentrys law- Duhem Moargus equation.

Dilute solutions: Introduction- Colligative properties- Lowering of vapour pressure-Elevation of boiling point- Depression of freezing point- Osmotic pressure.

Phase rule: Introduction- One component system (water and sulphur)- Two component system-Eutectic system, Pb- Ag system, Bi-Cd system-Compound formation, Zn-Mg system-Incongruent system.

Module-II

Electrochemistry and ionic equilibrium

Kohlrauches law- Transport number and its determination- Degree of dissociation- Ionic equilibria-Ostwald's dilution formula-Anomaly of strong electrolytes-Theory of strong electrolytes-Solubility products and its applications- Henderson equation.

Surface chemistry: Types of adsorption. Heat of adsorption- The Langmuir theory derivation-Langmuir and classical isotherms. Chemisorption- Differences with physical adsorption. Applications of adsorption.

Spectroscopy

Brief study of Raman, Mass and ESR spectroscopy.

Chemical Kinetics

Reaction rate- Rate constants-Reaction order-First order-Second order-Pseudo first order reaction- Integrated rate laws- Molecularity-Arrhenius equation.

Module-III

The colloidal state: Multimolecular, macromolecular and associated colloids. Stability of colloids. The zeta potential. Kinetic, optical and electrical properties of colloids. Electrokinetic phenomena: Electrophoresis, electro osmosis, sedimentation potential and streaming potential. Donnan membrane equilibrium.

Catalysis: Mechanism and theories of homogeneous and heterogeneous catalysis. Acid-base and enzyme catalysis. Bimolecular surface reactions. Langmuir-Hinshelwood mechanism.

Separation Methods: Classical separation methods: Theories of distillation, fractional distillation, steam distillation, sublimation and zone refining- Solvent extraction- Distribution law- Separation of mixtures, Craig method.

Analysis of Selected Materials: Analysis of milk products: Theory of the analysis of milk, butter and other diary items. Analysis of fats and oils. Characterization of fats and oils. Iodine value, iodine-bromine value and saponification value, and their significances. Analysis of drugs and pharmaceuticals: Classical and modern methods of drug analysis.

References:

(i) Physical chemistry by Puri and Sharma.

(ii) D.A.Skoog, D.M.West and F.Jholler, “Fundamentals of Analytical Chemistry”, Saunder College Publishing
(iii) J.N.Gurtu and H.Snehi, “Advanced Physical Chemistry”, Pragati Prakash.

Note: Question Paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus. Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

08-303 PROCESS CALCULATIONS (H)

Credits:4 L/T/P:3/1/0

Module I

Introduction to Chemical Engineering, Chemical process Industry, Unit Operations and Unit Processes.

Units and Dimensions: System of Units, Basic and Derived quantities, Conversion of units, Conversion of equations- problems.

Concepts of atomic weight, equivalent weight and mole. Composition of solids, liquids and solutions(weight percent, mole percent, molarity, normality etc.), other expressions for concentration. Ideal gas laws, gaseous mixtures, real gas laws, gas constant. Average molecular weight and density. Compressibility factor, compressibility factor charts, Critical properties, pseudo critical properties-problems.

Module 2

Vapour Pressure: Effect of temperature on vapour pressure. Application of Clausius Clapeyron equation. Vapour pressure plots, Cox charts, Duhrings Lines, Solutions - Henry's law, Raoult's law, Bubble point, vapour pressure of immiscible liquids.

Material Balance without chemical reactions- Introduction, key component, steps for solving material balance problems, material balance for unit operations-distillation, drying, evaporation, absorption etc. Recycling and bypass operations.

Module 3

Material Balance with chemical reactions; definition of terms (limiting reactant, percentage yield etc.) Combustion of solid, liquid and gaseous fuels, Calorific value, proximate and ultimate analysis of coal, Orsat analysis.

Material Balance problems for oxidation, chlorination, nitration, hydrogenation and related processes. Recycling, bypass and purging operations.

Energy Balance: Thermophysics.

Heat capacity, work, internal energy, heat capacity of solids, liquids and gaseous mixtures, Latent heat, enthalpy changes, energy balance for flow and non flow processes.

Thermochemistry: Standard heats of reaction, combustion, and formation- effect of temperature and pressure on heat of reaction. Hess law of constant heat summation, temperature of reaction, adiabatic reaction temperature.

Text Books

1. Bhatt and Vora, Stochiometry, T. M. H.
2. Himmelblau David M., "Basic Principles and Calculations in Chemical Engineeing", Prentice Hall of India.
3.K. V. Narayanan and B. Lakshmikutty, " Stochiometry and Process Calculations", Prentice Hall of India.

Note

*The question paper consists of Part A and Part B. Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus. Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

08.304 MACHINE DRAWING (H)

Credits:3 L/T/D:0/0/3

Conversion of pictorial views into orthographic views- Sectional views, types of sectional views, conventions- Dimensioning techniques.

Module I

Freehand sketching; Different forms of screw thread, conventional representations, different types of lock nuts, foundation bolts, forms of rivet heads, Riveted joints- Lap (chain, zigzag, multiple rows), butt joints (chain, zigzag, multiple rows, single cover and double cover plate). Different types of keys.

Module II

Dimensioned Drawing: Hexagonal and square headed bolt with nut, Sectional drawings of Socket and spigot joint, Knuckle joint, Flange coupling, Bushed pin flexible coupling and plummer block. Pipe joints: Sectional drawings of Cast Iron Flanged joint, Hydraulic joint and Union joint.
Assembly and working drawing (part drawing): Pedestal bearings, Valves: Stop valve for boilers, Ramsbottom safety valve and lever safety valve.

Note: The question paper shall contain 2 questions. The first question is from Module-I which carries 20 marks. It contains 3 subdivisions and 2 to be answered (2x10=20 marks). The second question is from module II (from either dimensioned drawing or assembly and working drawing) which carries 80 marks and is a compulsory question.

Reference:

1. N.D. Bhatt, Machine Drawing
2. P.I. Varghese, Machine Drawing
3. P.S. Gill, Machine Drawing
4. Parkinson, Machine Drawing

08.305 COMPUTER PROGRAMMING IN C++ (H)

Credits:4 L/T/P:2/2/0

Module – I

C++ Basics: The ***iostream*** class, C++ Comments, Function Prototypes and Keywords. Declarations: Standard data types – Integer, Boolean, Floating point, Character, I/O statements, Formatting of outputs. Operators in C++, Various Loops: Unconditional and Conditional, Concept of pointers, Object Oriented Concepts: Fundamentals of OOPs and OODs , Default Function Arguments, Variable Declaration placement, Scope Resolution Operator, constant variables and functions, ***enum*** as a type, Unnamed function parameters, Constructors for intrinsic types. Data Abstraction, Encapsulation, Introduction to classes, inheritance and Polymorphism, class hierarchies, References: References as Aliases and References as pointers, similarities and differences., References and function parameters, references as return values. Declaring and using of classes, class members, Creation of objects, Constructors and Destructors, Accessing data members.

Module – II

Returning a reference, 'Const' objects and member functions, the 'Const' qualifier,, inline functions, Classes and Dynamic memory allocation, the New, delete operators, 'this' pointer, Static members, friends, array of class objects, Overloading: Function overloading, Constructor overloading, Operator overloading- Overloading Unary operator, overloading binary operator, data conversion.

Module – III

Applications of Inheritance and Polymorphism, Derived class and base class, derived class constructors, overriding member functions, public and private inheritance, virtual functions, multiple inheritance, class within class, abstract classes, Generic functions, generic classes, exception handling, File processing-formatted-unformatted and random files. Data Structure concepts: Stacks, queue, list, linked list and tree.

Text Books :

Balaguruswamy, "Object Oriented Programming, TMH
Robert Lafore, Object Oriented Programming in Turbo C++ . GALGOTIA

Reference:

Bjarne Stroustrup, "The C++ Programming Language, Pearson Education

Note

The Part A in the question paper shall contain ten short answer questions each carrying 4 marks evenly distributed over the entire syllabus. Part B shall consist of three modules with two questions from each module of the syllabus. The candidate should answer any one question from each module which carries 20 marks.

08.306 PARTICLE TECHNOLOGY (H)

Credits:4 L/T/P:3/1/0

Module 1

Particle size analysis - mean diameter, shape factors, derived diameter. Sieving - cumulative and differential method of size analyses. Subseive size analysis - microscopic counting. Pipette analysis, hydrometer analysis, Photo sedimentation - sedimentation balance, sedimentation and decantation - ICI sedimentation - Elutriation, Laser beam Particle size analysis, Online particle analysis. Size reduction - equipments used for primary and secondary stage size reductions - Jaw crusher - Gyratory crusher - Roll crusher - Hammer mill - Ball mill - Rod mill - Disk attrition mills - cutters - Fluid energy mills. Cascade mills. Laws of size reduction, Selection of equipments. Screening - Industrial screens - Capacity of screens, effectiveness of screens - type of screening mechanisms. Closed circuit and open circuit grinding. Wet and dry grinding.

Module 2

Classification - Principles of free and hindered settling - Sizing and sorting. Classifiers - Hydraulic classifiers - Rake classifier-Spiral Classifier - Bowl classifier - Pneumatic classifier - Hydroclones. Principles of Sedimentation, coagulation and flocculation-Thickeners - Kynch theory - interpretation of batch sedimentation test. Design of continuous thickeners.

Filtration - constant rate and constant pressure filtration - batch and continuous filtration – filtration equipments- sand filter - chamber press - plate and frame filter press - leaf filter - rotary drum filter - Theory of filtration - incompressible cake - cake porosity - filter aids - methods of application -Cake washing- Optimum time cycles.

Centrifugal methods of separation - centrifugal filtration - batch, semi and continuous types of centrifuges - centrifuges for liquid-liquid and liquid-solid separation - critical speed.

Module 3

Mineral beneficiation – Ore Sorting- electronic sorting,, assay sampling, recovery, liberation, locked particles, classification as a means of concentration - Heavy media separation - Jigging - Wilfly table - froth flotation - magnetic separation - high voltage separation.

Gas cleaning methods: Bag filters, cyclone separation, electrostatic separation, scrubbing Storage of solids, liquids and gases. Transportation of bulk solids - different methods of transportation - type of conveyors and selection.

References:

1) McCabe and Smith, " Unit Operations in Chemical Engineering" 5th Edn. McGraw Hill
2) Badger and Banchero, "Introduction to Chemical Engineering" McGraw Hill.
3) Brown T. G et al., "Unit Operations", Asia publishing House
4) Wills B.A., "Mineral Processing Technology", 4th Ed., Pergamon Press.
5) Allen T, " Particle Size Measurement" Chapman and Hall, London, 1977.
6) Foust, "Principles of Unit Operations", McGraw Hill.
7) Gaudin A. M. "Principles Mineral Dressing ", McGraw Hill
8) Coulson and Richardson, "Chemical Engineering", Vol 2, Pergamon Press.
9) Perry and Chilton, Eds, "Chemical Engineer's Hand Book", McGraw Hill

Note: Question Paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus. Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

08. 307 **CHEMISTRY LAB-I (H)**

Credits:3 **L/T/P:0/0/3**

A. **Volumetric analysis**

1. Preparation of standard solution of sodium carbonate, standardisation of strong acids (Eg. HCl)
   and estimation of unknown concentration of NaOH.
2. Estimation of carbonate- bicarbonate mixture.
3. Preparation of standard oxalic acid, standardisation of potassium permanganate and estimation of unknown solutions of hydrated ferrous sulphate.
4. Preparation of standard ferrous sulphate solution and standardisation of potassium permangnate and estimation of Mohs salt.
5. Preparation of standard solution of potassium dichromate and estimation of iron.
6. Standardisation of sodium thiosulphate against dichromate
7. Preparation of standard sodium chloride and standardisation of silver nitrate.
8. Estimation of total and permanent hardness by EDTA method.

B. **Analysis of ores and alloys**

9. Estimation of iron in heamatite.
10. Estimation of copper in brass.
11. Estimation of calcium in lime stone or dolamite.

C. **Potentiometric measurements**

12. Estimation of strength of given HCl solution by titrating against sodium hydrode solution.
13. Determination of electrode potential and emf of an electrochemical cell.

D. **Conductometric measurements**

14. Coductometric titrations
    (i) Strong acid with strong base
    (ii) Strong acid with Weak base
    (ii) Mixture of acid with base

E. **PHmetric measurements**

15 (i) Preparation of buffer and standardisation of PH meter.
   (ii) Determination of molarity of HCl with M/10 NaOH.

References:

(i) Practical chemistry by A.O. Thomas.
(ii) A.I.Vogel, “A Text Book of Quantitative Inorganic Analysis”, Longman
(iii) Laborarory manual on Engineering chemistry by Dr. Sudha Rani.
(Dhanpat Rai Publishing company)

08 -308 CHEMICAL AND INSTRUMENTAL ANALYSIS LABORATORY(H)

Credits:3 **L/T/P:0/0/3**

Chemical Analysis:
Analysis of oils and fats : Acid value, saponification value and iodine value. Analysis of soap, washing soda and bleaching powder. Water analysis : Total alkalinity, acidity, hardness, chlorided sulphates, dissolved oxygen, residual and free chlorine. Analysis of industrial effluents : COD and BOD determination. Analysis of Cement , Analysis of Soil , Analysis of coal : Proximate analysis and coking characteristics. . Sugar analysis : Determination of sucrose content. Technical preparations : Soaps, detergents, paints and dye.

Instrumental Analysis:
Fuel gas analysis. Ph analysis, flame photometry spectro photometry. Determination of flash point, fire point, refractive index and viscosity. Calorific value of fuels

REFERENCES :
1. F.D. Snell and F.N. Snell "Commercial Methods of Analyses"
2. Vogel "Text Book of Quantitative inorganic Analyses"
3. Swing G.W., "Instrumental Methods of Chemical Analyses" M.G.H., 1960.

08.401 ENGINEERING MATHEMATICS III (CMPUNERFHB)

Credits:4 L/T/P:3/1/0

Module I

Complex Differentiation: Limits ,continuity and differentiation of complex functions. Analytic functions-Cauchy Reimann equations in Cartesian form (proof of necessary part only) properties of analytic functions-harmonic functions. Milne Thomson method

Conformal mapping: The Transformations $w=1/z$, $w=z^2$, $w=z+1/z$, $w=\sin z$,$w=\cos z$,Bilinear transformation

Module II

Complex Integration:Line integral- Cauchy's integral theorem-Cauchy's integral formula. Power series-radius of convergence-Taylors and Laurents series-zeros and singularities – Residues and residue theorem. Evaluation of real definite integrals-

2π

$\int_0 f(\sin\theta, \cos\theta)\, d\theta$, $\int_{-\infty}^{\infty} f(x)\, dx$ with no poles of $f(z)$ on the real axis (proof of theorems not required)

Module III

Numerical Techniques:Errors in numerical computation-solution of algebraic and transcendental equations by bisection method, regula false method,Newton- Raphson method. Solution linear systems by Gauss elimination and Gauss-Seidal method. Newtons forward and backward interpolation formula. Lagranges interpolation formula.Numerical integration. Trapezoidal and Simpson's rule.Numerical solutionof ODE Taylor series method, Eulers method,Runge Kutta methods(derivation of formulae not required for the above methods.)

References:

1. Peter v. O'neil, Advanced Engineering Mathematics, Thomson Pub.
2. Erwin Kreizig, Advanced Engineering Mathematics, Weiley Eastern.
3. Greenberg, Advanced Engineering Mathematics, Pearson.
4. B.S Grewal, Higher Engineering Mathematics, Khanna Publishers.
5. B.V Ramana, Higher Engineering Mathematics, Tata Mc Graw hill.
6. C T.Veerarajan and T.Ramachandran, Numerical Methods with programming.
7. S.S.Sastry, Introductory methods of numerical analysis.

Examination Duration: 3 hours

Note: The question paper shall consists of two parts. **Part A** (40 marks) Ten compulsory questions of 4 marks each. **Part B** (60 marks) Student must answer one out of two from each module .Each question carries 20 marks.

08.402 HUMANITIES (CTAFRHB)
Credits:3 L/T/P:2/1/0

Part I
ECONOMICS (2 periods per week)

Module – I

Definition of Economics – Basic Concepts Goods – Choice of techniques – Production possibility curve National Income concepts - GNP – GDP – NNP – Per Capita Income – Three Sectors of the Economy – Primary – Secondary, Tertiary Sector – Significance of Money.
Meaning of Demand and Supply – Types of demand – Determinants of Demand – Demand forecasting
Production function – Law of Variable proportion – Returns to scale - Least cost combination of inputs – Cost concepts – Cost output relationship

Module II
Inflation – causes of inflation – measures to control inflation – Demand – Pull inflation – cost push inflation – effects of Inflation – effects of inflations comparison between inflation and deflation

India's Economic crisis in 1991 – New economic policy – Global Financial meltdown in 2008 – Applicability of Keynesian Theory to UDC'S.
Stock Market and present scenario – Industrial sector past and present – Industry Analysis – Electronics – Chemical – Automobile – FMCG Industry.

Environment and Development – Basic Issues – Sustainable Development and Environmental Accounting – Population – Resources and the Environment – Poverty and the Environment – Growth versus the Environment – The Global Environment .

PART II

Module III

ACCOUNTANCY (1 Period per week)

Book- Keeping and Accountancy -Elements of Double Entry -Book- Keeping-rules for journalizing -Ledger accounts –Cash book-Banking transactions – Trial Balance- Method of Balancing accounts- the journal proper (simple problems).
Final accounts: Preparation of trading and profit and loss Account- Balance sheet (with simple problems) - Introduction to Accounting packages (Description only)

References :

1. K.K Dewett, Modern Economic theory
2. Michael – Todaro, Economic Development Addison Wesley Longman Ltd.

3. Mohinder Kumar Sharma _ Business Environment in India
4. D.M. Mithani-Money, Banking, International Trade and Public Finance, Himalaya publishing House, New Delhi.
5. Rudder Dutt and K.P.M Sundaran – Indian Economy
6. Hal R. Varian – Intermediate Micro Economics
7. Koutsiannis (second Edition) Micro Economics
8. Double Entry book Keeping – Batliboi
9. A Systematic approach to Accounting: Dr K.G. Chandrasekharan Nair

University question

Note: Part I and Part II to be answers in separate answer books.

Part – I Economics
Part A – 30 Marks (short answers) covering entire syllabus (3x10=30)
Part B – 40 marks (50% choice one out of two or two out of four from each module)
Part – II Accountancy

Three questions covering entire syllabus out of which two questions has to be answered (2x15=30)

08.403 ORGANIC CHEMISTRY (H)
Credits:4 L/T/P:3/1/0

Module-I
Reation mechanism: Electron displacement effects- Inductive effect, Electromeric effect, Mesomeric effect and Hyperconjugation- Homolytic and heterolytic fission- Structure and stability of C+ and C- ions.
Attacking reagents: Electrophiles and neucleophiles, Examples- Energy requirements of exothermic and endothermic reactions.
Substitution reactions: Free radical substitution-Nucleophilic substitution, SN1 and SN2 mechanism .
Addition reactions: Electrophilic addition: Addition of Br2 and HBr to alkenes. Nucleophilic addition: Addition of HCN to aldehydes and ketones.
Rearrangements: Mechanism of Beckmann rearrangement and Aldol condensation.
Synthesis and uses of Vanillin, Alizarin, Methyl orange, Glyptal and Polyaramide.
Alkaloids: Isolation from plants-Spath synthesis of nicotine.
Terpenes: Isolation, classification and isoprene rule. Citral synthesis and properties.

Module-II
Benzene and its homologues
Aromaticity- Huckels rule- Aromatic and non aromatic ring structures- Resonance structure of benzene, its stability. Mechanism of nitration, Sulphonation, Friedel Crafts alkylation and acetylation- Orientation in aromatic disubstitution.Directive influence of substituents. Ortho, para and meta directing groups- Anomolous behaviour of halogen substituents.
Aryl amines: Structure and basicity, comparison with alkyl amines-Bromination, nitration and carbylamine reaction of aniline.
Diazonium salts: Preparations and applications.
Phenols: Acidity- Riemer Tiemann reaction and Lederrer Mannase reaction.
Heterocyclic compounds: Pyrrole and pyridine-Structure, synthesis and properties.

Module-III
Cycloalkanes: General methods of preparation- Stability of cycloalkanes, Bayers strain theory, Sacshe Mohr concept.
Aminoacids: Synthesis- Gabriels method, Strecker method and Erlen Meyer azlactone method. Zwitter ion, isoelectric point- Classification and physical charecteristics of aminoacids.
Carbohydrates: Classification and synthesis- Conversions- Aldose to next higher aldose and next lower aldose (Killiani synthesis and Wohl's method). Aldose to ketose and Ketose to aldose- Muta rotation.
Soaps and detergents: Cleaning action- Manufacture of detergents- Classification- Water pollution caused by detergents.
Grignard reagents: Synthesis and applications.
Acetoacetic ester: Synthesis and applications.

References:
(i) Advanced organic chemistry by Bahl and Arun Bahl.

(ii) Organic chemistry by I.L. Finar, Volume I & II.

Note: Question Paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus. Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

08.404 FLUID FLOW OPERATIONS I (H)

Credits:4 L/T/P:3/1/0

Module 1:
Introduction – Concept of Continuum- Definition of fluid, ideal fluid - real fluid – fluid properties-density - specific weight - specific volume, specific gravity, viscosity, kinematic viscosity, measurement of viscosity, compressibility, surface tension, capillarity - absolute and gauge pressures.
Fluid statics – Pascal's Law, Basic equations of fluid statics, hydrostatic law, hydrostatic equilibrium, barometric equation, Continuous gravity decanter - Centrifugal decanter - measurement of pressure using barometer, manometer – simple and differential, Mechanical gauges. Pressure at a point in compressible fluid, Temperature at any point in compressible fluid, temperature lapse rate. Buoyancy and floatation- centre of buoyancy, metacentre, metacentric height, stability of floating and submerged bodies.
Introduction to fluid flow – Flow field, classification of flow- steady and unsteady flow, uniform and non uniform flow, one two and three dimensional flow, rotational and irrotational flow, adiabatic flow, streamline, streak line, path line, stream tube, stream function velocity potential

Module 2:
Potential flow, rheology of fluids, shear rate and shear stresses, Newtonian and non-Newtonian fluids, viscosity, momentum flux, Reynolds's experiment, turbulent flow, turbulence, nature of turbulence
Equations of change for isothermal systems - equation of continuity, equation of motion - Navier-Stoke's equation, Euler equation - Bernoulli equation, kinetic energy correction factors - correction in Bernoulli equation for fluid friction, Friction head loss for changes in velocity, direction and due to pipe fittings.
Shear stress and velocity distribution in circular channel. The friction factor - Hagen-Poiseuille equation, Frictional loss in non circular conduits- Hydraulic radius and equivalent diameter. Shell momentum balance for falling film, laminar flow of non-Newtonian fluids - Velocity distribution for turbulent flow. The friction factor chart
Flow in boundary layers , wake formation,. boundary layer thickness and boundary layer conditions in laminar flow-Blasius solution , boundary layer thickness and boundary layer conditions in transition and turbulent flow.
Dimensional analysis- Raleigh's method and Buckingham pi method.

Module 3:
Transportation and metering of fluids - pipes and pipe standards, tubings. Pipe joints - flange - expansion joints, valves-pressure relieving devices- safety and relief valves, accessories for safety relieving valves – materials of construction.
Pumps, reciprocating pumps, centrifugal pumps, centrifugal pump theory - selection of centrifugal pumps - various types, head Vs. flow rate - characteristics of centrifugal pumps, priming - cavitation, NPSH - Water hammer -calculations involving pump characteristics - loss of head and power in centrifugal pumps – Pumps in series and parallel-material of construction

of pumps-design of pipeline systems. The displacement and current meters - variable area meter, orifice meter, venturimeter, flow nozzles, rotameter, wiers and notches - Pitot tubes - velocity meters - anemometers, turbine flow meter, current meters, hot wire anemometer, laser dopper anemometry, flow visualization.

Text books:

1. McCabe and Smith, "Unit Operations in Chemical Engineeering", McGrawhill
2. Streeter, "Fluid Mechanics"
3. Kunii and Levenspiel, "Fluidization Engineering"
4. Christie J. Geankoplis, "Transport Processes and Unit Operations", Prenticehall of India.
5. K.L.Kumar, 'Engineering Fluid Mechanics', Eurasia Publishing House, New Delhi
6. N.DeNevers, 'Fluid Mechanics for Chemical Engineers", Second Edition., McGraw Hill, New York.

Note

The Part A in the question paper shall contain ten short answer questions each carrying 4 marks evenly distributed over the entire syllabus. Part B shall consist of three modules with two questions from each module of the syllabus. The candidate should answer any one question from each module which carries 20 marks.

08.405 ELECTRICAL TECHNOLOGY (H)
Credits:4 L/T/P:3/1/0

Module I

Transformers- construction -principle of operation -e.m.f.equation-phase diagram on load - equivalent circuit-regulation -losses and efficiency. - OC and SC test-determination of equivalent circuit -autotransformers-instrument transformers.

DC generators-Constructional details-principle of operation -e.m.f. equation-types of generators-performance characteristics and applications-DC motors-production of torque-shunt, series and compound motors-performance characteristics-applications-methods of speed control-starters-universal motor.

Module II

Three phase induction motors-constructional details-slip ring and cage type-production of torque-slip characteristics and applications. Starters-star delta and rotor resistance types. Losses and efficiency .No load and blocked rotor tests- circle diagram.

Single phase induction motors-types, characteristics and applications.

Module III

Alternator -Constructional details-frequency-e.m.f. equation -concept of regulation.

Synchronous motors-principle of operation-methods of starting-applications. Stepper motor-principle of operation and applications.

Electric heating-resistance furnaces and ovens-methods of temperature control. Electric arc furnaces and induction furnace High frequency heating - Induction and dielectric heating-applications- Electric welding-an overview of different types electric welding.

.

References:

1. B.L.Thereja, A.K.Thereja,"A Text Book of Electrical Technology",vol 2,S.Chand and Co.
2. M.L.Soni,P.V.Gupta,U.S.Bhatnagar,A.Chakraborthi,"A Text Book on Power System Engineering",Dhanapath Rai and Sons.
3. M.L.Soni,P.V.Gupta,U.S.Bhatnagar,A.Chakraborthi,"A Text Book on Power System Engineering",Dhanapath Rai and Sons.
4. Mehta V.K.,"Principle of Electrical Engineering and Electronics",S.Chand and Co.
5.Gupta J.B., "A Course in Electrical Power",S.K.Kataria and Sons, New Delhi.

Note: Question papers consists of two parts. Part A (40 marks). Compulsory ten short questions (10 * 4). Part B (60 marks) Three modules. Students must answer one out of two from each module.

08.406 Heat Transfer Operations I (H)
Credits:4 L/T/P:3/1/0

Basic Concepts: Overview of applications of heat transfer in different fields of engineering, modes of heat transfer- conduction, convection and radiation, heat transfer with and without change of phase.

Conduction: Mechanism of heat conduction, Isotropic and anisotropic materials, General heat conduction equation in Cartesian, cylindrical and spherical coordinates (derivation is required only for Cartesian geometry). Reduction of general equation to Laplace, Poisson, heat diffusion and Fourier equations. Different Boundary conditions applied in heat transfer problems. Formulation of heat transfer problems with and without generation of heat (uniform and non uniform heat generation) at steady and unsteady state for different boundary conditions.
.
One dimensional steady state heat conduction without generation of heat: Fourier heat conduction equation, thermal conductivity measurement; thermal conductivity of solids, liquids and gases- comparison between them, thermal conductivity measurement of solids and liquids, effect of temperature on thermal conductivity; thermal diffusivity. **Conduction through systems of constant thermal conductivity :-** conduction through plane, cylindrical and spherical wall, combined boundary condition systems (conduction-convection systems), conduction through composite slab:- multilayered plane, cylindrical and spherical shells. Electrical analogy to heat flow. Numerical problems of practical importance based on the above topics.

Thermal insulation: Analysis of Critical radius of insulation for cylindrical and hollow spheres; optimum thickness of insulation. Industrial Insulating materials-cold and hot temperature insulating materials, refractories- examples. Concept of optimum thickness of insulation. Concept of thermal contact resistance Numerical problems based on the above aspects

Steady state heat conduction in systems with uniform generation of heat (Constant thermal conductivity**):** Expression for temperature distribution for one dimensional heat conduction in solids in flat, cylindrical and spherical solid walls. Numerical problems based on the above aspects.

Heat Conduction in systems with variable thermal conductivity (without generation of heat**):** Steady state one dimensional heat conduction in plane walls, cylindrical and spherical hollow surfaces without generation of heat- expressions for heat flux and temperature distribution. Numerical problems of practical interest based on the above aspects.

Unsteady State heat Conduction: Analysis of transient heat flow with negligible internal resistance-lumped capacity analysis, concept of Biot Modulus and Fourier number- Numerical problems of practical importance.

Heizler Charts for transient one-dimensional Heat Flow in solids:- Features of Heisler charts. Use of Heisler charts for determination of temperature distribution and energy transfer for one dimensional transient heat conduction in plane wall, cylinder and sphere for boundary conditions of practical importance.

Heizler Charts for transient one-dimensional Heat Flow for infinite and semi-infinite solids: Heisler charts for infinite and semi-infinite flat walls and cylinders without generation of heat for boundary conditions of practical importance. Solution of numerical heat conduction problems based on the above categories for boundary conditions of practical importance using Heisler Charts.

Module-II

Convection: Mechanism, overview of continuity, momentum and energy balance equation, boundary layer concepts- thermal and velocity boundary layers, boundary layer thickness, relationship between hydrodynamic and thermal boundary layer thickness for flow over flat plates, the convective heat transfer coefficient, reference temperatures, thermal boundary layers for the cases of flow over a flat plate and flow through pipe, dimensionless numbers in heat transfer and their significance, dimensional analysis- Rayleigh and Buckingham's pi theorem, its limitations, principle of similarity, application of dimensional analysis to forced convection.

Forced Convection: General methods for estimation of convection heat transfer coefficient, Correlation equations for heat transfer in laminar and turbulent flow for external and internal flows for constant heat flux and wall temperature conditions- flow in a circular tube (both developing and developed flows with constant wall temperature-its analysis and constant heat flux conditions) and non-circular tubes, flow over flat plates, flow over cylinder, spheres and tube banks. Heat transfer in liquid metals- empirical correlations. Numerical problems of practical interest.

Analogy between momentum and heat transfer: Development of Reynold's and Prandtl, analogy. Overview of Colburn and Von-Karman analogies (No derivation required). Comparison of different analogy expressions

Natural Convection: Dimensional analysis**,** natural convection from vertical and horizontal surfaces under laminar and turbulent conditions for plates, cylinders under constant heat flux and wall temperature conditions, physical significance of Grashoff and Rayleigh numbers. Numerical problems of practical interest..

Module III

Heat Transfer in extended Surfaces: Types of extended surfaces (fins), General conduction analysis of fins, boundary conditions. Reduction of general equation to determine temperature distribution and heat flux for fin of uniform cross section for infinitely long fin and fin with insulated tip. Expression for temperature distribution and heat flux for fin of uniform cross section with convective boundary condition at the fin tip (No derivation is required). Effectiveness of fins- justification for providing fins on a surface; efficiency of fins-expression

for fin efficiency. Principle of fins for temperature measurent. Numerical problems of practical importance.

Heat transfer by radiation: Introduction- theories of radiation, electromagnetic spectrum, thermal radiation, spectral emissive power, surface emission- total emissive power, emissivity. Radiative properties- Emmision, irradiation, radiosity, absorptivity, reflectivity and transmissivity. Concept of black and grey body, radiation intensity, Laws of black body radiation, non-black surfaces- Grey, white and real surface, Lambert's cosine law., radiation between black surfaces and gray surfaces, radiation shape factor, reciprocity theorem, radiation between large parallel gray planes-derivation of expression for rate of radiant energy exchange, concentric cylinders and spheres (no derivation required), radiation between a small gray body and a large gray enclosure. Radiation shields.

Electrical Network analogy- radiation heat transfer between black surfaces; radiation heat exchange between grey bodies.
Radiation in gases. Errors in the measurement of temperature in a thermowell.

Note to question paper setters:

*1. Reference **No. 8** indicated in the group of references given below is allowed in the examination hall, which may be mentioned along with the directions to be provided on the facing sheet of the question paper.*

No charts, tables and codes are permitted in the Examination hall. Necessary relevant data shall be given along with the question paper by the question paper setter.

*2. The question paper consists of Part A and Part B. Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.*

*3. Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

REFERENCES:

1. Özisik M. N, "Heat *Transfer—A Basic Approach"*, McGraw-Hill.
2. Binay. K. Dutta, "*Heat Transfer Principles and applications*" Prentice Hall of India
3. Incropera F. P. and DeWitt D. P, "*Introduction to Heat Transfer*". John Wiley & Sons.
4. Holman J. P, "*Heat Transfer*", McGrawHill.
5. Sachdeva R.C, "*Fundamentals of Engineering Heat and Mass transfer",* New Age International, India
6. Rao Y.V.C, *"Heat Transfer",* University Press, India
7. Cengel A. Yunnus. "*Heat Transfer – A Practical Approach",* McGraw Hill
8. Kothandaraman C.P, "*Heat and Mass Transfer Data Book*" New Age International, India

08.407 **CHEMISTRY LAB-II (H)**

Credits:3 **L/T/P:0/0/3**

A. **Gravimetric analysis**

1. Estimation of percentage of water of hydration in hydrated barium choride.
2. Estimation of barium as barium sulphate.
3. Estimation of sulphate as barium sulphate.
4. Estimation of iron as ferric oxide.

B. **Physical chemistry experiments**

5. Determination of partition coefficient of

(i) Iodine between water and carbon tetra chloride.

(ii) Benzoic acid between water and benzene.

6. Determination of molecular weight by Rast's method
7. Determination of molecular weight by depression in freezing point and elevation of boiling point.
8. Determination of critical solution temperature of phenol water system and calculation of composition of a given mixture of liquids.
9. Determination of velocity constants of the following reactions.

(i) First order reaction-Hydrolysis of ethyl acetate with dil HCl.

(ii) Second order reaction-Hydrolysis of ethyl acetate with NaOH.

10. Determination of heat of nuetralisation reaction.

C. **Organic preparations**

11. Preparation of urea formaldehyde resin.
12. Preparation of phenol formaldehyde resin.
13. Preparation of aspirin.
14. Preparation of azodyes.
15. Preparation of phenyl benzoate.
16. Preparation of urea nitrate.

References:

(i) Practical chemistry by A.O. Thomas.

(ii) A.I.Vogel, "A Text Book of Quantitative Inorganic Analysis", Longman

(iii) Laborarory manual on Engineering chemistry by Dr. Sudha Rani. (Dhanpat Rai Publishing company)

08.408 ELECTRICAL LAB (H)

Credits:3 L/T/P:0/0/3

1. Measurement of three phase power using 2 watt meters.
2. Transformation ratio and load test on single phase transformers.
3. OCC of shunt generator – measurement of critical resistance.
4. Brake test of DC series motor - determination of characteristics.
5. Squirrel cage Induction motor - starting (star- delta) and load test.
6. Study of CRO for the measurements of voltage, phase angle & frequency.
7. Identification of electronic components.
8. Forward and reverse characteristics of semiconductor diode.
9. Design of zener voltage regulator
10. Half-wave and full-wave rectifiers with and without capacitor filter
11. Characteristics of NPN transistor.
12. Design and set up of common emitter amplifier.

08.501 ENGINEERING MATHEMATICS – IV (E,R,H,B,F)
Credits:4 L/T/P:3/1/0

Module I
Discrete and continuous random variables and their probability distributions- Probability distribution (density) functions - Distribution functions - Mean and Variance - Simple problems. - Binomial, Poisson, uniform and exponential distributions - Mean and Variance of the above distributions - Normal distribution - Properties of normal distribution - Computing probabilities using Binomial, Poisson, uniform, exponential and normal distributions

Module II
Curve fitting - Principle of least squares - Fitting a straight line - Fitting a parabola - Linear correlation and regression - Karl Pearson's coefficient of correlation - Sampling distributions - Standard error - Estimation - Interval estimation of population mean and proportions (small and large samples) - Testing of Hypothesis - Hypothesis concerning a mean, Equality of means - Hypothesis concerning one proportion, difference of two proportions.

Module III
Joint probability density function - Properties - Marginal and conditional distribution - Independence - Random processes - Classification of random processes - Examples - Average values such as mean, autocorrelation, autocovariance, correlation coefficient of random processes - stationarity - strict sense stationary process - wide sense stationary process - Autocorrelation function and its properties - Power spectral density and its properties (no proof) - Related problems - Markov chains. Transition probability matrices - Chapman-Kolmogorov equation (no proof) - Poisson process - Mean and autocorrelation of Poisson process - Related problems

References:

1. Papoulis and S.U. Pillai, Probability, random variable and stochastic processes, 4/e, TMH
2. Veerarajan, Probability and Random Processes, 2/e, TMH
3. Stark and Woods, Probability and Random processes with application to signal processing, 3/e, Pearson Education
4. Gubner, Probability and Random Processes for Electrical and Com*puter* Engineers, Cambridge University Press, 2006

Note:
The question paper shall consist of two parts. Part A (40 marks) shall contain 10 compulsory questions of 4 marks each. Part B (60 marks) will have 3 modules. There shall be 2 questions from each module (20 marks each) out of which one is to be answered.

08.502 FLUID FLOW OPERATIONS II (H)

Credits:4 L/T/P:3/1/0

Module 1

Flow past immersed bodies - Drag coefficient - Flow through packed bed - Ergun equation - Kozney-Carman equation - Blake Plummer equation - Design of packed beds - Motion of particles through fluids - Motion from gravitational and centrifugal fields - Terminal settling velocity - Approximate equation - Stoke's law - Intermediate law - Newton's law - Hindered settling

Fluidization - The phenomenon of fluidization - Liquid-like behaviour of fluidized beds - Comparison with other contacting methods - Advantages and disadvantages of fluidized beds for industrial applications - fluidization quality. Pressure drop - vacuum - flow rate diagrams, minimum fluidizing velocity, effect of pressure and temperature on fluidized bed behaviour. The expanded bed - Flow patterns in fluidized beds - Design of fluidized beds.

Module 2

Fans and Blowers- classification , power consumption. Compressors –classification, Positive displacement compressors, reciprocating compressors , multistaging,power consumption, compressor output.

Compressible fluids - Mach number - Continuity equation - Total energy balance - Mechanical energy balance - Ideal gas equation - Equations for isentropic flow - Adiabatic frictional flow - Isothermal flow - Measurement of compressible fluid flow.

Module 3

Non-Newtonian fluids - Time dependent flow - Viscosity, rate of shear Vs. shear stress for non-Newtonian fluids - Agitation and mixing of liquids - Agitation equipments - Impellers, propellers, paddles, turbines, flow patterns in agitated vessels, standard turbine design, circulation, velocities and power consumption in agitated vessels - Flow number - velocity gradient and velocity patterns, power correlations, dimentionless groups, blending and mixing, mixer selection, scale-up of agitator design.

Mixing of solids and pastes - Mixers for pastes and plastic masses - change can mixers, kneaders, dispersers and masticators, mixer extruders, mixing rolls, Muller mixers, power requirements, mixing index, mixers for dry powders, mix index in blending granular solids

References:

1. McCabe and Smith, "Unit Operations in Chemical Engineeering", McGrawhill
2.. Streeter, "Fluid Mechanics"
3.. Kunii and Levenspiel, "Fluidization Engineering"
4. Christie J. Geankoplis, "Transport Processes and Unit Operations", PHI
5. K.L.Kumar, 'Engineering Fluid Mechanics', Eurasia Publishing House, New Delhi, 1995
6. N.DeNevers, 'Fluid Mechanics for Chemical Engineers", Second Edition., Mc Graw Hill , NewYork, 1991

Note:

The question paper consists of Part A and Part B.

*Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.*

*Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module*

08.503 HEAT TRANSFER OPERATIONS – II (H)
Credits:4 L/T/P:3/1/0

Module – 1

Classification of heat exchangers: Classification according to transfer processes: Indirect-contact heat exchangers, direct-contact heat exchangers; Classification according to number of fluids; Classification according to surface compactness: gas-to-fluid exchangers, liquid-to-liquid and phase-change exchangers; Classification according to construction features: tubular heat exchangers, plate-type heat exchangers, extended surface heat exchangers, regenerators; Classification according to flow arrangements: single-pass exchangers, multi-pass exchangers; Classification according to heat transfer mechanisms.
Basic construction of a shell and tube heat exchanger with details of the various parts, concept of overall heat transfer coefficient- derivation of expression for LMTD and overall heat transfer coefficient, concept and types of fouling, fouling factors, determination of overall heat transfer coefficient with and without fouling. Heat exchanger analysis, concept of sizing and rating problems. Numerical problems on rating problems. Concept of logarithmic mean temperature difference and its correction factor, Heat exchanger analysis using LMTD method in parallel flow, counter flow exchanger, cross flow and multi-pass heat exchangers, Temperature - distance plots for different flow arrangements in single and multi-pass heat exchangers. Determination of area, length, number of tubes required for a given duty in different configurations using LMTD method of analysis.

Concept of Effectiveness- NTU method, definition of effectiveness, effectiveness NTU relations for single pass exchangers in counter-flow and parallel flow configurations, - development of equations for effectiveness for parallel and counter-flow configurations, Determination of area, length and number of tubes using Effectiveness- NTU method, use of effectiveness- NTU charts for design of various heat exchanger configurations, *(the students will be permitted to use the Effectiveness- NTU charts in the examination hall),* interpretations of effectiveness-NTU plots. Determination of individual heat transfer coefficients using Wilson's plot, Compact heat exchangers - heat transfer and flow characteristic for specific configurations.
Double pipe heat exchangers: - construction, various steps for the design of double pipe heat exchangers. Thermal design of agitated vessels, empirical correlations for individual heat transfer coefficients. Construction of compact heat exchangers: Plate heat exchangers, design considerations of spiral heat exchangers. General selection guide lines for major heat exchangers types.

Module – 11

Boiling and Condensation: - Dimensionless parameters in boiling and condensation. Pool boiling - Boiling curve, hysteresis in the boiling curve, mechanism of nucleate boiling - modes of pool boiling, pool boiling correlations - Nucleate pool boiling - correlations - Yamagata et al correlation, Rohsenow correlation. Correlation for critical heat flux for nucleate pool boiling - Zuber correlation. Correlation for minimum heat flux - Zuber correlation. Correlations for film

pool boiling. Parametric effects on pool boiling, numerical problems. Forced convection boiling - Brief over view of external forced convection boiling and internal forced convection boiling.

Different types of boilers and their Classification based on different aspects, terms associated with boiler operation: circulation rate, equivalent evaporation, factor of evaporation, boiler efficiency, boiler capacity and blow down. Heat transfer characteristics in boiler operation and determination of heat transfer rate, parameters to be considered in boiler design. Numerical problems.

Condensation: Physical mechanisms, types of condensation, factors affecting condensation, Laminar film condensation on a vertical plate - detailed analysis by Nusselt to determine the heat transfer coefficient. Laminar film condensation on radial systems - condensation on spheres, horizontal tubes and for a vertical tier of horizontal tubes, condensation inside a horizontal tube, correlations, film condensation inside horizontal tubes. Drop wise condensation – correlations- Numerical problems. Comparison between drop-wise and film type condensation, promoters and inhibitors used in condensation. Effect of non- condensables on condensation. Turbulent film condensation.

Heat transfer augmentation: General study of various methods available heat transfer augmentation for heat transfer with and without change of phase, Detailed study of heat transfer augmentation using extended surfaces:- Different types of fins – Derivation of differential equation for the temperature profile in a fin of a general geometry for any boundary condition, derivation of expressions for the temperature profile and heat transfer rate along a rectangular fin for fin tip maintained at first, second and third type of boundary conditions, concept of fin effectiveness and fin efficiency with the expressions for their determination, numerical problems.

Module - 111

Evaporation: Principle of Evaporation, types of evaporators- their construction and operation:- Natural circulation evaporators, short tube vertical or calandria type evaporators, basket type vertical evaporators, long tube vertical evaporators, forced circulation evaporators, falling film evaporators, climbing or rising film evaporators, agitated thin film evaporators, the plate evaporator. Evaporator auxiliaries: - vacuum devices, steam traps and its variants, entrainment separators. Single effect and multiple effect evaporators, Performance of evaporators, capacity and economy of evaporators, factors affecting the performance of evaporators. Overall heat transfer coefficient, effect of liquid head and boiling point elevation. Material and energy balances for single effect evaporator and the calculations on single effect evaporator.

Multiple effect evaporators: temperature profile of liquids in the evaporator, enthalpy of solution, Different feeding arrangements in multiple effect evaporators – their merits and demerits. Multiple effect evaporator calculations. Evaporator selection considerations.

Vapour recompression evaporators- Mechanical and thermal recompression- Energy balance, numerical problems.

REFERENCE:

1. **Ramesh K. Shah and Dušan P. Sekulic,** *Fundamentals of Heat Exchanger Design,* John Wiley & Sons, Inc. 2003
2. **M.Necati. Ozizik**, *Heat transfer - A basic Approach,* McGraw-Hill College (1985)
3. **Binay K. Dutta,** *Heat Transfer- Principles and Applications*, Prentice Hall of India.
4. **Geankopolis C J,** *Transport Processes and Separation Process Principles*, Prentice Hall of India, 4th Edition, Eastern Economy Edition (2004)
5. **Holman J P,** *Heat Transfer*, McGraw Hill Book Co. (1992).
6. **Incropera F P and DeWitt D P,** *Introduction to Heat Transfer,* 2nd Ed John Wiley New York (1996).
7. **Kern D Q,** *Process Heat Transfer*, McGraw Hill Book Co. (1997).
8. **Coulson J M and Richardson J F,** *Chemical Engineering* Volume 1, Pergamon Press (1999).
9. **Kothandaraman C.P,** "*Heat and Mass Transfer Data Book*" New Age International, India

Note to question paper setters:

1. *Reference **No. 9** indicated in the group of references given below is allowed in the examination hall, which may be mentioned along with the directions to be provided on the facing sheet of the question paper. Steam tables are also permitted in the examination hall. No other charts, tables and codes are permitted in the Examination hall. Necessary relevant data shall be given along with the question paper by the question paper setter.*

2. *The question paper consists of Part A and Part B. Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.*

3. *Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

08.504 INDUSTRIAL MANAGEMENT (H)

Credits:3 L/T/P:2/1/0

Module I

Evolution of Scientific Management and industrial Engineering. Functions of Management- Brief description of each function . System concept. Types of organization structures such as line, line and staff, functional, project and matrix organizations. Types of companies and their formation. Personal Management – Objectives and functions – Recruitment, Selection, Training and Induction concepts and Techniques.

Cost concept: Break even analysis (simple problems). Depreciation: Methods of calculating depreciation.

Module II

Facilities Planning- Factors to be considered in site selection, layout planning, plant layout, types of layout, systematic layout planning, computerized planning techniques.

Introduction to Material Handling Principles, equipments and their selection

Work study – methods study and Time measurement, Steps in method improvement – use of charts and diagrams. Performance rating and Methods- Types of allowances, computation of basic time and standard time. Wages and incentives -system of wage incentive plans. Job evaluation and Merit rating.

Module III

Fatigue and methods of eliminating fatigue- industrial relations - Industrial disputes- Settlement Machinery – collective bargaining – Trade unions- workers participation in management in Indian context.

Labour welfare and social security- Industrial safety – Methods and Techniques.

Production Planning and Control - functions and Objectives- job, batch, mass and continuous production – Inventory control- selective inventory control techniques. Definition of EOQ.

Quality Engineering :– Quality Control- Quality Vs Cost concept, Control chart for variables and attributes- Introduction to Six Sigma- Introduction to ISO, Total Quality Management, Quality information system, Bench marking, Quality circles

Introduction to Marketing and its Environment- different concepts- marketing mix-product life cycle.

References:

1. M.A.Shahaf, “Management Accounting Principles & Practices”,Vikas publications Pvt.
2. Grant and levenworth, “Statistical Quality Control”, TMH .
3. Krafewsk. “Operations Management”, Pearson Education 6th Edn.
4. “Introduction to Work Study”- ILO
5. Besterfield, “Total Quality management”, Pearson Education
6. Richard L. Francis & John .A. White, “Facility Layout & Location”, Prentice Hall
7. Kotler, “Marketing Management”, Pearson Education.
8. Roger G. Schroedu, “Operations Management”,Mc Graw Hill.
9. Monappa, “Industrial Relations”, TMH.
10. Stephen P Robbins, David A. Deceyo,” Fundamentals of Management”, Pearson Education.

Note: Question Paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus. Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

8.505 MASS TRANSFER OPERATIONS 1(H)
Credits:4 L/T/P:3/1/0

MODULE 1

Introduction to Mass Transfer and Diffusion - Molecular diffusion in liquids and gases -- Fick's Law for Molecular Diffusion - - Steady state diffusion under stagnant and laminar flow conditions - Pseudo steady state diffusion - Diffusion through a varying cross sectional area - Molecular diffusion in Biological solutions and gels -Diffusivity measurements and prediction - multicomponent diffusion - Principles of Unsteady state and Convective Mass Transfer- Convective mass transfer coefficients - theories of diffusion in turbulent flow, mass, heat and momentum transfer analogies. Derivation of Mass Transfer coefficients in Laminar flow - Mass Transfer for flow inside pipes - Mass Transfer for flow outside solid surfaces - Diffusion of gases in porous solids and capillaries - Interface mass transfer, diffusion in solids. Equipment for gas-liquid operations, tray towers, ventury scrubbers, wetted wall towers, spray towers and spray chambers, baffle towers and packed columns.
Gas absorption : Absorption conditions of equilibrium between liquid and gas, The Henry's law - the mechanism of absorption and desorption between phases - Single stage Equilibrium contact - Counter current Multiple stage contact - Analytical Equations for Counter current stage contact (The Kremser Equations) - interphase mass transfer, liquid and gas side resistance. Design of absorbers - Liquid phase hold up - Pressure drop - Loading, flooding in packed towers. Absorption of one component, overall coefficients, dilute solution. Non-isothermal operations. Multicomponent absorption : Absorption with chemical reaction.

MODULE 2

Humidification : General theory, definition of absolute humidity- humid volume, humid-heat total enthalpy, adiabatic saturation temperature, wet-bulb temperature and psychrometric chart Enthalpy calculations involved in the following operations : Adiabatic humidification and dehumidification processes, cooling towers and related equipments, Evaluation of heat and mass transfer coefficients, Theory and calculations of Water cooling towers - Types of cooling equipments. Dehumdification - hot gas quenching towers - spray ponds .

MODULE 3

Drying : Equilibrium between a wet solid and drying air. Batch drying equipment, rate of drying curve, time of drying continous drying equipments, calculation of rate drying - Design of batch and continuous dryers.
Crystallisation : Factors governing nucleation and crystal growth rates, growth and properties of crystals, saturation, nucleation crystallisation rate and growth kinetics. Effect of impurities on crystal formation, effect of temperature on solubility, fractional crystallisation, caking of crystals, crystallisers batch crystallisers, tank crystallisers, evaporators. Use of vaccum continuous crystallisers, controlled growth of crystals, classification of equipments and typical

crystallisers. Controlled growth of crystals. Principles of design of crystallisers. MSMPR crystallisers.

TEXT BOOK

1.Treybal R.E. "Mass Transfer Operations" 3rd Edn. MGK (1980)

REFERENCES

1. Coulson J.M. and Richardson J.F. 'Chemical Engineering' Vol.I, Eb.3.
2. McCabe W.L. and Smith J.C. 'Unit Operations of Chemical Engineering' Ed. 6, (MGK - 2001)
3. Coulson J.M. and Richardson J.F., 'Chemical Engineering' Vol 2., Unit Operations, Edn. 3., Permom Press (1978)
4. Philip C. Wankat," Equilibrium Stage Separations", Prentice Hall, 1989.
5. Foust A.S. Wsenzel, L.A. Clump, C.W.Naus, And Anderson, L.B. " Principles of Unit Operations ", 2nd Edn. Wiley, 1980.

Note:
The question paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus. Part B is for 60 marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

08. 506 CHEMICAL ENGINEERING THERMODYNAMICS (H)
Credits:4 L/T/P:3/1/0

Module 1
Introduction and fundamental concepts; First law of thermodynamics- General statement of first law, first law of thermodynamics for cyclic processes, Internal energy, first law of thermodynamics for non-flow process, Enthalpy, First law of thermodynamics for flow process, Heat capacity. P-V-T relations of fluid, equations of state, principles of corresponding states, compressibility charts, Heat effects accompanying chemical reactions. Second law of thermodynamics- Limitations of first law, general statements of second law, Entropy, Carnot principle, calculations of entropy changes, Clausius inequality, mathematical statement of second law, entropy and irreversibility, Third law of thermodynamics. Applications of laws of thermodynamics-Flow processes, Refrigeration, Liquefaction processes, Steam power plant, I C Engines.

Module 2.
Thermodynamic properties of pure fluids- Reference properties, energy properties, derived properties, work function, Gibbs free energy, Relationships among thermodynamic properties: Maxwell's relations, Clapeyron equation, Entropy-heat capacity relationships, effect of temperature, pressure and volume on internal energy, enthalpy and entropy. Joule-Thomson coefficient, Gibbs-Helmholtz equation, Fugacity, Activity, Departure functions and generalized charts, Thermodynamic diagrams.
Properties of solutions: Partial molar properties, Chemical potential, fugacity in solutions, Henry's Law and dilute solutions, Activity in solutions, Activity coefficients, Gibbs-Duhem equations, Property changes of mixing, Heat effects of mixing processes, Excess properties.

Module 3
Phase equilibria: Criteria of phase equilibrium, criterion of stability, phase equilibria in single component and multicomponent systems, phase rule for non reacting systems, Duhem's theorem, vapour-liquid equilibria, phase diagram for binary solutions, vapour-liquid equilibria in ideal solutions, Non- ideal solutions, Azeotropes, vapour-liquid equilibria at low pressures, Activity coefficient equations- Wohl's three-suffix equations, Margules equation, van Laar equation; Consistency tests for VLE data. Calculation of activity coefficients using Gibbs-Duhem equation, VLE for systems of limited miscibility. Liquid-liquid equilibrium diagrams-Binary Liquid-liquid equilibrium, Ternary Liquid-liquid equilibrium diagrams. Chemical reaction equilibria: Criteria of chemical reaction equilibrium, equilibrium constant, equilibrium constant and standard free energy change, evaluation of equilibrium constant and its dependence on temperature, effect of pressure on equilibrium constant. Liquid phase reactions, Heterogeneous reaction equilibria, Simultaneous reactions, Phase rule for reacting systems.

Text Books:

1. Smith J. M and H. C. Van Ness, "Introduction to Chemical Engineering Thermodynamics", McGraw Hill,
2. K V Narayanan, "A Textbook of Chemical Engineering Thermodynamics", PHI

Reference Books:

1. Barnett F. Dodge, " Chemical Engineering Thermodynamics,
2. Abbott and Van Ness, "Schaums Outline of Theory and Problems of Thermodynamics"
3. Weber H. C and Meissner H. P, "Thermodynamics for Chemical Engineers"

Note

The question paper consists of Part A and Part B.

Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.

Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

08.507 Particle Technology And Mineral Processing lab (H)

Credits:3 **L/T/P:0/0/3**

Particle size analysis: Sieving, hydrometer analysis, pipette method, decantation and elutriation.
Screening: Study of industrial screening equipments, determination of effectiveness of screens.
Mineral Benefication: Study of equipments - mineral jig - Wilfley table
Size reduction: determination of Rittinger number using drop weight crusher, verification of laws of crushing - study of industrial equipment - ball mill - jaw crusher - hammer mill
Sedimentation: Batch sedimentation test, design of continuous thickners from batch sedimentation test data.
Study of industrial equipments for classification, centrifugal filtration, centrifuging and solids transportation
Filtration: Determination of rate of filtration curve for constant pressure filtration and determination of specific cake resistance.
Free settling: verification of stoke's law.
Cyclone separator: Determination of efficiency of separation
Flotation: Determination of efficiency of separation and optimum concentration of additives.

08.508 FLUID MECHANICS LAB (H)

Credits:3 **L/T/P:0/0/3**

Study of Plumbing tools, pipe fittings, valves, gauges and meters
Measurement of flow using notch and weirs
Measurement of flow using orifices and mouth pieces under constant and varying heads
Calibration of flow meters
Reynold's experiment
Determination Losses in pipes and fittings
Determination of Darcy's coefficient
Determination of equivalent length
Determination of velocity profile using pitot tube
Study and experiments on reciprocating pumps and centrifugal pumps
Study and experiments on centrifugal pumps

08.601 MASS TRANSFER OPERATIONS II (H)

Credits:4 L/T/P:3/1/0

MODULE 1

Basic concepts of Distillation: Vapour - Liquid equilibrium pressure - temperature - concentration - phase diagram - isothermal and isobaric equilibrium - Relative Volatility - Raoult's law - ideal solutions deviations from ideality - Minimum and maximum boiling azeotropes - Partially miscible liquids distillation - Insoluble liquids(Steam distillation) - Enthalpy - concentration diagrams - Treatment of multicomponent systems-Different distillation Methods : Flash Vapourisation of binary mixture - Simple distillation of binary mixtures - Vacuum distillation - Continuous rectification methods - brief discussion on general characteristics of tray and packed tower - Azeotropic and extractive distillation, low pressure distillation and molecular distillation.

Multistage Tray tower Design : Material and enthalpy balance of a fractionator - Ponchon and Savarit and McCabe - Thiele Method -Enriching section with total condenser and reflux below the bubble point - partial condenser - Stripping section. Complete fractionation- Feed below bubble point - Feed tray location - Effects of reflux ratio - total reflux - minimum reflux - Optimum reflux. Reboiler arrangements - use of open steam - Use of multiple feeds - efect of heat loss - Introduction of feed and its influence on operating lines - q-lines and location of tray - Fractionation of azeotropic and partially miscible binary mixtures - Tray efficiencies.

Continuous Contact Equipment: Concepts of transfer units - HTU and NTU - and height of the enriching section and stripping section - Graphical methods.

MODULE 2

Description of liquid extraction - terminologies - application of ternary liquid equilibrium - representation in equilateral triangular co-ordinate of different type systems - Effect of temperature - Representation of ternary equilibrium data in rectangular co-ordinates on total and solvent free bases, equilibria of multicomponent systems - Criteria for selection of solvent.

Design of stage wise extractors : Mixers -settlers - Sieve tray tower single - stage extraction - graphical method of determining composition, flow rates. Multistage crosscurrent extraction with practically miscible and immiscible solvents, graphical method of determining number of stages. Continuous countercurrent multistage extraction - graphical method of determining number of stages - composition and minimum solvent on total and solvent free basis - Counter current extraction with insoluble solvents - continuous counter current extraction with reflux - Graphical solution in total and solvent free basis - total reflux minimum reflux ratio.

Constructional & hydrodynamic aspects of stagewise extractors - Design of differential continuous contact extractors. Common characteristics of differential extractors. Types of extractors and their brief description - Design of differential contact tower extractors - Two resistance theory - Overall transfer Coefficient and corresponding HTU and NTU for insoluble liquids and dilute solutions - Hydro dynamics of differential contact extractors selection of extractors.

Solid Liquid Extraction: Description of leaching operations and technologies - Applications of leaching - Preparation of solid - Methods of Operation and classification of equipment - Solid - Liquid Equilibrium in leaching - methods of representation on total and inert free basis - Counter current leaching - material balance and graphical solution.

MODULE 3

Description of adsorption processes and their application - Types of adsorption - nature of adsorbents - adsorption equilibria - adsorption hysterisis - Isotherms for adsorption of single components and mixtures - Effect of temperature and pressure - Freundlich equation. Stagewise adsorption : Contact filtration of liquids - single and multistage crosscurrent adsorption - Multistage Countercurrent adsorption - Agitated vessels for solid - liquid adsorption - Multi stage fluidised bed adsorber for recovery of Vapour - Continuous Contact Adsorption : Steady state moving bed adsorber - Countercurrent adsorption of one component - Adsorption of two components - Unsteady state fixed bed adsorber - adsorption wave - break through curves and rates of adsorption.

Ion Exchange : Principles of ion exchange techniques and application - Ion exchange Equilibira - Rate of ion exchange. Modern separation Techniques - Membrane separation process - solid and liquid memberance separation process solid and liquid membranes - concept dialysis and electrodialysiss - Continuous dialyser - concept of diffusion and permeation - Concept of osmosis and reverse osmosis - Industrial application and design aspects.

TEXT BOOK :

1. Treybal R.E, " Mass Transfer Operations."

REFERENCE BOOKS :

1. Coulson J.M. and Richardson, F.F. "Chemical Engineering, Vol.I fluid Fluid, heat transfer, and Mass transfer Ed.3, Pergamon Press.
2. Coulson J.M. and Richardson, J.F. "Chemical Engineering, Vol.2 Unit Operations, Ed.3, Pergamon Press (1978).
3. Mc Cabe, W.L. and Smith J.C., "Unit Operations of Chemical Engineering" MGK.
4. Sherwood, T.K.P, R.L. and Walke, C.R., "Mass Transfer".
5. King C.J. "Separation Processes".
6. Coulson J.M. and Richardson J.F. "Chemical Engineering Volume I"
7. Coulson J.M. and Richardson J.R. "and Chemical Engineering Volume V solutions to the problem in Chemical Engineering Vol. II".
8. Marcel Mulder, "Basic Principles of Membrane Technology", ISBN 978 - 81- 8128-683
9. A . Suryanarayana, "Mass Transfer Operations".
10. Anantharaman & Sheriffa Begum, "Elements of Mass Transfer Part 1"
11. Principles of Mass Transfer - Kal Renganathan Sharma
12. Mass Transfer 1 and II by K.A.Gavhane Nirali Prakashan

Note: Question Paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus. Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

08. 602 CHEMICAL REACTION ENGINEERING I (H)

Credits:4 L/T/P:3/1/0

Module I

An overview of chemical reaction engineering. Brief outline of reactor design procedure and types of industrial reactors.

Basic concepts of chemical kinetics. Classification of chemical reactions with examples.

Rate equations, rate constant, temperature dependency- Arrhenius law, collision theory, transition state theory, comparisons and predictions.

Concentration dependency-non-elementary homogeneous reactions:

Active intermediates, pseudo steady state hypothesis (PSSH), searching for a mechanism, General considerations, hydrogen bromide reaction, polymerisation - steps in free radical polymerisation . Other examples of non-elementary reactions.

Module II

Analysis of rate equations –Interpretation of batch reactor data: integral and differential method of rate analysis.

Integral method; irreversible first order ,second order and third order type reactions, zero order reactions, reversible first and second order reactions, autocatalytic reactions. Variable volume batch reactor.

Differential method of rate analysis, method of half lives, method of initial rates, least square analysis, linearisation of rate laws.

Evaluation of laboratory reactors, Integral (fixed bed) reactor, stirred batch reactor, stirred contained solid reactor (SCSR), Differential reactors: Continuous stirred tank reactor (CSTR), Laminar flow reactor, stirred through transport reactor, recirculating transport reactor.

Module III

Ideal reactors, concept of ideality, design equations for batch, tubular and stirred tank reactors. Space time and space velocity, steady state mixed flow, plug flow and laminar flow reactors.

Multiple reactor systems, Plug flow reactor in series and parallel, equal sized mixed reactors in series, mixed flow reactors of different sizes in series, determination of the best system for a given conversion. Advantages and limitations of series combinations.

Recycle reactors, optimum recycle ratio, plug flow and mixed flow reactors for an autocatalytic reaction.

Reactor Scale-up.

Design for multiple reactions: Reactions in parallel, contacting patterns for reactions in parallel, quantitative treatment of product distribution and reactor size for reactions in parallel and series, kinetics of series parallel reaction.

Pressure drop in reactors, accounting the pressure drop in the rate law, flow through a packed bed, pressure drop in pipes, simultaneous reactions and separations, Reactive distillation, membrane reactors, inert membrane reactor.

Enzymatic reaction fundamentals, Michaelis - Menten kinetics, batch reactor calculations for enzymatic reactions. Bioreactors-cell growth kinetics- Monod equation- batch and chemostat models.

TEXT BOOKS :

1. Levenspiel Octave , "Chemical Reaction Engineering", John Wiley & Son's.

2. H, Scott Fogler, "Elements of Chemical Reaction Engineering", Prentice Hall of India

3. Smith J.M, "Chemical Engineering Kinetics," Mc Graw Hill.

Note

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
Note: No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.603 CHEMICAL TECHNOLOGY I
Credits:4 L/T/P:3/1/0

Module1

Introduction to Chemical Technology, Sectors of Chemical Industry, Overview of Indian Chemical Industry. *Industrial gases:* manufacture, properties and uses of hydrogen, oxygen, nitrogen, carbon dioxide, carbon monoxide, acetylene, hydrogen and rare gases. *Industrial acids:* Hydrochloric acid - manufacture by synthesis process, manufacture of sulphur from fuel gases, sulphuric acid manufacture by DCDA and single absorption processes, lead chamber process, sulphuric acid concentration, nitric acid manufacture from ammonia, phosphate ore beneficiation, phosphoric acid manufacture by wet process and electric furnace process. *Fertilizers:* Ammonia manufacture, manufacture of urea by once through process and total recycle process, ammonium sulphate manufacture from coke-oven gas and by direct neutralisation. *Manufacture of nitrogenous fertilizers* - ammonium chloride, ammonium sulphate, ammonium nitrate, ammonium phosphate, calcium ammonium nitrate, barium nitrate, nitro chalk and urea. P*hosphatic fertiizers* - super phosphates. P*otassium fertilizers:*-, basic slag, potassium chloride, potassium sulphate. *Compound and complex fertilizers:*- MAP and DAP, urea ammonium phosphate, ammonium phosphate sulphate, nitro phosphates, NPK fertilizers. *Other fertilizers:* Mixtures and granulated products, fluid fertilizers, controlled release fertilizers. Secondary nutrients and micro-nutrients.

Module II

Marine chemicals: Manufacture of sodium chloride, sodium sulphate, sodium silicate, byproducts of salt industry, recovery from bitterns, bromine manufacture. *Soda ash:* Manufacture by Solvay process and modified Solvay process. *Chlorine and caustic soda:* Manufacture by electrolytic process - Diaphragm cells, membrane cells, mercury cells. Purification of caustic soda and chlorine. *Electrothermal products:* Manufacture, properties and uses of graphite, fused alumina, silicon carbide, carbon disulphide. *Cements: R*aw materials, proportioning and manufacture of ordinary portland cement, dry, semi-dry and wet processes, Puzzolona Portland cement and other types of cements. Testing of cement. *Glasses:* Types, raw materials and methods of manufacture. *Ceramics:* Types, raw materials, processing methods - drying and firing of ceramic wares. *Refractories:* classification, manufacture and testing of refractories.

Module III

Oils, fats and waxes:-Manufacture of Vanaspati, *Edible and essential oils:* raw materials, manufacture, expelling methods, solvent extraction and refining. *Soaps and detergents:* Soap manufacture by fat splitting – byproduct glycerine and its purification - detergents - anionic and non-ionic - manufacture of alkyl-benzene sulphonates. *Pulp and paper:* Manufacture of pulp, mechanical and semi-mechanical and chemical methods - bleaching - paper making, recovery of chemicals from spent liquor, by-products and their uses. *Perfumes, flavours and cosmetics. Organic surface coatings* - raw materials, formation and manufacture of paints, varnishes,

enamels and lacquers. *Leather:* leather making, vegetable tanning and chrome tanning - finishing operations - chamois leather.

Text Books:

1. Austin G.T. "Shrieves Chemical Process Industries" 3rd Edn.
2. Dryden C.E. "Outline of Chemical Technology" 2nd Edn.
3. Chemtech Vol. I – IV..
5. Shukla S. I. and Pandey G.N., "A Text Book of Chemical Technology"

Note:

Question Paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus. Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

08.604 PROCESS DYNAMICS AND CONTROL (H)

Credits:4 L/T/P:3/1/0

Module 1

Introduction to process control concepts

Introduction with a suitable example to bring out concepts like *feedback control*, *feedforward control*, *negative feedback* and *positive feedback*. Importance of study of dynamics for control purpose. Generalized objectives of chemical process control: Illustrative examples to show how the effect of external disturbances are suppressed, how a process is stabilized and how an optimization of the overall performance is carried out.

Classification of variables in a chemical process. Typical design elements of a control system. Control aspects of a complete chemical plant. A brief study of various hardware elements of a typical control system. Sensors for measuring devices. Sensors for flow, pressure, temperature, composition etc. Transmission lines. Final control elements. Use of digital computers in process control.

Development of a mathematical model for control purpose

State variables and state equations of chemical processes. Transport rate equations, kinetic rate equations, reaction and phase equilibria relationships, equations of state. Dead time. Mathematical models of CSTR. mixing process, tubular heat exchangers and binary distillation columns. Input-output models of stirred –tank- heaters, mixing processes and such physical systems. Degrees of freedom and process controllers. Linearization of nonlinear systems (systems with one and two variables). Deviation variables. Linearization of nonisothermal CSTRs. Introduction to state space models concepts. State space model development of simple dynamic systems.

Laplace Transforms and Transfer Functions.

Definition of Laplace Transforms (LT). LT of the following: exponential, trigonometric, step, pulse, impulse and translated functions, derivatives and integrals. Initial value theorem, final value theorem. Inversion of Laplace Transforms. Methods of solving Ordinary Linear Differential Equations (OLDE) by using LT. Examples.

Transfer functions of systems with single input. Transfer function matrices of systems with multiple outputs. Development of the transfer function matrix for a CSTR. Representation of transfer functions with block diagrams. Block diagram algebra. Poles and Zeros of transfer functions. Qualitative nature of response of dynamical systems.

Module 2

Dynamic behavior of Low Order Systems and Pure delay Systems.

Dynamic systems with a capacity for mass storage and energy storage, Pure capacitive process, Response of pure capacitive process, Dynamic response of first order lag system. Effect of parameters on the response of a first order system. First order systems with variable time constants and gain. Second order systems. Damping factor/coefficient. Underdamped, critically damped and overdamped responses. Characteristics of standard underdamped dynamic systems

used as a measure of performance. Approximation of multicapacity process with second order models. Interacting and noninteracting capacities in series with examples. Manometer dynamics. Dynamics of tanks -in –series liquid level systems. N capacities in series. Jacketted heat exchange vessels. Systems with dead time. Systems with inverse response.

Analysis of Feedback Control Systems:
Types of feedback controllers, Proportional (P), Proportional Integral (PI) and Proportional Integral Derivative (PID) type of controllers. Parameters of PID type controllers. Block diagrams and closed loop responses. Closed loop response of the liquid level in a tank. Closed loop temperature response of a tank heater. Effect of proportional, integral and derivative control actions on the response of a controlled process. Effect of composite control actions.

Stability analysis of Feedback Systems:
The notion of stability, Characteristic equation, Routh-Hurwitz criterion for stability. Root locus analysis. Frequency response, Bode stability criterion, Bode diagrams, Nyquist stability criterion, Nyquist plots. Frequency response of closed loop systems.

Module 3

Design of Feedback Controllers:
Outline of the design problems. Simple Performance criteria, Time-integral performance criteria, Selection of type of feedback controllers. Design of Feedback Controllers by Frequency Response Techniques. Gain and Phase margins, Controller tuning, Zeigler – Nichols Tuning technique, Cohen and Coon tuning method.

A brief introduction to advanced control systems.
Only familiarity of the terms like *dead-time compensation, cascade control, selective control, split –range control, feedforward control, ratio control, adaptive control, nferential control, distributed control, direct digital control and supervisory control*. Concept of discretization and Z-transforms.

Text Book.
George Stephanopoulose, **"**Chemical Process Control, An Introduction to Theory and Practice", Prentice Hall of India, New Delhi 1999.

References :

1. Coughnowr, "Process Systems Analysis and Contro". McGraw Hill, Singapore, Second Edition, 1991.
2. W. L. Luyben, "Process Modeling, Simulation and Control for Chemical Engineers", McGraw Hill Singapore, 1990.

Question Paper:
The question paper shall contain two parts: Part A and Part B. In Part A, there shall be 10 questions each carrying 4 marks, evenly distributed over the whole syllabus. Part B shall contain two questions each carrying 20 marks, from each module of the syllabus. The candidates should answer all questions in Part A and any one question from each module in Part B.

08.605 NUMERICAL METHODS FOR PROCESS ENGINEERS (B,H)

Credits:4 **L/T/P:2/2/0**

Module 1

High speed computations using digital computers. Computer arithmetic, Error analysis. Approximation of functions- Chebyshev polynomials Economized power series, Rational functions, Fourier series. Methods of fitting models to data. Empirical relations.

Numerical solution of nonlinear, transcendental and polynomial equations. Linear interpolation methods: Bisection method, Secant method, False position method, Birge- Vieta method, Newton Raphson method, Mullers method, Fixed point iteration method, Bairstow's method, QD algorithm, Chebyshev's method, Graeffe's root squaring method, Newton Raphson method for system of nonlinear equations.

Linear Algebraic Equations: Physical problems modeled with set of linear algebraic equations, Solution of sets of linear algebraic equations. Gauss elimination, Gauss- Jordan method, LU decomposition, Crout reduction, Triangular decomposition, Iterative methods, Jacobi method, Gauss- Seidel iteration, Relaxation method, Eigen value problems- Power method, Jacob's method, Given's method.

Module 2

Finite differences: Forward, backward and central differences. Properties and relations between finite difference operators, Property of difference of a polynomial, factorial polynomial and reciprocal factorial function. Difference equations.

Interpolation with Equal Intervals: Gregory- Newton forward interpolation formulae, Central difference interpolation formulae, Gauss's forward and backward interpolation formulae, Stirling's interpolation, Bessel's interpolation, Laplace- Everet interpolation. Interpolation with Unequal Intervals: Lagrangian polynomials, Divided differences, hermite interpolation, Piece-wise linear interpolation, Cubic splines, Bezier curves and B- splines.

Numerical Integration and Differentiation: Derivatives using Newton's forward and backward interpolation formulae. Use of Stirling's formula, Undetermined coefficients and Finite difference. Newton- Cotes Quadrature formula, Trapezoidal rule, Composite Trapezoidal rule, Simpson's rule, Boole's rule, Romberg integration. Gaussian Quadrature, Gauss- Legendre integration. Lobatto integration, Adaptive integration, Double integrals.

Module 3

Ordinary Differential Equations (ODE): Physical examples- The spring- mass problem, Initial value problem, Taylor- Series method, Euler's method, Modified Euler's method, Runge- Kutta method, Multi- step methods- Predictor- Corrector methods, Adams- Moulton method, Adams-Bashforth method, Boundary Value Problems:

Partial Differential Equations (PDE): Types of PDE, Physical examples: Temperature distribution in a rod, Temperature distribution in a slab, Solution methods: Shooting method, Alternating direction implicit method. Types of partial differential equations: Solution techniques for the Heat equation and the Wave equation in one and two dimensions- Numerical solution of Lapace equation.

Reference Books:

1. CURTIS F. GERALD and PATRICK O. WHEATLEY. Applied Numerical Analysis, Pearson Education Asia, Sixth Edition, 2002.
2. T. VEERARAJAN and T. RAMACHANDRAN, Numerical Methods With Programs in C, Second edition, TMH, 2006.
3. M. K. JAIN, S. R. K. IYENGAR and R. K. JAIN, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, 2007.

Note

The Part A in the question paper shall contain ten short answer questions each carrying 4 marks evenly distributed over the entire syllabus. Part B shall consist of three modules with two questions from each module of the syllabus. The candidate should answer any one question from each module which carries 20 marks.

08.606 EL1 (A) Colloid & Interface Science (H)
Credits:3 L/T/P:2/1/0

ModuleI
Colloids of Materials, Basic concept, Preparation Techniques and Characterization methods of colloidal Material- Brownian motion and Brownian Flocculation- Colloidal and Interfacial forces: Vander Walls, Double layer and Other short -range forces

Module II

Interfaces: Basic concept, Interfacial tensions- Laplace equation- Contact angle and Young and Laplace equation-Methods to evaluate contact angles- Thermodynamics of Interfaces- Interfacial tension- Specific interface energy- Gibbs adsorption Equation-Kelvin equation- Two dimensional Equation of state- Hamakkar constant.

Module III
Stability of Colloidal Dispersion and Interfaces: DLVO theory, Thin Film Stability-
Electrokinetic Phenomena- Electrophoresis and other phenomena- Zeta potential determination methods- Electro viscous flow- Capillary statics- shapes of dros and thin films
Association of Colloids: Micelles, Micellar Thermodynamics, Micellar applications
Industrial applications: detergency, Shampoo, Ink, Spray and other system

Reference Books:

1. P.C. Hemenz and R. Rajagoplan, Principle of Colloids and Surface Chemistry, 3rd Ed, Dekker, New York, 1997.
2. R.. Stokes and D.F. Evans, Fundementals of Interfacial Engineering, Wiley, New York, 1997
3. A.W. Adamson and A.P. Gast, Physical Chemistry of surfaces, 6th ed, Wiley, New York, 1997
4. C.A. Miller and P. Neiagi, Interfacial Phenomena, Dekker, 1985

Note:
The question paper consists of Part A and Part B.Part A is for 40 marks and comprises of ten compulsory short answer questions each carrying 4 marks, covering the entire syllabus. Part B is for 60 marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module

08.606 EL 1(B) Fertilizer Technology (H)

Credits:3 **L/T/P:2/1/0**

Module 1

Introduction, history and development, classification - chemical, organic, inorganic and biofertilizers. Solid and liquid fertilizers. Fundamentals of nutrient management, primary, secondary and micronutrients, economics of plant nutrient use. Basic soil plant relationships, nutrient availability in soil, fertilizer usage, fertility evaluation of soil. Manufacture of fertilizers and their intermediates: Ammonia manufacture, manufacture of urea by once through process and total recycle process, ammonium sulphate manufacture from coke-oven gas and by direct neutralisation.

Module II

Manufacture of nitrogenous fertilizers - ammonium chloride, ammonium sulphate, ammonium nitrate, ammonium phosphate, calcium ammonium nitrate, barium nitrate, nitro chalk and urea. Phosphatic fertilizers - phosphate ore beneficiation, phosphoric acid manufacture by wet process and electric furnace process. super phosphates - single and triple super- phosphate. Potassium fertilizers - basic slag, potassium chloride, potassium sulphate. Compound and complex fertilizers:- MAP and DAP, urea ammonium phosphate, ammonium phosphate sulphate, nitro phosphates, NPK fertilizers. Other fertilizers: Mixtures and granulated products, granulation techniques. Fluid/liquid fertilizers - Urea Ammonium Nitrate, Superphosphoric Acid, Ammonium Polyphosphate, controlled release fertilizers.

Module III

Biofertilizers: rhizobium blue green algae, azospirillum, azolla, acetobactor and phosphate solubilizing bacteria. Organic farming Vs chemical farming. Sampling and analysis of fertilizer, grading, regulations, consumption pattern, optimum dosage/fertilizer management system, storage and handling pricing and their manufacturing industries in India. Safety, health and environment – Corrosion in fertilizers industries, green house emission, effluent treatment and disposal.

References:

1. Ferman E Bear., "Chemistry of soil".
2. John L Havlin, James D Beaton, Samuel L Tisadale, Wernor L Nelson., "Soil fertility and fertilizers". PHI publications
3. Nyle C Brady., "Nature and properties of soil", Eureshia publication
4. Austin G.T. "Shrieves Chemical Process Industries" 3rd Edn.
5. Chemtech Vol. II
6. Govt. of Kerala proceedings of the national workshop on fertility evaluation for soil health enhancement.
7.Fertilizer Manual., United Nations Industrial Development Organization (UNIDO) & International Fertilizer.Development Center (IFDC)., Kluwer Academic Publishers.
8. Pitam singh & U.S. Aw Asthi "Fertilizer Industry in India", Karishma publishers.
9. Bench mark, "Soils of kerala", soil survey organization, Agriculture unit.

Note: *Question Paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus. Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

08.606 EL I (C) FUEL CELL TECHNOLOGY (H)
Credits:3 L/T/P: 2/1/0

MODULE I

Fuel Cell & Electrochemistry Basics and thermodynamics: Introduction/History, Fuel Cell and conventional processes – comparison, Fuel Cell types brief outline: PEM FC, DMFC, SOFC, AFC, PAFC, Energy & power relations, units, Performance characteristics, Application scenarios, Power converter for sustainable energy – advantages and disadvantages, General Thermodynamics, Enthalpy-Heat potential of fuel, Gibb's free energy-Work potential of fuel, Reversible voltage - NERNST Equation, Voltage and P, T and concentration dependence – examples, Faraday's Laws, Efficiency: thermodynamic, voltage and fuel.

MODULE II

Fuel Cell & Electrochemistry Basics: Kinetics and transport fundamentals: Electrochemical reaction fundamentals, electrode kinetics, Charge transfer and activations energy, Exchange current density - slow and fast reactions, Potential and equilibrium - galvanic potential, Reaction rate and potential - Butler Volmer equation & Tafel equation, Electrocatalysts and reaction kinetics – typical exchange current densities, Electrode design basics, Charge transport resistances, voltage losses, Ionic and electronic conductivites, Ionic conduction in different FC electrolytes: Aquesous, polymeric and ceramic, Diffusive transport & voltage loss: Limiting current density, Nerstian and kenetic effect, Convective transport: flow channels, gas diffusion / porous layer, gas velocity, pressure, Flow channel configurations.

MODULE III

Power plant subsystems and FC System variants: Brief outline: PEMFC, AFC, PAFC & SOFC comparison Gas storage options, Humidification systems for PEMFC, Thermal management systems, Control and monitoring strategies, Micro Fuel Cells (MFCs), Regenerative Fuel cells (RFCs), Bio fuel Cells (BFCs).

REFERENCES

1. **Vielstich, W.; Gasteiger, H. A.; Lamm, A.** (Eds):*Handbook of Fuel Cells-Fundamentals, Technology and Applications.* John Wiely & Sons Ltd: NY, 2003; Vols1-4
2. **Larminie, J.; Dicks, A.** *Fuel Cell Systems Explained.* John Wiely & Sons Ltd: Chichester, 1999.
3. **Ryan P. O'Hayre, Suk-Won Cha, Whitney Colella & Fritz B. Printz,** *Fuel Cell Fundamentals*, John Wiley & Sons, Inc., New Jersey, 2006
4. Fuel Cell Handbook,7the Edn., EG & G Technical Services, Nov 2004
5. **Kordesch, K.; Simader, G.** *Fuel Cells and Their Applications.* VCH: 1996
6. **Hordeski, M. F.** *Alternative Fuels: The Future of Hydrogen*, The Fairmont Press: Lilburn, GA, 2007.
7. **Costamagna, P.; Srinivasan, S,** ***J*** *Power Sources* **2001**, *102*, 242-252.

8. **Costamagna, P.; Srinivasan, S,** *J. Power Sources* **2001**, *102*, 253-269.
9. **Andreas Zuttel; Andreas Borgschulte; Louis Schdaptach,** *Hydrogen as a future energy carrier*, Wiley-VCH Verlag GmbH & Co., KGaA, Weinheim, 2008.

Note
*The question paper consists of Part A and Part B. Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.*
*Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

08.606 EL I(D) OPERATIONS RESEARCH (H),
Credits:3 L/T/P:2/1/0

Module 1

Origins, nature and impact of Operations Research (OR). Development of OR as a branch of knowledge since World War II. Fields of applications of OR. Steps to be performed when an OR study is to be carried out. Introduction to Linear Programming (LP). LP model, assumptions of LP, Graphical solution, Simplex method, Revised Simplex Method, Duality Theory and Sensitivity analysis. Economic interpretation of duality and relationship between *primal* and *dual* problems. Applications. Dual Simplex method, Parametric linear programming, upper bound technique, Transportation problem, Assignment problem, Transhipment problem. Practical applications and examples.

Module 2

Network Optimization Models: Terminology of networks, Shortest path problem, Minimum - spanning -tree problem, Maximal -flow problem, Travelling salesman problem, Minimum cost flow problem. Network Simplex method. Project Management: Use of network concepts to represent project management problems, Scheduling a project with PERT/CPM. Uncertain activities, Controlling project costs, Time-cost trade-off
Introduction to dynamic programming, Stochastic programming and Integer programming. Replacement – Replacement in anticipation of failure, Individual and Group replacement. Scheduling on Machines – Two-job Two-machine problem, Johnson's algorithm, Graphical solution.

Module 3

Game theory – Practical applications of game theory, Two-person zero-sum games, Solving simple games, Mixed strategy, Graphical solution, Solving by LP. Decision Theory, Statistical decision theory, Decision making with and without experimentation, Decision Trees, Utility theory.
Stochastic processes, Markov Chains, Chapman- Kolmogorov Equations, Classification of states of a Markov chain, Long-Run properties of Markov Chains, First passage times, absorbing states, Continuous –tine Markov Chains. Queuing theory, Queueing Models, Exponential distribution, Birth- and- death processes, Basic queuing process, Single server and multiple server models, Poisson input and exponential service, Limited queue, Priority disciplines, Applications.
Inventory theory, Deterministic continuous- Review models, Deterministic periodic review models, Stochastic continuous-review model, model for perishable products. Stochastic periodic review models, Large inventory systems in practice.

References :

1. Hillier and Lieberman, *Introdu7ction to Operations Research*, Tata McGraw Hill 2001
2. Paneer Selvam, Operations Research, 2nd edition, Prentice Hall of India,

3. Taha, *Operations Research*, MacMillan
4. Naqner and Prandtl Philips and Ravindran, *Introduction to Operations Research*, John Wiley
5. Ackoff and Sasienie, *Fundamentals of Operations Research*, Wiley
6. Churchman, Ackoff and Arneff , *Operations Research*, Wiley

Note:
The question paper shall contain two parts. Part A shall contain ten compulsory short questions, evenly distributed over the whole syllabus and each carrying 4 marks. Part B shall contain three separate modules with two questions from each module of the syllabus. The candidate has to answer any one from each module. Questions in each module shall carry 20 marks each.

08. 606 EL 1(E) ELECTROCHEMICAL TECHNOLOGY(H)

Credits:3 **L/T/P:2/1/0**

Module I

Electrodes and separators for the electrolytic production of inorganic chemicals – preparation, characteristics and applications of graphite, magnetite, lead dioxide coated anodes, noble metal coated anodes, noble metal oxide coated anodes, spinal anodes, Perovskite anodes, steel cathodes, coated cathodes, diaphragms and ion exchange membranes. Electrolytic production of sodium hypochlorite, chlorates, bromates and iodates of sodium and potassium, sodium, potassium and ammonium perchlorates, perchloric acid, potassium and ammonium persulphates, hydrogen peroxide, potassium permanganate, cuprous oxide and maganese dioxide – Basic principles, reaction mechanisms, effect of operating variables, cell design and operating characteristics of industrial cells. Production of hydrogen by water electrolysis. Electrodialysis and its application to desalination of water electrolysis and waste recovery.

Module II

Basic principles of Electro organic chemistry, constant current electrolysis, controlled potential electrolysis, material yield, current efficiency, selectivity and energy consumption for electro organic synthesis. Paired synthesis with example. Cathodic reduction of carbonyl compounds, nitro compounds, unsaturated compounds, nitriles and oximes. Electrohydrodimerization and cathodic coupling reactions, cathodic reactions using mediators. Anodic halogenation, oxidation through redox carriers – metal ion, non-metal ion and organic mediators. Anodic coupling reactions. Kolbe synthesis, mechanism and applications. Anodic oxidation of aromatic hydrocarbons and phenol.

Module III

Anodic substitution reactions: alkoxylation, acetoxylation, cyanation and acetamidation. Electro polymerization. Anodic and cathodic polymerization with example (anionic polymerization, cationic polymerization and radical polymerization). Electrochemical preparation of conducting polymers such as polyacetylene, polypyrrole, polythiophene, polyaniline and their applications (excluding mechanism of polymerization). Industrial Electro organic processes such as adiponitrile from acrylonitrile, dimethyl sebacate from monomethyl adipate, Tetra alkyl lead from alkyl chloride, perfluorooctanoic acid from octanoylchloride, Aromatic aldehydes from toluenes. Electrochemical fluorination of organic compounds - Electrochemical perfluorination, Electrochemical selective/partial fluorination with examples.

Text books:

1. D.Pletcher and F.C.Walsh, “Industrial Electrochemistry”, Chapman and Hall, London, 1990.
2. A.T.Kuhn, “Industrial Electrochemical Process”, Elsevier Publishers, 1971.
3. M.M.Baizer, “Organic Electrochemistry”, Dekker Inc, Newyork, 1983.
4. M.R. Riti and F. H. Covitz Marcel Dekker, “Introduction to Organic Electrochemistry”, Inc. NewYork 1994

Note:
The question paper consists of Part A and Part B.
*Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.*

*Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module*

08.606 EL1 (F) ENERGY ENGINEERING (H)
Credits:3 L/T/P:2/1/0

Module 1
Classification and sources of energy; problems relating demand and supply of various energy sources- Energy, Economics and Environment relations- GDP coupling- Coal : origin and formation, composition and classification, resources and production, exploration and mining; analysis and testing storage and handling- coal carbonization-briquetting,-coal hydrogenation- Wood and wood products.- Petroleum; origin, occurrence; Chemical composition.- World reserve, production, refining operations, storage and conveying, testing and analysis different products from petroleum like naphtha, aviation gasoline, kerosene, diesel oil, gas oil, lubricating oil, asphalts etc., petroleum coke, oil shale and oil sand- Combusting methods; and systems, pulverised coal furnaces; cyclone furnaces, oil fired systems, gas fired systems, waste heat boilers.

Module 2
Nuclear energy: basic aspects of nuclear radiation, fission and fusion, process reactor systems; BW/PW/HW reactor; gas cooled reactors, fast breeder reactor; thermal design; problems of nuclear power generations and remedial measures.
Solar energy: Facts and scope; solar radiation; radiation measuring instruments; basic flat collector; solar heat pump and heat engine cooling and refrigeration; solar pond; conversion of solar energy into electrical energy; solar thermal power generation; hydroelectric energy; problems of hydro-electric energy and remedial measures. Thermal power plants, generation cycles, energy from ocean tidal wave, ocean thermal source; geothermal energy; wet steam and water, hot dry rocks, electricity from exothermal; sources; wind energy; tunnel mills and conversion cycles.

Module 3
Biogas plant and its design: KVIC plants, process kinetics, digester design, sludge treatment, energy from wastes. Development in energy routes-Conversion of heat to power : thermoelectric converters; thermo-electric refrigerators magneto-hydrodynamics; fuel cells; conversion of chemical energy into electricity, fuel cell performance; energy accounting utility and process system optimization, energy audit, energy economics, reducing energy loss, co-generation, efficiency improvement; energy conversion in petrochemical industries, polymer industries, natural organic industries, fertilizer industries etc.

Text Books**;**

1. S.B Pandya, Conventional Energy Technology - Fuels and chemical Energy - TMH (1987)
2. S.P. Sharma and Chander Mohan, Fuels and Combustion, TMH, 1984
3. Kash Kori, C., Energy resources, demand and conservation with special reference to India, TMH, 1975.
4. J.Twidell and T.Weir, Renewable Energy Sources ,Cambridge University Press

Reference Books**:**

1. Gulp Jr., Principles of Energy Conservation, MGK (1979)
2. Chemtech I, Manual of Chemical Technology, Vol.I. S. chand and Co., New Delhi (1985)
3. Pryde P.R., Non Conventional energy resources" JW (1983)
4. Connolly, T.J., Foundation of nuclear engineering JW (1978)
5. Gray T.J. and Gashos G.K., Tidel Power,Plenum Press (1972)

6. Sarkar S., Fuels and Combustion, Orient Longmahs (1974)
7. Duffie T.R. and Beckman, W.A., Solar Energy Thermal Processes JW (1974).

Note:
The question paper consists of Part A and Part B
Part A is for 40 marks and comprises of ten compulsory short answer questions each carrying 4 marks, covering the entire syllabus.
Part B is for 60 marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module

08.606 ELI (G) TECHNICAL ENGLISH COMMUNICATION SKILLS (B,H,E)

Credits:3 **L/T/P:2/1/0**

MODULE I

Vocabulary and Functional English: This area attempts at making learners withstand the competition at the transnational technical environment so as to enable them to undertake various professional operations.
1) Vocabulary – a basic word list of one thousand words.
2) Functional grammar, with special focus on Common Errors in English.
3) Idioms and Phrasal verbs.
(A brief review of the above topic is only desired)

Listening, Speaking and Reading: This area exposes the learners to the standard expressions including stress, rhythm and various aspects of isolated elements and connected speech.

The use of diphthongs, elements of spoken expression, Varieties of English, accent neutralization

Listening Skills: Listening for general content, Intensive listening, listening for specific information. Sounds, stress, intonation, question tag, listening to lectures, audio/video Cassettes, asking and answering questions, note-taking, dialogue-writing.

Speaking Skills: Oral practice: Describing objects/situations/people-Role play-(Individual and group activities) Just A Minute (JAM)/Group Discussion.

Reading Comprehension: This area exposes the learners to the techniques deciphering and analyzing longer texts pertaining to various disciplines of study.

Types of Reading, Sub skills of Reading, Eye span – fixation, Reading Aloud and Silent Reading, Vertical and Horizontal Reading, Vocalization and sub-vocalization.

Reading Skills: Skimming the text- exposure to a variety of technical articles, essays, graphic representation, and journalistic articles.

MODULE II

Written Communication Skills: This area exposes the learners to the basic tenets of writing; the style and format of different tools of written communication

Description (through Paragraph Writing), Reflection (through Essay Writing), Persuasion (through indented Letter Writing), Skills to express ideas in sentences, use of appropriate vocabulary -sentence construction-paragraphs development-note making, informal letters,

essentials of telephonic conversation, invitations, minutes of a meeting, editing a passage and essay writing.

Technical communication skills

Technical Report Writing (Informational, Analytical and Special reports), Technical Vocabulary, Technical communication- features, distinction between general and technical communication, language as a tool of communication: levels of communication, interpersonal, organizational, mass communication, the flow of communication: upward, downward and lateral, importance of technical communication, barriers to communication.

Technical English for specific purposes (ESP): Business letters-sales and credit letters, letter of enquiry, letter of quotation, placing order. Job application and resume. Official letters-government letters, letter to authorities. Reports-types, significance, structure and style, writing reports, condensing .Technical proposals-writing a proposal –the steps involved. Technical papers- projects- dissertation- thesis writing. Preparing audio-visual aids.

MODULE III

A non-detailed study of the autobiography: "Wings of Fire-An Autobiography by APJ Abdul Kalam".

Students should read the book on their own and selected topics may be discussed in the class.

REFERENCES

1. **Andrea J Rutherford**, *Basic Communication Skills for Technology, Pearson* Education.
2. **Mohan K and Sharma R C**, *Business Correspondence and Report Writing*, Tata Mc Graw Hill
3. **Barun K Mitra,** *Effective Technical Communication,* Oxford University Press, New Delhi.
4. **Robert J Dixson,** *Everyday Dialogues in English*, Prentice Hall of India.
5. **Lakshmi Narayanan K.R,** *English for Technical Communication,* Vol. I and II, Sci Tech Publications.
6. **Abdul Kalam A.P.J,** *Wings of Fire-an autobiography, Universities* Press, 2004.
7. **Randolph Quirk,** *Use of English Ist Edn,* Pearson, 1962
8. **Thomson A.J and Martinet A.V,** *Oxford Practical English Grammar 3rd Edn,* University
9. **Thomas Eliot Berry,** *Most Common Mistakes in English Usage*, McGraw Hill
10. **Sarma B.S,** *Structural Patterns and Usage in English*, Poosha Series
11. **John Langan, College Writing Skills**, Tata McGraw Hill, 2001.
12. **Louis Trimble,** *Technical Communication Skills in English,* Cambridge University Press.
13. **John Gartside,** *Business Communication,* ELBS, 1991.
14. **Sethi J and Dhamija P.V,** *A Course in phonetics and spoken English*, Prentice Hall, 2004.

University Examination. Maximum Marks: 100

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Six *short questions to be answered out of 8 questions from Module I. Each question in Module I carries 5 marks (So the maximum Marks for Module I is 30). Two questions out of four have to be answered from Module II. Each question in module II carries 15 marks. (So the maximum mark for Module II is 30). Module III consist of four essay questions out of which two questions has to be answered. Each question in Module III carries 20 marks. (So the maximum mark for Module III is 40).*

08.606 ELI (H) NANO-ENGINEERING OF MATERIALS (H)
Credits:3 L/T/P:2/1/0

MODULE I

Introduction to; Nanotechnology. its emergence and challenges, classification of nano-materials: Zero, one, two and three dimensional nano-structured materials. Supramolecular Chemistry: Definition and examples of the main intermolecular forces used in supramolecular chemistry. Self-assembly processes in organic systems. Main supramolecular structures. Types of Nanomachines and nanotechnology-periodic table-Atomic structure molecules and phase Energy-Molecular and Atomic size-surfaces and dimensional space-Top down and bottom up.

Instrumentation for nanoscale characterization: Basic characterization techniques; Electron microscopy; Atomic force microscopy; Photon correlation spectroscopy. The measurable properties and resolution limits of each technique, with an emphasis on measurements in the nanometer range.

MODULE II

Methods of Synthesis of Nanometerials: Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches. Biologically-Inspired nanotechnology basic biological concepts and principles that may lead to the development of technologies for nano engineering systems. Coverage will be given to how life has evolved sophisticatedly; molecular nanoscale engineered devices, and discuss how these nanoscale biotechnologies are far more elaborate in their functions than most products made by humans.

Synthesis of nano-particles through homogenous and heterogeneous nucleation, kinetically confined synthesis of nano-particles synthesis of nano-wire, rod, tubes and thin films. Special nano-materials: carbon, carbon fulrenes and carbon, nano-tubes, nano and microporous materials, core shell structure and nano-composites. Electrical, magnetic, optical, thermal and mechanical properties of nano-structured materials. Applications of naon-materials in molecular electronics, nano-electronics, catalysis, photoelectrochemical cells, photonics, quantum well, quantum dot and quantum wire devices.

MODULE III

Manufacturing of nanoscale materials: Chemical vapor deposition of varbon nano tubes, Plasma deposition of ultra thin functional films on nano materials, structural nano composites, carbon nano fibre and carbon nano tube/polymer composite fibres and films.Nano scale intelligent materials and structures. Synthesis of Boron nitride nano tubes using ball milling and annealing method.

REFERENCES

1. **Jean-Marie Lehn,** *Supramolecular Chemistry,* Wiley VCH, 1995
2. **Jonathan Steed & Jerry Atwood,** Supramolecular Chemistry, John Wiley & Sons, 2004
3. **Jacob Israelachvil**, *Intermolecular and Surface Forces*, Academic Press, London, 1992.

4. Rao **C.N.R., Muller A., Chutham A.K,** *The Chemistry of Nanoparticles Synthesis, Properties and Applications, Vol 1 and Vol 2,* WILEY-VCH
5. **Challa Kumar,** *Tissue, Cell And Organ Engineering*, Vol 9, WILEY-VCH, 2006
6. **Challa Kumar,** *Nanomaterials for Medical Diagnosis and Therapy,* Vol 10, WILEY VCH,
7. **William A. Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J. Iafrate,** *Handbook of Nanoscience, Engineering, and Technology,* CRC Press Taylor and Francis Group, 2007
8. **Bhushan**, *Handbook of Nanotechnology*, Springer–Springer,2007
9. **Challa Kumar,** *Nanomaterials for Cancer Diagnosis and Therapy, Vol 6 and 7*, WILEYVCH, 2007
10. **Challa Kumar**, *Nanodevices for Life Sciences, Vol 4*,WILEY-VCH, 2006
11. **Gero Decher and Joseph B. Schlenoff,** *Multilayer Thin Films*, Wiley-VCH Verlag GmbH and Co. KGaA, 2003
12. **David S. Goodsell,** *Bionanotechnolog, Lessons from Nature*, Wiley-Liss, 2004.
13. **Kenneth J. Klabunde,** *Nanoscale Materials in Chemistry*, John Wiley & Sons, Inc., 2001
14. **Christof M. Niemeyer and Chad A. Mirkin,** *Nanobiotechnology: Concepts, Applications and Perspectives* by Wiley-VCH; 1 edition, 2004
15. **Guozhong A.O,** *Nano structure and nano-materials,* Imperial College Press, London
16. **Poole P, Jr and Frauk J. Owens,** *Introduction to Nano technology*, Charles P, Wiley Interscience, New Jersey, 2003.
17. **Carl C. Koch. Noyes,** *Nano-structured materials: Processing, properties and Potential Applications*, William Andrew Publishing New York.
18. **David S. Goodsell,** *Bionanotechnology: Lessons from Nature,* Wiley
19. **Pradeep.T,** *Nano: The Essentials,* Tata McGraw-Hill Publishing Company Ltd, 2007.
20. **Nicholas A.Kotov** , *Nanoparticles Assemblies and Superstructures,* 2006, CRC.
21. **Ralph et al,** (Eds), *Nanoscale Technology in Biological Systems,* 2005, CRC.
22. **Fujita H,** *Micromachines as Tools for Nanotechnology*, Springer Verlag, 2003
23. **Niemeyer C.M and Mirkin C.A,** *Nanobiotechnology Concepts, Applications and Perspectives* 2004, Wiley VCH Verlag GMBH and Co.
24. **Mark J. Schulz, Mannur J. Sundaresan, Ajit D. Kelkar,** *Nanoengineering of Structural, Functional and Smart Materials,* CRC Press

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10 compulsory** *short answer questions each carrying 4 marks covering the entire syllabus. Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.*

08.607 MASS TRANSFER OPERATIONS LABORATORY(H)
Credits:3 L/T/P:0/0/3

Diffusion coefficient measurement _ Wetted wall column, measurement of mass transfer coefficient.
Distillation : Determination of VLE, steam requirement and vapourisation efficiency, efficiency in steam distillation, verification of Rayleigh's equation for simple distillation, Distillation in packed columns, HETP.
Absorption : Verification of design equation for height of packing in packed tower absorption of ethanol in water, absorption of carbon dioxide in sodium carbonate solution.
Surface evaporation - Free convection mass transfer.
Liquid extraction : Determination of ternery liquid - liquid equilibria.
Leaching : simple leaching; cross current leaching and counter current leaching.
Adsorption : Determination of absorption isotherm.
Drying : Determination of drying rate curve and mass transfer coefficient for atmospheric batch drying.
Fluidisation - Determine experimentally the pressure drop versus superficial velocity plot and find minimum and settling velocity.

REFERENCES :

1. Shankar Srinivas, "Mass Transfer Operations- A Lab Manual for Chemical Engineering CEED, III Madras
2. R.E. Treybal, "Mass Transfer Operations " MGH
3. Perry and Chilton, "Chemical Engineers Hand Book" MGH.

08.608 HEAT TRANSFER OPERATIONS LABORATORY (H)
Credits:3 L/T/P:0/0/3

1. Determination of thermal conductivity of solids
2. Determination of thermal conductivity of liquids
3. Determination of emmissivity for surface heat transfer
4. Determination of heat transfer coefficient by natural convection:
5. Determination of heat transfer coefficient by forced convection: Forced convection heat transfer for flow of fluids through heated ducts- Determination of forced convection heat transfer coefficients and heat verification of established correlations.
6. Determination of heat transfer coefficient of fins by natural convection
7. Determination of heat transfer coefficient for fins by forced convection
8. Forced Convection Heat transfer without Phase change:Determination of heat transfer coefficient by film-type condensation
9. Determination of boiling heat transfer coefficient by conducting pool boiling experiment: Determination of heat transfer coefficients in pool boiling heat transfer for single and multi-component systems.
10. Determination of overall heat transfer for parallel flow and counter flow in double pipe heat exchanger
11. To conduct test on heat pipe and compare the temperature distribution
12. Determination of overall and individual heat transfer coefficients and effectiveness in shell and tube heat exchanger
13. Determination of overall heat transfer coefficient in an open pan evaporator
14. Heat Transfer in Composite walls- Determination of effective thermal conductivity and overall resistance.
15. Determination of radiation constant, emissivity, natural convection and radiation heat transfer coefficient for combined convection and radiation.
16. Evaporation: Study of evaporation equipment - determination of steam economy in multiple effect evaporators.
17. Heat transfer in packed beds.
18. Heat transfer in fluidised beds
19. Transient Heat Conduction: Determination of natural Convection heat transfer coefficient using the principle of lumped and distributed parameter capacity analysis using Heisler Charts.

Note : At least 10 experiments shall be performed.

REFERENCES

1. Shankar Srinivas, "Heat Transfer Operations - A Lab Manual, Chemical Engineering Education Development Centre, IIT Madras
2. Perry and Chilton, "Chemical Engineers Hand Book".
3. Fundamentals of Heat and Mass Transfer, Incropera and Dewitt, Wiley

08.701 CHEMICAL ENGINEERING DESIGN I (H)
Credits:5 L/T/P:3/2/0

Module I
General design considerations; Design codes; Design pressure; Design temperature; Design stress; materials; welded joint efficiencies; corrosion allowances; Design loads, liquid storage tank codes, classification, Storage tanks for liquefied gases, Horizontal, cylindrical storage tanks with flat head, design of shell, bottom plates, self supported, and column supported roofs, wind girder, nozzles and other accessories.
Bolted Flanges: Types of Flanges, and selection, Gaskets-Design and selection of gasket, gasket seating , bolt diameter. Design of non-standard flanges.

Module II
Unfired pressure vessel: Pressure vessel codes, classification of pressure vessels, Design of cylindrical and spherical shell under internal and external pressures; Selection and design of flat plate, torisperical, ellipsoidal, and conical clousures, compensations of openings.
Tall vertical & horizontal vessels: Pressure dead weight, wind, earthquake and eccentric loads and induced stresses; combined stresses, Shell design of skirt supported vessels. Vessel supports; Design of skirt, lug, and saddle supports.
Design of Pipes: Pipe thickness, pipe diameter for condensate piping, pipe diameter for steam, pipe supports. Design of pipe lines for natural gas, transportation of crude oil. Pipe lines in sea water. Pipeline design on fluid dynamics parameters. Optimum size of delivery of pump operation.

Textbooks:
1. Bhattacharya, B.C.,"Introduction to Chemical Engineering Design – Mechanical Aspect", Chemical Engineering Education Development Centre, IIT, Madras.
2. Joshi, M.V., "Process Equipment Design", McMillan India.
3. Brownell & Young, "Process Equipment Design", John Wiley.

References:
1. Perry, Robert H., Green Don W "8th Edn- Perry's Chemical Engineering Handbook"-McGraw Hill New Delhi.
2. E.E. Ludwig – "Applied Process Design in Chemical Petrochemical Plants" – Gulf Publishing Co. 1964 Vol. – 2.
3. Coulson J.M. Richardson J.F. – "Chemical Engineering Vol-6th Edn". Pergaman Process.
4. Standards : IS 403 (1967), 803 (1963) & 2825 & TEMA

Note:
The question paper consists of Part A and Part B. Part A is for **50** marks and comprises of 2 questions from first module. The candidate has to answer one question from it. Part B is for **50** marks and comprises of 2 questions from second module. The candidate has to answer one question from it. IS Codes mentioned in the reference (item no. 4) are permitted for the examination.

08.702 CHEMICAL TECHNOLOGY II (H)
Credits:4 L/T/P:3/1/0

Module I

Petroleum: Classification of crude, characteristics of crude – U.O.P Characterisation factor, Correlation Index, Distillation Characteristics –True Boiling Point(TBP) and ASTM distillation, Equilibrium Flash Vapourization (EFV), viscosity and viscosity index, refinery classification and chemical composition of crude. Processing of crude - sweetening, atmospheric and vacuum distillation of crude, cracking and coking, refining, reforming, hydro - cracking and isomerisation. Production of lubricating oils, lube additives. Motor gasoline, kerosene, aviation turbine fuel and aviation gasoline. *Petrochemicals:* Primary processes for olefins, acetylenes, higher homologues, aromatics and their derivatives, propylene, acetylene, methanol and its derivatives. *Sugar:* Manufacture from sugar cane and sugar beet, refining of crude sugar, by-products of sugar industry. *Starch:* Raw materials, manufacture from corn, maize, tapioca. Manufacture of Dextrin and Dextrose. *Fermentation Products:* Manufacture of alcohol, alcoholic beverages and High Fructose Corn Syrup (HFCS).

Module II

Pesticides:- Classification of Insecticides, Fungicides, Weedicides, Herbicides and Rodenticides. Manufacture of Malathion, Parathion, DDT, BHC, and Endosulfan. *Dyes and intermediates:* Classification, unit processes and unit operations in the manufacture of dyes, pigments and brighteners. *Drugs and Pharmaceuticals:* Classification, raw materials and manufacture of important sulpha drugs, analgesic, antipyretic, antibiotics and anti-inflammatory drugs. Formulations of Tablets, Capsules, Ointments, Liquids and Parenterals. Phytochemicals. *Wood and Wood chemicals:* Saccharification of wood, destructive distillation of wood. Composite wood: - plywood, laminated wood, fibre board and particle board.

Module III

Plastics: Classification, techniques of polymerization, manufacture and uses of phenol formaldehyde, urea formaldehyde, polyethylene, poly vinyl resins, cellulose nitrate and cellulose acetate. Processing of plastics. *Man made fibres:* Manufacture of viscose rayon fibre, cellulose acetate fibres, nylons, polyesters, acrylics and modacrylic fibres, vinyl and vinylidines, glass fibres. *Rubber:* Manufacture of natural and synthetic rubbers. Styrene butadiene rubbers (SBR), acrylonitrile butadiene rubber (NER), polymethanes, silicon rubbers, polybutadiene. Compounding, vulcanising and reclaiming of rubber, processing of rubber.

Text Books :

1. Austin G.T. "Shrieves Chemical Process Industries" 3rd Edn.
2. Dryden C.E. "Outline of Chemical Technology" 2nd Edn.
3. Chemtech Vol. I – IV
4. Shukla S. I. and Pandey G.N., "A Text Book of Chemical Technology".

Note:

Question Paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus. Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

08.703 CHEMICAL REACTION ENGINEERING II (H)
Credits:4 L/T/P:3/1/0

Module 1

Non isothermal reactor design - Temperature and pressure effects - single reactions : Heat of reaction from thermodynamic, heat of reaction and temperature, equilibrium constants from thermodynamics, equilibrium conversion, adiabatic temperature and equilibrium, general graphical design procedure, optimum temperature progression.

Heat effects: adiabatic operations and nonadiabatic operations, Nonisothermal continuous flow, reactors at steady state, application to the CSTR, adiabatic tubular and batch reactor, steady state tubular reactor with heat exchange. Product distributions and temperature for multiple reactions.

Unsteady state operation: General design equations, unsteady operations of plug flow reactors, CSTR and batch reactors.

Module II

Heterogeneous Reactions

Catalysis and catalytic reactors: Catalysts, types of catalysts, catalyst properties, steps in a catalytic reaction, adsorption equilibrium constant, desoption, surface reaction, rate limiting step, contacting patterns for two phase systems.

Development of design equations for ideal mixed batch reactor, plug flow tubular reactor and perfectly mixed continuous stirred tank reactor for heterogeneous systems. Heterogeneous data analysis for reactor design, deducing the rate laws from the experimental data, catalyst deactivation, deactivation mechanisms, weight loss.

Diffusion and reaction in porous catalysts- effective diffusivity, tortuosity-modelling of diffusion with reaction on a spherical catalysts. Thiele Modulus, internal effectiveness factor, Overall effectiveness factor. Estimation of diffusion and reaction limited regimes - Weisz - Prater criterion for internal diffusion, Mears criterion for external diffusion.

Fluid Particle Reactions (Non catalytic)

Selection of a model: Unreacted core model for spherical particles of unchanging size, model development for diffusion through gas film, ash layer, and chemical reaction controls.

Rate of reaction for shrinking spherical particles - chemical reaction controls, diffusion controls-application to design.

Fluid-fluid reactions - Rate equations, Kinetic regimes for mass transfer and reactions, rate equation for instantaneous and fast and slow reactions, two film theory, film conversion parameters.

Module III

Non-ideal Flow

Residence time distribution for chemical reactors: General characteristics - RTD functions. Measurement of the RTD - pulse input, step tracer input, integral relationships, mean residence time, other moments of the RTD, Normalized RTD function E(theta), Interval age distribution. RTD in ideal reactors: Batch and plug flow reactors, single CSTR RTD, Laminar flow reactor, PFR/CSTR series RTD. Reactor modelling with RTD - use of RTD to determine conversion. RTD models - segregation models, tanks in series model, the dispersion model. Conversion for the tanks-in-series model, fitting the dispersion model for small extents of dispersion and large

extents of dispersion. Models for small deviations from plug flow and long tails. Mixing of fluids - self mixing of fluids - degree of segregation, early and late mixing of fluids.

TEXT BOOKS :

1. Levenspiel Octave, "Chemical Reaction Engineering, Third Edition", John Wiley & Son's
2. H,Scott Fogler, "Elements of Chemical Reaction Engineering", Prentice Hall of India
3. James J Carberry, "Chemical &Catalytic Reaction Engineering", Mc Graw Hill

Note:

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
Note: No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.704 EL 2 (A) BIOCHEMICAL ENGINEERING (H)
Credits:4 L/T/P:3/1/0

Module I

Micro Biology: Cell theory, Structure of cells: – Procaryotic and Eucaryotic cells, cell fractionation, classification of microbes, protist kingdom. Important cell types (animal and plant cell) and their distinguishing characteristics. *Chemicals of life:* Cell polymeric chemicals - repetitive and non repetitive bio polymers - lipids, sugars and polysaccharides, nucleotides - RNA and DNA, amino acids and proteins. Protein structure, hybrid bio-chemicals, hierarchy of cellular organization. *Kinetics of Enzyme catalyzed reactions:* simple enzyme kinetics with one or two substrates, Michaelis - Menten Kinetics, Evaluation of parameters in Michaelis - Menten equation, kinetics of two substrate reactions.

Module II

Substrate concentration dependence of enzyme catalysed reactions: substrate activation and inhibition, multiple substrates reacting on a single enzyme. Modulation and regulation of enzyme activity - competitive and uncompetitive inhibition, other influences on enzyme activity. Enzyme specificity and enzyme specificity hypotheses. Applied enzyme catalysis: enzymes of industrial importance. Isolation of crude enzyme - Koji technique - Enzyme purification. Immobilized enzyme technology: enzyme immobilization - industrial process using immobilized enzymes - medical and analytical applications of immobilized enzymes. Applications of hydrolytic enzymes: esterases, carbohydrases, proteolytic enzymes, enzyme mixtures, pectic enzymes and additional applications. Medical application of enzymes, non hydrolytic enzymes in current and developing industrial technology.

Module III

Metabolic pathways and energetics of the cell: Metabolic reaction coupling : ATP, ADP and NAD. Oxidation and reduction- Coupling via NAD. Embden-Meyerhof pathway (EMP), Pentose phosphate cycle - Entner Doudorff (ED) pathway, Respiration - TCA cycle, Kerb cycle, Photo Synthesis. Transport across cell membranes - passive transport, active transport and facilitated diffusion. Kinetics of substrate utilization - product formation and biomass production, measuring and monitoring of growth process (Hemacytometer, colony count and turbidity methods). Batch cultivation - growth cycle (lag, exponential, stationary and death phase). Fermentation schemes - Gaden's classifiation (type I, II and type III) and Deindoerfer classification. Transport phenomena in Bio process system-Gas-liquid mass transfer in cellular system - basic mass transfer and concepts - rates of metabolic oxygen utilisation - determination of oxygen transfer rates-mass transfer across free falling or raising bubble and free surface with or without agitation in heat transfer. Microbial heat generation and correlation, bio-chemical reactors, types of reactors for sterilization, fermentation and Bimass production.

Text Books :

1. James E. Baileay and David F. Ollis., “Bio-chemical Engineering Fundamentals”. Mc Graw Hill International Editions.
2. D G Rao., “Introduction to Biochemical Engineering”, Tata Mc Graw Hill.
3. Michael L Shuler and Frikret Khargi., “Bioprocess Engineering Basic Concepts” Phi Publications.

4. Rajiv Dutta., “Fundamentals of Biochemical Engineering”. Anu books.

Note: *Question Paper consists of Part A and Part B.Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus.Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

08. 704 EL I1 (B) POLYMER TECHNOLOGY (H)
Credits:4 L/T/P:3/1/0

MODULE 1
Properties of polymers : Classification & Properties of polymers - Polymerisation process, Mechanism and kinetics of polymerisation reactions -chain growth (addition polymerisation), Step growth (polycondensation) polymerisation synthesis and application of some common industrial polymers –
Mechanism and Kinetics of polymerisation reactions - Determination of physical and chemical properties of polymer theology and mechanical properties of polymers, intrinsic viscosity - solubility paper maters. Polymer analysis of characterise sation - testing methods (physical, chemical, electrical), characterisation. Behaviour of polymers - crystalline, thermal, dilute solution, rheological, chemical degradation, stability of polymers - polymer waste disposal and remedies.
Mechanism and kinetics of polymerisation reactions, step reaction polymerisation, radial chain polymeristion - non radical chain polymerisation - C0-polymerisation - conditions of polymerisation reactions and details of manufacture. Olefin polymerisation - Polymers derived from dienes - vinyl and vinilidane polymers - Fluro carbon polymers - Hetero chain thermo plastics - Cellulose polymers - Thermosetting resins.

MODULE 2
Polymer Technology - Plastic, fibres, elastomers, adhesives, polymer additives - plasticizers, fillers and reinforcements etc. Plastic Technology - Moulding - plastification - injections and compression moulding - Transfer moulding - calendering - Cast blowing - Coating - extrusion - Forming - Thermofusion - Fillers - Plasticisers and other additives.
Polymer processing - Casting, thermoforming, forming lamination reinforcing, processing of fibres, moulding process, calendaring` . Polymer bleeds, toughened plastic and phase separated bleeds, mechanical properties and fabrication.

MODULE 3
Commodity of Plastic & fibres – Poly olefins – vinyl polymers – thermoplastic polymers – fibres (natura) and synthetic fibres – cellulosic – non cellulosic – fibre spinning operations
Natural Polymers – Poly saacharides – proteins – nucleic acids – natural rubber – Inorganic Polymers – silicons, poly phosphene – organo metallic co polymers – coordinate polymers – Net work polymers- elastomers and thermosets – Diene elastomers – non diene elastomers – thermo plastic elastomer – thermosets – epoxys – unsaturated polymers – formaldehyde resins – Engineering and Speciality polymers – Engineering thermo plastics – poly amides – ABS – poly carbonates – Engineering polyester – Fluro polymers
Speciality polymers – Polyimides – ionic polymers – poly acryl ether ketone – speciality poly olefins –
Liquid crystalline polymers – conductive polymers – bio medical polymers – polymers for combating environmental pollution

TEXT BOOKS :
1. Kumar and Gupta - Fundamentals of Polymer Science and Engineering, Tata Mc Graw Hill.

2. P. Bahadur N.V.Sastri, “Principles of Polymer science,” Narosa Publication

REFERENCE BOOKS :

1. Billmeyar, - F.W, Text book of Polymer Science.
2. Schmidt - Marlier - Principle of High Polymer Theory and practical.
3. Rodriguax Terdianol - Principles of Polymer systems, Mc Graw Hill Kusha (1970)
4. Joel R. Fried ,“Polymer Science & Technology”, Prentice Hall India Ltd
5. R.Sinha, “Outlines of Polymer Science &Technology – Processing Polymers”, Prentice Hall of India, New Delhi

Note:

The question paper shall contain two parts. Part A shall contain ten compulsory short questions, evenly distributed over the whole syllabus and each carrying 4 marks. Part B shall contain three separate modules with two questions from each module of the syllabus. The candidate has to answer any one from each module. Questions in each module shall carry 20 marks each.

08.704 EL II (C) PROCESS MODELING AND SIMULATION (H)
Credits:4 L/T/P:3/1/0

Module 1
Introduction to modeling. Principles of system modeling, System modeling applied to process engineering systems. Systematic approach to model building, Classification of models, Conservation principles, thermodynamic principles and reaction kinetics principles of process systems. Development of steady state lumped parameter models. Dynamic lumped parameter models based on first principles.

Module 2
Analysis of ill-conditioned systems. Development of Grey-box models, Empirical model building. Statistical model calibration and validation. Population balance models, Stochastic models. Examples.

Module 3
Solution strategies for lumped parameter model. Stiff differential equations solutions. Solution for distributed parameter models. Solving parabolic, elliptic and hyperbolic partial differential equation models, Finite element and finite volume methods.

References:

K. M. Hangos and I. T. Cameron, *Process Modelling and Model Analysis*, Academic Press, 2001

W. L. Luyben, *Process Modeling, Simulation and Control for Chemical Engineers*, 2nd edition, McGraw Hill Book Co. New York, 1990.

W. F. Ramirez, *Computational Methods for Process Simulation*, Butterworhs

Mark E. Davis, *Numerical Methods and Modelling for Chemical Engineers*, John Wiley and Sons, 1984.

Singiresu S. Rao, *Applied numerical Methods for Engineers and Scientists*, Prentice Hall, NJ, 2001

Note:
The question paper shall contain two parts. Part A shall contain ten compulsory short questions, evenly distributed over the whole syllabus and each carrying 4 marks. Part B shall contain three separate modules with two questions from each module of the syllabus. The candidate has to answer any one from each module. Questions in each module shall carry 20 marks each.

08.704 EL2(D) NEW SEPARATION PROCESSES(H)
Credits:4 L/T/P:3/1/0

Module I
Limitations of common separation techniques like sedimentation, screening, filtration, evaporation, distillation, absorption, liquid-liquid and solid liquid extraction.
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. Concepts and definitions in adsorption: adsorbent types; their preparation and properties; different types of adsorption isotherms and their importance; adsorption types; basic mathematical modeling with suitable initial and boundary conditions for different cases such as thermal swing, pressure swing, and moving bed adsorption.

Module II
Introduction to membrane processes. Types of membranes, Membrane processes and their applications, Porous sand solid membranes, Osmosis, Micro – Filtration, Ultrafiltration, Nanofiltration, Reverse Osmosis, Piezodialysis, Electrodialysis, Dialysis, Membranes for gas separation, Pervaporation. Applications to these processes. Liquid membranes: Supported and unsupported liquid membranes, Applications and mathematical modeling. Characterization of porous membranes, Characterization of ionic membranes, Characterization of non – ionic membranes. Polarization phenomena and fouling concentration polarization, Characteristic flux behavior in pressure driven membrane operation, Various models, Temperature polarization, Membrane fouling, Methods to reduce fouling. Modules and process design: plate and frame, Spiral wound, Tubular, Capillary, Hollow fiber modules and their comparison, System design.

Module III
Foam Separation: Surface Adsorption, Nature of foams, Apparatus, Applications, and controlling factors. Parametric pumping: thermal parametric pumping, batch, continuous pumping, multi-component separation, pH-parametric pumping, heatless parametric pumping. Ionic Separation: Controlling factors, Applications, Equipments for Electrophoresis, Dielectrophoresis, Electro Dialysis and Ion - Exchange, Commercial processes. Adductive Crystallization: Molecular addition compounds, Clathrate compounds and Adducts, Equipments, Applications, Economics and Commercial processes. Adsorptive chromatographic separations processes, hybrid separation technologies-membrane chromatography and electrochromatography. Extractive separation, aqueous two-phase extraction, supercritical extraction.

Textbooks:

1. H. M. Schoen, "New Chemical Engineering Separation Techniques", Inter Science Publications, New York, 1972.
2. Wankat PC , Rate Controlled separations , Elsevier, 1990
3. Asenjo JM, Separation processes in Biotechnology, 1993, Marcel Dekker Inc
4. Basic Principles Of Membrane Technology, Marcel Mulder, Kluwer Academic Publishers, 1997

References:

1. King J. – Separation Process – McGraw Hill

2. Kaup EC – Design Factors In reverse osmosis – Chemical Engineering 80 (1973).
3. Arden TV – Water Purification By ION Exchange – Butterworth, London, 1968
4. Sirkar K. & Winston H.O. "Membrane Hand Book" Van Nostrand Reinhold, New
5. D. M. Ruthven, "Principles of adsorption and adsorption processes", John Wiley & sons, 1984
6. Belter PA and Cussler *E, Bioseparations*, Wiley 1985
7. The McCabe WL and Smith JC-Unit Operation of Chemical Engineer Tata McGraw – Hill

Note:

The question paper consists of Part A and Part B.

*Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.*

*Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module*

08.704 EL (2)E FOOD TECHNOLOGY AND ENGINEERING(H)
Credits:4 L/T/P:3/1/0

Module I
Food Process Engineering - Fundamentals: Fundamentals of food process engineering, application of quantitative methods of material and energy balances in food engineering practices. Unit Operations In Food Industries: Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations in food processing. 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. Mechanical Operations In Food Processing: Conversion operations, Size reduction and screening of solids, mixing and emulsification, filtration and membrane separation, centrifugation, crystallization, extraction.

Module II
Rice: Harvesting, Threshing and Drying, Milling of Paddy, Parboiling, Ageing and Curing, Utilization of By-Products of Rice Milling, Processed Rice Products, Storage of Paddy. Wheat: Production and Marketing, Handling and Storage, Chemical Composition, Quality criteria, Milling, Milled Products and their Utilization, Indian Standards for wheat and wheat products. Pulses Milling: Traditional Milling of Pulses, Modern method and machinery for dhal milling, Puffing of Pulses, Manufacture of Gum from Guar seeds. Fruits and Vegetables: Present status of Industry, Raw materials, Preservation of fresh fruits and vegetables, manufacturing methods, Fruit and vegetable processing machinery and equipment, regulation of manufacturing practices and standards. Cashew nut: Cashew industry, Processing of Cashew nuts, By products. Spices: Spice production and export, Production and Processing of individual spices, Spice products. Starch: Introduction, Starch manufacture, Properties of Starch, Starch conversion products, standards for starch and starch products. Bread and Biscuits: Importance of Baking industry in India, Raw materials for bread manufacture, manufacture of bread, biscuits

Module III
Confectionery: Raw materials, manufacture of sugar confectionery, typical Confectionery products, chocolate Confectionery, Indian Confectionery. Vegetable Protein Products: Vegetable protein availability in India, vegetable raw materials and their processing, vegetable protein products. Soft beverage industry: Synthetic soft drinks, Coffee, Processing of Coffee beans, Tea, Tea processing, Cacao, Processing of cacao fruit, processing of cacao nibs. Alcoholic beverages: Fermented beverages, distilled beverages, by products, ISI Specifications for alcoholic beverages. Dairy Products: Milk management, fluid milk processing, manufacture of dairy products, new process innovations. Meat: Production, Slaughtering and dressing, Cold storages, meat and poultry products, byproducts. Fish and fish products: Marine fish production, fresh fish, frozen fish, canned fish, cured fish, fish products and byproducts, fish processing machinery. Infestation Control: Post harvest practices, techniques of infestation control in tropical urban and rural storages, pesticide formulations, equipment and appliances.
Food preservation: Drying, freeze drying, precooling, freezing, storage of food products.

Text books:

1. R. T. Toledo, "Fundamentals of Food Process Engineering", AVI Publishing Co., 1980.
2. R. Angold,G.Beech and J.Taggart, " Food Biotechnology", Cambridge University Press, 1989.
3. Lidsay, willis Biotechnology, Challenges for the flavour and food industries, Elsevier Applied Science

REFERENCES:

1. J. M. Jackson and B. M. Shinn, "Fundamentals of Food Canning Technology", AVI Publishing Co.,
2. J. G. Bernnan, J. R. Butters, N. D. Cowell and A.E.V.Lilley, "Food Engineering Operations", 2nd Edn.,
Applied Science, 1976.

Note:

The question paper consists of Part A and Part B.
*Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.*

*Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module*

08.704 EL 2(F) Production of particulate systems (H)

Credits: 4 **L/T/P: 3/1/0**

Module I

Characterization of solid particles- shapes and sizes- Sampling Techniques for solids: Tabling, coning and quartering etc- isokinetic sampling for suspensions, Production of particulate system: size reduction fundamentals, ultra grinding-granular flows-storage of solids-Pneumatic transportation, flow in bins, silos etc

Module II

Introduction of agglomerisations- Pelletizing, briquetting, extrusions, granulation, tabletting etc- Role of binders for agglomerisation- Product characteristics: Durability, Abration and Drop resistance.

Agglomerization systems: The importance of mixing, Proportioning, Control- Post treatment of agglomerisation- Metering of recycle, screening- Population Balance model applications to agglomerisation systems-Applications.

Module III

Introduction to Atomization- Applications- Break up of drops- Disintegration of liquid jets and sheets- Drop size distribution: mean diameter- Drop size dispersion

Different types of Atomizer- Pressure Atomizers, Rotary Atomizers, Air assist Atomizer, Ultrasonic atomizers, Effervescence Atomizers etc

Reference Books:

1. Arthur. H. Lefebvre, Atomization and Sprays, Hemisphere Pub.co, 1989
2. Nasr. G.G, Industrial Sprays and Atomization: Design, Analysis and applications, London, Springer, 2002
3. L.J. Enrique, Spray atomization and deposition, John Wiley, 1996
4. K. Kesava Rao, Introduction to Granular flow, Cambridge University Press, 2008
5. M.J Howe, Interfaces in materials: Atomic structures, Thermodynamics and Kinetics of solid-Vapour, Solid-Liquid and Solid-Solid interfaces, New york, John Wiley, 1997.

Note:

The question paper consists of Part A and Part B

Part A is for 40 marks and comprises of ten compulsory short answer questions each carrying 4 marks, covering the entire syllabus.

Part B is for 60 marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module

08.704 EL2(G) Process Plant safety & Hazard assessment(H)

Credits: 4 **L/T/P: 3/1/0**

MODULE 1

Introduction to safety- Goals of safety engineering- chemistry of fire - combustion- composition of combustion-Classification of fires-Flame: flammability principles, Ignition, rate of burning-Heat transfer from flames-Fire hazards - health- flammability - reactivity (stability). Air contaminants generally found in fires- toxic effects of fire gases- Fire prevention - handling (storing flammable and combustible liquids, elimination of ignition sources).

Fire detection-smoke detection, heat detectors, flame detectors. Fire suppression - different type of fire extinguishers and their handling-Fixed automatic sprinklers- water deluge and portable fire extinguishers

MODULE II

Origin of process hazards- laws, codes, standards-Chemical, mechanical, physical and health hazard of industrial substance- Hazard zone classification-hazard due to static electricity-safety in electrical systems- Chemical hazards, toxic chemicals- dust, gases, fumes, mists, vapours and smoke- Safety in chemical reactions and storage and transport of chemicals.-Material transportation rules- Hazard chem. Code- Safety in the case of processes or operations involving explosives or flammable dust, gases, etc.- work permit system- First aid and treatment to victims- Personnel protection system-House keeping- Inherent safety design principles

MODULE III

Importance of safety- identification of hazards- different adopted methods for the identification of hazards- HAZOP, HAZAN, fault and even tree analysis- Fire protection in plants and factories- fire walls, fire doors etc- Designing for safety, emergency planning and disaster management.-Safety movement- safety organizations and movement: ILO, NSC, LPA Safety management system: BS8800, SHAS, 18001 &18002

Text books:

1. Simonds: Safety management
2. Gupta R.S.: Handbook of Fire Technology
3. Dan Peterson: Techniques of safety management

Reference:

NFPA, Fire protection hand book
R S Gupta, Hand book of fire technology
F P Lease, Loss prevention in process plant
G L Wells, Safety in process plant design

Note:

The question paper consists of Part A and Part B

Part A is for 40 marks and comprises of ten compulsory short answer questions each carrying 4 marks, covering the entire syllabus.
Part B is for 60 marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module

08.705 EL3(A) BIOPROCESS ENGINEERING (H)

Credits: 4 **L/T/P: 3/1/0**

MODULE – I

***Overview of bioprocess engineering*:** Engineering perspective of fermentation processes – role of bioprocess engineers- integrated bioprocessing-- comparison of bioprocess engineering with biochemical engineering.

Kinetics of microbial growth and product formation: Microbial growth as an autocatalytic reaction- specific growth rate- Malthus' law-quantification of cell concentration-determination of cell number density and biomass concentration- direct and indirect methods- Key determinants of cell population kinetics- growth patterns and kinetics in batch cultures- batch growth curve-kinetics of exponential growth- implications of endogeneous and maintenance metabolism- death phase kinetics- yield and maintenance coefficients- classification of microbial products - growth associated, non-growth associated and mixed growth associated product formation- Leudeking Piret equation- influence of various environmental conditions such as temperature, pH, DO concentration, redox potential, DCO_2 concentration, ionic strength and substrate concentration on growth kinetics-heat evolution by microbial growth- classification of fermentation processes-Gaden's scheme and Deindoerfer's scheme- Batch, fed-batch and continuous fermentations-ideal reactors for kinetics measurements- Ideal batch reactor, Ideal chemostat, fed-batch reactors, ideal plug-flow tubular reactors- design equations based on biochemical reactions.

Thermal death kinetics of cells and spores: Survival curve- decimal reduction factor, Extinction probability-sterilization of culture medium- batch and continuous sterilization- design aspects- air sterilization- design of fibrous type filters.

Kinetic modelling of cell growth: Model structure and complexity- different perspectives for kinetic representations using models- prediction of specific growth rate using unstructured un-segregated models-Monod equation- Monod chemostat model- Models with growth inhibitors (substrate inhibition, product inhibition and inhibition by toxic compounds)- logistic equation-growth models for filamentous organisms-structured kinetic models- compartment models, metabolic models, cybernetic models.

***Bioreactor engineering*:** Comparison of bioreactors with chemical reactors- Analysis of non-ideal behavior in bioreactors- reasons for non ideality-importance of RTD studies- stimulus-response experiment-circulation time distribution, exit age distribution, F-curve and C-curve-mean and variance of residence time-diagnosis of ills of flow reactors- models for non-ideal reactors- zero, one and two parameter models (with emphasis on the tanks in series model and dispersion model)- estimation of biochemical conversion using these models- application of dispersion model to design of continuous sterilizers – design of novel bioreactors- packed bed bioreactors, Bubble-column bioreactors, fluidized bed bioreactors, trickle bed bioreactors, airlift loop bioreactors, photobioreactors,- Key issues in bioreactor design and operation -alternate bioreactor configurations- bioreactor dynamics- stability analysis in bioreactors- nontrivial and wash out steady states.

MODULE-II

Mass transfer in bioprocessing systems: Gas liquid mass transfer- volumetric oxygen transfer coefficient- correlations (Cooper correlation, Oldshue correlation, Yamamoto correlation, Yoshida correlation, Richards correlation) – oxygen transfer mechanism- assessment of K_La-

chemical method, dynamic differential gassing out method, dynamic integral gassing out method, oxygen balance method, enzymatic method- merits and demerits of each method.
Scale up and scale down of bioprocess systems: Need for scale up and scale down- operating boundaries for aerated and agitated fermenters- scale up criteria for microbial cell processes- constant power input per unit volume, constant K_La, constant mixing quality, constant momentum factor, constant impeller tip speed, constant mixing rate number- scale up example with flow chart- scale down procedure.
Monitoring and control of bioprocesses:
Fermentation monitoring: Various physical, chemical and biological parameters measured or controlled in bioreactors-Physical and chemical sensors for fermentation medium and gases- online sensors for cell properties-offline analytical methods- measurement of medium properties and cell population composition- flow cytometry.
Analysis by Microfluidics: Basic principles of flow based analytical techniques, flow injection, sequential injection, Bead injection and Sequential injection chromatography- methods and applications.
Measurement analysis: Use of digital computers for data acquisition, interpretation and analysis- software systems- data smoothing and interpolation –Fault analysis- state and parameter estimation methods- use of observers or estimators.
Process control: Open loop and closed loop control-direct regulatory control, cascade control of metabolism- programmed control- application of artificial intelligence in bioprocess control- knowledge based expert systems, neural networks (A brief overview of the above is only required).
Bioprocess modeling and simulation: Structure of bioprocess models- concept of balance domain- model validation using MATLAB- objectives and benefits of bioprocess simulation- simulation tools such as SIMULINK, Biopro Designer, Biotechnology Design Simulator and Bioprocess Simulator.
MODULE-III
Medium engineering for cell cultivation and bioreaction: Technological concerns of medium design engineering in bioprocessing-design procedure for growth and production medium- stoichiometric design approach- bioorganic reaction medium engineering- Novel media.
Immobilized cell systems: Potential advantages of cell immobilization, methods of active and passive immobilization-diffusional limitations in immobilized enzyme systems-bioreactor considerations.
Bioprocess considerations in using plant and animal cell cultures: Methods for cultivation of animal cells-requirements for culturing of animal cells-bioreactor design considerations- perfusion systems-products of animal cell cultures- importance of plant cell cultures-comparison of plant cell and microbes in culture-bioreactor considerations for suspension cultures, immobilized systems and organ cultures- products of plant cell cultures
Bioprocess systems for genetically engineered organisms: Basic elements of genetic engineering, genomics and bioinformatics- guidelines for choosing host-vector systems- comparison of strategies-genetic instability in recombinant cell cultures- segregational loss, plasmid structural instability, host cell mutations, growth rate dominated instability- considerations in plasmid design to avoid process problems- simple mathematical model for prediction of genetic instability- regulatory constraints on genetic processes- outline of metabolic engineering and protein engineering with simple case studies.

Medical applications of bioprocess engineering: overview of tissue engineering-commercial tissue culture processes-gene therapy using viral vectors-use of bioreactors as artificial hybrid organs and for mass production of cells for transplantation.

REFERENCES

1. **Pauline. M. Doran,** *Bioprocess engineering principles,* Academic press.1995.
2. **James. E.Bailey, David.F. Ollis** *Biochemical engineering fundamentals*, Second edition, McGraw Hill.1986.
3. **Michael. L.Shuler, Fikret Kargi** *Bioprocess engineering- Basic concepts* ,second edition, Prentice Hall of India.2002.
4. **Colin Ratledge and Bjorn Kristiansen** *Basic Biotechnology*, Second edition, Cambridge university press.2001.
5. **Mukhopadhyay. S.N** *Process Biotechnology fundamentals*.
6. **Mukesh Doble and Sathyanarayana.N.Gummad**, *Biochemical Engineering*, Prentice Hall of India. 2007.
7. **D.G.Rao**, *Introduction to Biochemical Engineering*, Tata Mcgraw Hill. 2005.
8. **Nielsen J and Villadsen J and Liden G,** *Bioreaction Engineering Principles*, 2nd Edition, Kluwer Academic. 2003.
9. **Irving J. Dunn, Elmar Heinzle, John Ingham and Jiri E. Prenosil,** *Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples*, 2nd Edition, Wiley- VCH. 2003.
10. **Jackson AT,** *Bioprocess Engineering in Biotechnology,* Prentice Hall, Engelwood Cliffs, 1991.
11. **Aiba S, Humphrey AE and Millis NF,** *Biochemical Engineering*, 2nd Edition, University of Tokyo press, Tokyo, 1973.
12. **Mansi EMTEL, Bryle CFA.** *Fermentation Microbiology and Biotechnology*, 2nd Edition, Taylor and Francis Ltd, UK, 2007.

Note:

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.

08.705 EL III(B) COMPUTATIONAL FLUID DYNAMICS (H)

Credits: 4 **L/T/P: 3/1/0**

Module 1

Introduction to Computational Fluid Dynamics (CFD). History of development of CFD. Philosophy of CFD, CFD as a research and design tool. Experimental, analytical and computational approaches to prediction of fluid flow and heat transfer processes. Review of derivation of governing equations of transport processes. Classification of the differential equation models. Navier–Stokes and Euler equations. Turbulent flow: Time–averaged equations of turbulent flow, Turbulence–kinetic energy equations, k-ε model, Mixing length model, the Physical meaning of these equations and forms suitable for CFD methods.

Module 2

Discretization methods – Taylor series, variational formulation, weighted residuals, Concepts of finite control volume and infinitesimal fluid elements. Finite difference and finite element methods. Properties of discretization schemes- conservativeness, boundedness, transportiveness, Grid generation- structured, unstructured and adaptive grid generation.

Steady state one- dimensional conduction, grid spacing, interface conductivity, Nonlinearity, source-term linearization, boundary conditions. Steady one-dimensional convection – diffusion, Discretization equations in one, two and three dimensions. The upwind scheme, exponential scheme, hybrid scheme, power law scheme. Higher order schemes.

Module 3

Un-steady state one-dimensional conduction. Crank Nicholson scheme, Fully implicit schemes, Fully implicit discretization equation, CFD methods for solving unsteady flow equations, Implementation of inlet, outlet and wall boundary conditions, Constant pressure boundary condition, Two and three dimensional situations, Beam warming algorithm, MacCormack's scheme, upwind scheme. Discretization of transient convection-diffusion equation, Overrelaxation and underrelaxation. Customizing commercial CFD solvers. Construction of geometry and discretization using Gambit-Fluent's manuals : Commercial CFD Solver packages. Components of CFD packages.

References :

1. Anderson J. D., *Computational Fluid Dynamics: The Basics with Application,* McGraw Hill Co. Inc
2. Anderson D. A., Tannechil J. C., and Pletcher R. H., *Computational Fluid Mechanics and Heat Transfer*, Hemisphere Publishing Corp.,
1. ANIL W. DATE, Introduction to Computational Fluid Dynamics, Cambridge University Press, 2005
2. Suhas V. Patangar, *Numerical Heat Transfer and Fluid Flow*, Hemisphere Publishing Corp., 1980

3. C. T. Shaw, using Computational Fluid Dynamics, Prentice Hall, 1992.
4. Joel H. Ferziger, Milovan Peric, *Computaional Methods for Fluid Dyamics*, Springer Verlag, 3rd edition, 2001.
5. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press

Note:
The question paper shall contain two parts: Part A and Part B. In Part A, there shall be 10 questions each carrying 4 marks, evenly distributed over the whole syllabus. Part B shall contain two questions each carrying 20 marks, from each module of the syllabus. The candidates should answer all questions in Part A and any one question from each module in Part B.

08.705 EL III(C) PROCESS OPTIMIZATION (H)

Credits: 4 **L/T/P: 3/1/0**

Module 1

Scope and hierarchy of optimization, Examples of application of optimization in Chemical Process Engineering. Features of optimization problems. General procedure for solving optimization problems. Simple problems of optimization.
Classification of models for the purpose of optimization. Fitting models to empirical data. Factorial experimental designs, method of least squares. Fitting models to data subject to constraints. Formulation of objective functions, Investment costs and operating costs. Time value of money. Measures of profitability, Optimizing profitability, Financial evaluation of projects. Cost Estimation. Continuity of functions, unimodality and multimodality, convex and concave functions, convex region, necessary and sufficient condition for extremum of an unconstrained function, Interpolation of objective function in terms of quadratic approximation

Module 2

Optimization of unconstrained functions: Numerical methods for optimizing functions of one variable: Scanning and bracketing, Newton's method, quasi-Newton's method, and secant method. Region elimination methods, two –point equal interval search, dichotomous search, golden section method, Fibonacci search, polynomial approximation methods, Quadratic and Cubic interpolation, Application of line search to multidimensional problems.
Unconstrained multivariable optimization: Direct methods- Random Search, Grid Search, univariate Search, Nelder Mead Simplex method, method of Conjugate Directions, Powells Method, Indirect Methods: Gradient Method, Steepest Descent and Steepest Ascent, Method of Fletcher and Reeves, Indirect Second order method, Newton's method, method of forcing the Hessian to be Positive definite, Marquardt's method, Movements in search directions. Line search, Trust regions, Termination Secant method, BFGS Method

Module 3

Linear Programming and its Applications: Basic Concepts of Linear Programming, Degenerate LPs, Graphical Solution, Natural Occurrence of linear Constraints, Simplex method, Standard LP form. Dual Simplex method, Big- M method, Revised Simplex Method, Sensitivity Analysis, Duality in LP, Karmarker Algorithm, LP applications. Introduction to dynamic programming: Advantages and Disadvantages of dynamic programming, applications of dynamic programming, examples. Integer programming and mixed integer programming.
Application of Optimization in Chemical Engineering: Optimum design and operation of staged distillation columns. Optimal design of shell and tube heat exchangers. Applications to fluid flow systems.

Text Book:

T. F. Edgar and D. M. Himmelblau, “Optimization of Chemical Processes”, McGraw Hill, Singapore, 1989.

Reference:

A. Ravindran, K. M. Ragsdell and G. V. Reklaitis, “Engineering Optimization: Methods and Applications”, Wiley India Pvt Ltd. New Delhi, 2006.

Note:
The question paper shall contain two parts. Part A shall contain ten compulsory short questions, evenly distributed over the whole syllabus and each carrying 4 marks. Part B shall contain three separate modules with two questions from each module of the syllabus. The candidate has to answer any one from each module. Questions in each module shall carry 20 marks each.

08.705 EL III (D) WATER AND WASTE WATER ENGINEERING (H)

Credits: 4 **L/T/P: 3/1/0**

Module I

Introduction to Water Supply and Wastewater- Water Quality Parameters and Standards- Characteristics of water: physical, chemical and biological parameters, standard methods of water analyses, biodegradable waste and agricultural runoff in streams, population forecasting, prediction of water demand and wastewater generation, water and wastewater quality,

Module II

Water and wastewater treatment plants and systems: physical, chemical and biological systems, primary, secondary and tertiary treatment- Design considerations for sedimentation, coagulation, flocculation, filtration, adsorption, ammonia removal, aeration, anaerobic and aerobic digestion, activated sludge and trickling filter, ion exchange, lagoons, disinfection, natural treatment systems, sludge treatment and disposal

Module III

Industrial wastewater treatment – Overview Major industries (dairy, distillery, sugar, textile, tannery, pulp & paper, metal finishing, petroleum refining, pharmaceutical and fertilizer; thermal power), their water requirements, and the typical quantities and characteristics of wastewaters generated. Environmental consequences of wastewater discharge and the regulatory requirements for treatment and disposal treatment levels and available technologies. Theory and design of waste stabilization ponds and oxidation ditches. Concept of sustainable waste water treatment. Management, administration, legal and financial aspects of water and wastewater treatment plants. Operational problems encountered in treatment plants: typical problems arising in various units, trouble shooting. Operation and maintenance of plant operations. Training of operating personnel.

Textbook

1. Metcalf & Eddy, "Wastewater Engineering – Treatment and Reuse", Revised by G.Tchobanoglous, F. L. Burton, and H. D. Stensel, 4th edition. Tata McGraw-Hill, 2003.
2. Casey, T.J., "Unit Processes in Water and Wastewater Engineering". Wiley Interscience, 1997. ISBN: 0471966932
3. W.W. Eckenfelder, "Industrial Water Pollution Control", Mc-Graw Hill, 1999

Reference books

1. Weber, W.J. and DiGiano, F.A. "Process Dynamics in Environmental Systems". Wiley Interscience. ISBN: 0471017116

2. McCarty, P., and Rittmann, B., "Environmental Biotechnology: Principles and Applications", McGraw Hill, 2000. ISBN: 0072345535

08.705 EL3(E) PEROLEUM REFINERY ENGINEERING (H)

Credits: 4 **L/T/P: 3/1/0**

MODULE 1

Petroleum - Origin, nature, composition, classification, exploration, drilling, transportation and storage. Petroleum processing - Nature of crude from India, Indonassia, Burma and Middle East countries, classification of crude, evaluation of petroleum - Important properties and test methods T.B.P. and ASTM distillation-Dewatering and desalting- Primary Oil refining - Treatments of crude-Topping, vaccum distillation.

MODULE 2

Thermal cracking, visbreaking and coking, catalytic cracking, fluid bed and hydro cracking, reforming, chemical reforming and catalytic reforming, polymorisation, alkylation, hydrogination isomerisation, cyclization.

Treatment process : Sweatening, desalting, hydregon treatment, hydrodesulfurification process, solvent extraction of kerosene, stabilization of gasoline.

Lube oild manufacture - solvent dewaxing, solvent extanction, propane deasphalting, and treatment, clay treatment, hydro finishing, hydrotreatment, lube oil, additives and asphalt boiling.

MODULE 3

Petroleum products : LPG Motor spirit, aviation gasoline, kerosene, aviation turbine fuel, white spirit, and solvents, diesel fuel, gas oil, fuel oil, petroleum coke, petroleum waxes, lubricating oil and bitument.

Petrochemicals -Olefines, and acetylene, propylene, butadiene, isoprene, aromatics, benezene, xylone etc. Methanol, formaldehyde, chloromethane, ethylone oxide, ethanol amine, acetone, cumene, phenol, styrene, phthalic anhyride.

TEXT BOOKS :

1. Venkateswarlu (Ed),CHEMTECH IV -, CEED, Department of Chemical Engg., III Madras.
2. B.K. Bhaskara Rao, Modern Petroleum Refining process -, Oxford IBH Publishing Company, New Delhi.
3. W.L. Nelson, Petroleum Refinery Engg., Mc Graw Hill.
4. R.A.Meyer's Hand Book of Petroleum Refining Process , Mc Graw Hill

REFERENCE BOOKS :

1. Charles E. Dryden,Out lines of Chemical Technology
2. Shreve Chemical Process Industries
3. S.D. Sukla & G.N. Pandy, A Text Book of Chemical Technology, Vol. II , Vani educational books, Sahibabad 201010 (UP)
4. Encyclopaedia of Chemical Technology.
5. N. K.Sinha, Petroleum Refining & Petrochemicals

Note:

The question paper consists of Part A and Part B

Part A is for 40 marks and comprises of ten compulsory short answer questions each carrying 4 marks, covering the entire syllabus.

Part B is for 60 marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module

08.705 EL III (F) RUBBER TECHNOLOGY (H)

Credits: 4 **L/T/P: 3/1/0**

MODULE I

A historical introduction on the application of latex and rubber for the manufacture of rubber goods. Introduction and importance of rubber.

Natural rubber from latex, Concentration and stabilization of latex, Latex Compounding- latex compounding acids, wetting, dispersing and emulsifying agents, stabilizers, thickening agents and other miscellaneous materials.

Rubber additives and compounding- Vulcunizing agents, activators, accelerators, fillers, softners, antioxidants, peptisers, retarders, stiffeners, flame retardants, colours and pigments, cackifying agents, blowing agents, bonding agents etc. Compounding development and compounding of rubbers. Processing equipments.

MODULE II

Natural Rubber: - Source, Chemical formula, molecular weight distribution, mineral and micro gel-end groups. The protein effect-Elasticity of rubber chain- elasticity of a network- network defects and crystallization- non-gaussian network-Money-type equation- thermodynamics of rubber elasticity- structure property relationships in rubber- Non-rubber properties- Chemical reactivity- solution properties- electrical, structure and processing properties- strength of rubbers.
Diene homopolymers:- Synthesis of monomers-isomerism in diene rubbers- Characterization of micro-structure-polymerization of dienes structure and diene rubbers.
Diene-Based Copolymer Rubbers:- Methods of synthesis- structure, properties of SBR, NR, reactivity of diene rubbers- chemical properties- cross linking.
Polychloroprenes:- Monomer preparation and properties- synthesis of polymers- oxidation and aging. Technological comparison of polychloroprenes.
Thiokol, Hypalon, Silicone rubber, Polyurethane rubber, spandex, sponge rubber, foam rubber, laminates, rubber cement.

MODULE III

Oxidation properties of rubber:- Oxidation of saturated and unsaturated hydrocarbons, sulphides and olefin-sulfide systems, Oxidation of diene rubber network, use of antidegradants-Theory of mastication and mechanochemistry.

Manufacture of latex products by impregnation and spreading process; casting impregnation; dipping process (eg. Surgeon gloves, balloons, dipped fabric gloves etc); latex coatings; latex cement and adhesives; latex thread and coir; latex foam.

Manufacture of rubber products:- Manufacture of rubber products like tubes, hoses and foot wear, belts and cables. Reclamation of rubber.

Rubber industries in India: Development and scope of elastomer industry in India.

08.705 EL3 (G) TOTAL QUALITY MANGEMENT (H)

Credits: 4 **L/T/P: 3/1/0**

MODULE I

INTRODUCTION: Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs – Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

TQM PRINCIPLES: Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

MODULE II

STATISTICAL PROCESS CONTROL: The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

TQM TOOLS: Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

MODULE III

QUALITY SYSTEMS: Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

Total Quality Environment Management and EMS 14000: Municipal pollution prevention Programmes – Environment Management System-14000- Systematic, Structured and Documented Response to Environmental Issues - Auditable and Time Targeted Environmental Improvement Programs.

Hierarchy of Environment Management Practices**:** Waste-specific pollution prevention: Waste pre - generation focus on minimization / recycling, Waste-specific pollution control treatment:

pre - generation focus on disposal/ recycling- Waste-specific Post-release-to environment focus: recycling/ remediation

REFERENCES:

1. **Dale H.Besterfiled, et at.,** *Total Quality Management*, Pearson Education Asia, 1999. Indian reprint 2002.
2. **James R.Evans & William M.Lidsay,** *The Management and Control of Quality*, 5th Edition, South- Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).
3. **Feigenbaum.A.V.** *Total Quality Management,* McGraw-Hill, 1991.
4. **Oakland.J.S.** *Total Quality Management*, Butterworth Heinemann Ltd., Oxford. 1989.
5. **Narayana V. and Sreenivasan, N.S.** *Quality Management – Concepts and Tasks*, New Age International 1996.
6. **Zeiri,** *Total Quality Management for Engineers* Wood Head Publishers, 1991.
7. **Bishop P,** *Pollution Prevention: Fundamentals and Practice, McGraw-Hill,Singapore, 2000*
8. **Roy K,** *(Editor), Chemical Technology for better Environment,* Allied publishers Ltd, Chennai 1998
9. **El Halwagy**, M. M, *Pollution Prevention through Process Integration : Systematic Design Tools,* Academic Press, N.Y. (1997)
10. **Anastas P.T. and Warner J.C.,** *Green Chemistry: Theory and Practice.,* Oxford University Press. N.Y.1998

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*

Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.

Note: No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.706 MINI PROJECT, SEMINAR AND INDUSTRIAL TRAINING

Credits: 2 **L/T/P: 0/0/2**

Students should do a mini project and submit a report. They also have to present a seminar and submit a report. A report of the industrial visits done during V to VII semesters should be submitted.

Credits : Mini Project: 70 marks
Seminar: 60 marks
Industrial visit: 20 marks

08. 707 SOFTWARE LAB (H)

Credits: 3 L/T/P: 0/0/3

C++ Programming exercises

Develop programmes to implement the following numerical methods
Solution of

1. Nonlinear and transcendental equations
2. Linear Algebraic Equations, Set of equations
3. Methods for interpolation and extrapolation
4. Numerical Differentiation and Integration
5. Solution of Ordinary Linear Differential Equations
6. BVP Ordinary and Partial Differential Equations
7. Fitting Models to data

Learning and Use of Matlab

Exercises in Matlab application to Solution of Engineering problems, Systems Simulation, Optimization and Control.

Software Packages

Steady State Simulation and Optimization of Flash Drums, Reactor Models, Distillation Column models. Chemical Process Plant Simulation and Design Using State –of –the art software packages like ASPEN PLUS, HYSIS, CHEMCAD, DESIGN II etc.
Simulation studies of dynamics and control of reactors including bio reactors, Distillation Columns, Pressure driven Processes and Reactive Distillation Columns.

08.708 REACTION ENGINEERING AND PROCESS CONTROL LABORATORY (H)

Credits: 3 **L/T/P: 0/0/3**

Determination of kinetics of chemicals reactions - Batch reactor - Tubular flow reactors - Stirred tank reactors - cascade of ideal reactors. Residence time distribution (RTD) - Stirred tank - Tubular reactor - Cascade of ideal reactors - Fixed bed and fluidized bed reactors.
Dynamics of first order and second order systems - Liquid level systems - Optimum controller settings for laboratory scale temperature control system, pressure control system, and level control system, Tuning of controllers for distillation control system.

08.801 TRANSPORT PHENOMENA (H)

Credits: 5 L/T/P: 3/2/0

MODULE I

Viscosity and the mechanisms of momentum transfer: Newton's law of viscosity, molecular momentum transport, generalization of Newton's law of viscosity, pressure and temperature dependence of viscosity of gases and liquids, prediction of viscosity of gases: Rigid sphere model and rigorous models, prediction of transport coefficients of liquids. Numerical problems Shell momentum balances and velocity distributions in laminar flow: shell momentum balances and boundary conditions, flow of a falling film along a flat surface and on the surface of cylinders, flow of a Newtonian fluid in between two slits formed by two flat plates, flow through a circular tube, flow through annulus, and flow of two adjacent immiscible fluids. Flow of a Bingham fluid through a cylinder- Buckingham- Reiner Equation.

General transport equation for momentum, derivation of continuity equation, Analysis of equation of motion in rectangular coordinates (derivation not desired), Navier Stoke's equation and Euler equation with significance of each terms, transport equation in curvilinear coordinates (derivation not desired), application of transport equations to solve steady flow problems:- flow through a tube, tangential annular flow, rotating liquid, cone and plate viscometer.

Velocity distributions in turbulent flow: comparisons of laminar and turbulent flows, time-smoothed equations of change for incompressible fluids, and the time- smoothed velocity profile near a wall.

MODULE II

Energy Transport: Thermal conductivity and the mechanism of energy transport- prediction of thermal conductivity of gases, effect of temperature and pressure on thermal conductivity of gases, relationship between thermal conductivity and viscosity of gases. Thermal conductivity of solids, relationship between thermal and electrical conductivity of solids, Numerical problems.

Shell energy balance:- Boundary conditions, application of shell balances to heat conduction problems with electric, nuclear and viscous heat sources, fixed bed flow reactor, cooling fins with insulated tip condition, heat transfer by free and forced convection.

Equations of energy in rectangular coordinates, energy equations in curvilinear coordinates (derivation not desired), application to steady state heat transfer problems:- tangential flow in annulus with viscous heat generation, free convection from vertical plate, flow of non-isothermal film and transpiration cooling.

MODULE III

Diffusivity and the Mechanism of Mass Transport: Definition of concentrations, velocities and mass fluxes, Fick's law of diffusion, kinetic theory of diffusion in gases at low density,

theory of ordinary diffusion in liquids. Prediction of diffusivity of gases and liquids. Numerical problems.

Shell mass balances: Boundary conditions, diffusion through a stagnant gas film, diffusion with homogeneous and heterogeneous chemical reaction, diffusion into a falling liquid film (gas absorption), diffusion and chemical reaction inside a porous catalyst: the effectiveness factor. Analogies between heat, mass and momentum transfer.

Derivation of equation of continuity for binary mixtures in rectangular coordinates, general study of equation of continuity in curvilinear coordinates (derivation not desired). Application to combined heat and mass transfer, thermal and pressure diffusion.

Note: The students are permitted to use the copy of the **tables of general equations of continuity, motion and energy in rectangular and curvilinear coordinates** inside the examination hall for the University examination.

REFERENCES:

1. **Bird R.B., Stewart W.C and Lightfoot F.N**, *Transport phenomena*, John Wiley & Sons.
2. **Theodore L**, *Transport Phenomena for Engineers* by, International text book Company, U.S.A
3. **Geankoplis**, *Transport processes and unit operations*, 3rd, , PHI, 1997.
4. **Welty, Wicks and Wilson,** Fundamental of Heat, Momentum And Mass Transfer, John Wiley.
5. **John C Slattery,** *Momentum, Energy and Mass transfer in continua*, McGraw Hill, Co.
6. **Robert S. Brodkey and Harry C Hersing,** *Transport Phenomena a Unified approach* McGraw Hill Book Co.
7. **Bennet C U** and **Myers J E,** *Momentum, Heat and Mass Transfer,* Tata McGraw Hill Publishing Co.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus. Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.*

Note: No charts, tables, codes other than mentioned above are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.802 CHEMICAL ENGINEERING DESIGN II (H)
(Open Book Examination)

Credits: 4 **L/T/P: 2/2/0**

Design Of Heat Transfer Equipments: Design and Drawing of Heat Transfer Equipments such as Double pipe heat exchangers, shell and tube heat exchangers, condensers- tubular horizontal and tubular vertical, evaporators- single effect and multiple effect, crystallizers.

Design Of Mass Transfer Equipments: Design and Drawing of mass transfer equipments such as distillation columns, absorption columns, dryers.

Text books:

1. Standards : IS 403 (1967), 803 (1963) & 2825 & TEMA
2. Perry and Chilton, "Chemical Engineers' Handbook", McGrawhill, 8th Edition.
3. B.C.Bhattacharya, "Introduction to Chemical Equipment Design"
4. M.V.Joshi, "Process Equipment Design", McMillan India Ltd.
5. Vilbrandt and Dryden, "Chemical Engineering Plant Design "
6. Peters and Timmerhaus, "Plant Design and Economics for Chemical Engineers"

References:

1. Brownell and Young, "Process Equipment Design"
2. Harvey, "Process Vessel Design"
3. E.E. Ludwig, "Applied Process Design in Chemical and Petrochemical Plants"

Note: The question paper shall contain two questions and the student must answer any one

08.803 ENVIRONMENTAL POLLUTION: CONTROL, DESIGN AND MODELING (H)

Credits: 4 **L/T/P: 3/1/0**

MODULE 1

Introduction - Abiotic origin - Origin of the Universe- The radiation era- The matter era -The life era - Nucleo synthesis - Solid earth - Formation of the Earth - Zonal structure of the earth Differentiation of Elements - Hydrosphere - Atmosphere - Biosphere -Units of measurement liquids and gases - Law of con servation of mass and energy- Chemical equilibria - Nuclear Chemistry .

Impact of man on the environment : an overview, the biosphere. The hydroligic cycle and measurement of precipitation , the nutrient cycle, Mathematics for Growth - Consequence of population growth. - Energy problem. Importance of environment for mankind. Pollution of air, water and soil. Dangers of pollution and its solution.

Legislation : Legislative aspects including water (Prevention and control of pollution) Act 1974, Air (prevention and control of pollution) Act 1981, Environmental protection Act 1986 and effluent standards.

Air pollution : Sources and effects - Nature of air pollution classification, properties and sources of pollutants. Acid rain - Greenhouse effect- Ozone depletion - Effects of man, animal, vegetation and material dangers.

Atmospheric stability, lapse rates, inversions, plume behaviour and theory of pollutant disqersion Air quality criteria and standards, methods of pollutant sampling and measurement

MODULE 2

Control methods for particulate emulsions and pollutants - Design aspects of Cyclone separator, Electrostatic precipitator- Bag house filter - Scrubbers - Different types - Indoor Air Pollution Conrol.

Water pollution : Sources and classification of water pollutants and thier effects. Sampling and analysis. Waste water treatment : Design aspects of Preliminary, primary, secondary and tertiary treatment of waste water. Recovery of materials from process effluents. -Anaerobic and aerobic Sludge treatment and disposal- Cake filtration and composting - Methods of physio-chemical and biological treatment of industrial effluents from fertilizer, petrochemical, pulp and paper, caustic soda, tanning and sugar industries. Alternate routes of manufacture and sequencing of operations as a means of pollution control. Alternate use for by product as means of pollution control.- Advanced treatment methods reverse osmosis and carbon adsorption.

MODULE 3

Solid waste management : Sources, classification and microbiology of solid waste. Solid waste characteristics- Health aspects, methods of collection and disposal, Solid waste processing and recovery - composting. Sanitary land filling, thermal processes, regeneration and recycling. City waste and industrial wastes management-

Nuclear waste : Sources and nature of nuclear waste, treatment, storage technology for liquid, solid and gaseous (ration active) wastes.

Noise control : Noise control programme, noise control criteria, administrative and engineering controls, acoustical absorptive materials.

Environmental Management - ISO standards - Ecomark - Green production - Kyoto protocol- Montreal Protocol - Euronorms etc
Environmetnal Impact assessment - Environmental agencies - standards and legal aspects in Environmental Management

TEXT BOOKS :

1. Venkateswaralu, "CHEMTECH-1", CEED, IIT Madras.
2. C.S. Rao, "Environmental Pollution Control Engineering", Wiley Eastern Ltd.
3. A, D, Bhide and B. B Sundaresan, "Solid Waste Managment in Developing countries", INSDOC, New Delhi - 67.
4. Arcadio P. Sincero and Gregoria A.Sincero, "Environmental Engineering - A design approach ", Eastern Economy Edition- PHI.

REFERENCES:

1. Metcalf and Eddy, " Waste Water Engineering", TMH
2. R. M. Berthe, Van Nostrand Reinhold, "Air Pollution Control Technology", 1978.
3. M. N. Rao and H.V.N. Rao, "Air pollution", Tata McGraw Hill.
4. W. Straus, "Industrial Gas Cleaning", Pergammon Press Ltd.
5. Cunniff P.F, "Environmental Noise Pollution", John Wiley.
6. Mantell C.L., "Solid Wastes: Origin, Collection, Processing, Disposal ", John Wiley.
7. Mahajan S.P, "Pollution Control in Process Industries, TMH.
8. R. K. Trivedi, "Pollution Management in Industries", Environmental Publications, P.B. 60, Karad, 415110.
9. S.C.Bhatia, "Environmental Pollution and Control in Chemical Process Industries", Khanna Publishers.
10. Santhosh Kumar Garg, " Environmental Engineering", (Vol I and II) Khanna Publishers, New Delhi, 2004.
11. P. Venugopal Rao, "Text book of Environmental Engineering", PHI, New Delhi 2002.
12. J. P. Sharma, " Comprehensive Environmental Studies", Laxmi Publications, New Delhi 2004.

Note:

The question paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.

Part B is for 60 marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

08.804 PROCESS INSTRUMENTATION (H)

Credits: 4 L/T/P: 3/1/0

MODULE 1

Basic principles of measurements - Classification methods of measurements - Direct and indirect measurements, various elements in a measuring instrument - Sensing element, transducing element manipulating element and functioning element etc- Principles of working with a suitable example, static and dynamic characteristics of measuring instrument, accuracy, reproducibility, sensitivity, static error, dead zone, dynamic error, fidelity lag, speed of response etc.

Sensing elements - various types of sensing elements, sensors for temperature, pressure and fluid flow, transducers, different types of transducers, their principles and working, transmission methods, indicating and recording means.

Temperature measurements, temperature scales, basic principles and working of thermometers, mercury in glass thermometers, resistance thermometers, thermocouples, optical pyrometers, radiant pyrometers, ranges of different types of temperature measuring instruments, sources of errors and precautions to be taken in temperature measurements.

MODULE 2

Pressure measurement - Principles of working of manometers, various types of manometers - Macleoad gauge, Kundsen gauge, Bourden gauge, bellows, diaphram, electrical pressure transducers peizo electric manometers, thermal conductivity guages- ionization guage high pressure measuring instrument, liquid level measurements - Sensitive measurements, conductivity meters, measurements of PH.

MODULE 3

Flow measurements - Liquid and gas flow measurements, ways of measuring liquids and gas flow, direct volume measurements, quantity meters, gas meters, magnetic flow meters, heat input flow meters, elbow flow meters, impact meters, variable area meters, rotameters, cylinder and piston type - Liquid flow velocity, turbine meters, open channel flow measurements, wires notches, head meters, pitot tube, orifice meters ventury meters, theory and working flow measurements, electrical transducers, turbine type flow meters strain gauge flow meters mass flow meter, measuring flow of dry materials. Thermal analysis - Differential thermal analysis, thermo gravimetric, conductimetric analysis Chromatography and application, developments of P&I, diagram for flow systems, level, PH control temp control, Heat exchangers, Distillation column, reaction system etc.

TEXT BOOKS:

1. D.P. Eckman, Industrial instrumentation, Wiley Eastern
2. FRIBANCE, Industrial instrumentation fundamentals, T.M.H. Edition
3. R.K. Jain, Mechanical and industrial measurements, Khanna Pub

REFERENCE :

1. Patranabis, Principles of industrial instrumentation , T.M.H
2. Beckwith and Buck, Measurement systems

Note:

The question paper consists of Part A and Part B

Part A is for 40 marks and comprises of ten compulsory short answer questions each carrying 4 marks, covering the entire syllabus.

Part B is for 60 marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module

08.805 EL IV(A) DRUGS AND PHARMACEUTICAL TECHNOLOGY (H)

Credits: 4 **L/T/P: 2/2/0**

Module I

Introduction: Development of Drug and Pharmaceutical Industry – Therapeutic agents, their use and economics; Regulatory aspects.

Drug Metabolism and Pharmacokinetics: Drug metabolism: physico-chemical principles, radio activity pharma kinetic action of drugs on human bodies.

Module II

Important Unit Processes and their Applications: Bulk drug manufacturers, Type of reactions in bulk drug manufacture and processes. Special requirement for bulk drug manufacture.

Module III

Manufacturing Principles: Compressed table, wet granulation-dry granulation or slugging-direct compression-tablet presses, coating of tablets, capsules, sustained action dosage forms-parental solution oral liquids-injections-ointment-topical applications, Preservation, analytical methods and test for various drug and pharmaceuticals, packing-packing techniques, quality management, GMP.

Pharmaceutical Product and their Control: Therapeutic categories such as vitamins, laxatives, analgesics, non-steroidal contraceptives, Antibiotics, biologicals, hormones.

Reference

1. Leon Lachman tet al Theory and Practice of Industrial Pharmacy, 3 Edition, Lea and Febiger, 1986
2. Remington's Pharmaceutical Science, Mark Publishing and Co.

Note

*The question paper consists of Part A and Part B. Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

08.805 EL IV (B) ENTREPRENEURSHIP DEVELOPMENT (H)

Credits: 4 **L/T/P: 2/2/0**

MODULE I

Entrepreneur: Meaning of Entrepreneur; Evolution of the Concept; Functions of an Entrepreneur, Types of entrepreneur, Intrapreneur – an emerging class, Concept of Entrepreneurship-Evolution of Entrepreneurship; Development of Entrepreneurship; The entrepreneurial Culture; Stages in entrepreneurial process. Concepts of Entrepreneur, Manager, Intrapreneur/Corporate. Entrepreneur–comparative study-Roles, Responsibilities, Career opportunities. Entrepreneurship as a career, Entrepreneurship as a style of management, The
changing role of the entrepreneur: mid career dilemmas–Closing the window:

Creativity and Innovation: Creativity, Exercises on Creativity, Source of New Idea, Ideas into Opportunities. Creative problem solving: Heuristics, Brainstorming, Synectics, Value Analysis Innovation and Entrepreneurship: Profits and Innovation, Globalization, Modules of Innovation, Sources and Transfer of Innovation, Why Innovate, What Innovation, How to Innovate, Who Innovates.

Business Planning Process: Meaning of business plan, Business plan process, Advantages of business planning, Marketing plan, Production/operations plan, Organizational plan, financial plan, Final project report with Feasibility study, preparing a model project report for starting a new venture.

MODULE II

Institutions supporting entrepreneurs Small industry Financing developing countries, A brief overview of financial institutions in India, Central level and state level institutions, SIDBI, NABARD, IDBI, SIDO, Indian Institute of Entrepreneurship, DIC, Single window, Latest Industrial policy of Government of India

Family Business: Importance of family business, Types, History, Responsibilities and rights of shareholders of a family business, Succession in family business, Pitfalls of the family business, strategies for improving the capability of family business, Improving family business performance.

MODULE III

International Entrepreneurship Opportunities: The nature of international entrepreneurship, Importance of International business to the firm, International versus domestic entrepreneurship, Stages of economic development, Entrepreneurship entry into international business, exporting, Direct foreign investment, barriers to international trade.

Informal risk capital and venture capital: Informal risk capital market, venture capital, nature and overview, venture capital process, locating venture capitalists, approaching venture capitalists.

Managing growth: Using external parties to help grow a business, franchising, advantages and limitations, investing in a franchise, joint ventures- types, Acquisitions and mergers

REFERENCES:

1. **David H. Holt, *Entrepreneurship-new venture creation,*** Prentice Hall of India
2. **Poornima Charantimath,** *Entrepreneurship Development-Small Business Enterprise*, Pearson Education, 2007
3. **Robert D Hisrich, Michael P Peters, Dean A Shepherd**, *Entrepreneurship,* 6th Edition, The McGraw-Hill Companies, 2007.
4. **Mathew J. Manimala,** *Entrepreneurship theory at crossroads,* Biztantra, 2007
5. **Vasant Desai**, *Entrepreneurial Development and Management*, Himalaya Publishing House, 2007
6. **Madhurima Lall, Shikha Sahai,** *Entrepreneurship*, Excel Books, 2006
7. **Kurakto,** *Entrepreneurship-Principles and practices*, 7th Edition, 2007, Thomson publication
8. **Satish Taneja and S.L.Gupta,** *Entrepreneurship Development New Venture Creation*
9. **Marc J. Dollinger ,** *Entrepreneurship: Strategies and Resources*
10. **Brigitte Berger ,** *The Culture of Entrepreneurship*.
11. **Peter F. Drucker,** *Innovation and Entrepreneurship*
12. **Dale Meyer G., Kurt A. Heppard ,** *Entrepreneurship As Strategy*
13. **Sahay A. and.Chhikara M.S,** *New Vistas of Entrepreneurship: Challenges & Opportunities*

*The question paper consists of Part A and Part B. Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus. Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

08.805 EL 4 (C) SURFACE COATINGS (H)

Credits: 4 **L/T/P: 2/2/0**

Module 1

An overview of surface coatings: Different types of surface coatings and their uses - General properties of different surface coatings. Pre-treatment of surfaces - Types of surface contamination –Surface cleaning Advantages and disadvantages of solvent cleaning and alkaline water-based cleaning - Precautions necessary in operating a solvent degreaser - Methods of pre-treatment for most common metals - Safe pre-treatments for high-strength steels, aluminium alloys, stainless steels and similar high-alloy steels. History and development of paint industry, function and classification. Raw material for industry, drying oils, natural and synthetic resins, pigments and extenders. Auxiliaries like driers, plasticizers, softeners, dispersing and flatting agents varnishes and lacquers, formulation and manufacturing of paints, machinery used in paint manufactures, methods of application, applications of industrial and architectural finishes. Common defect in paints and varnishes.

Module II

Electrochemical processes:- Processes of dissociation and ionisation - Influence of changes in electrolyte temperature, metal concentration and agitation on reactions taking place in the cathode film - Process of the crystal build-up on the cathode surface to produce deposits and its effect on stress and ductility - Faraday's Laws in relation to anode and cathode efficiency - Effect of variations in cathode efficiency on metal distribution - Influence of deposition potential on the ability to electroplate into recesses and hollows - Effect of pretreatment on adhesion and porosity – Porosity of coatings - Pitting in coatings - Coating hardness and its effect on wear resistance – Electrodeposition – Anodizing – Phosphating – Chromating- Oxidation – CVD - Environmental impact of coatings and the requirements of legislation. Non-electrolytic coating processes: Hot Dipping Processes - Zinc galvanising - Hot dip tinning - Hot dip aluminium - Cladding of metals with metals, with plastics - Vitreous enamelling - Vacuum metallisation by: Evaporation, Sputtering, Ion plating - Physical Vapour Deposition (PVD)

Module III

Organic coating:- Properties and uses of primers, primer-surfacers, primer-fillers, undercoats, topcoats coating - Diffusion Coating Processes - thermal spraying of materials (Hot and Cold), lacquers and varnishes - Convertible and non-convertible polymer systems - properties and uses of solvent-containing paints, emulsions, water-based paints , powder coatings - Conversion coatings - Chemistry of the phosphating of steel - Conversion coatings for aluminium and its alloys - Paint spraying coatings - types of spray painting techniques - Dipping and flow coating – electrocoating - Common tests for paint films - Common film defects and Remedies.

References:

1. R. Lambourne and T. A. Strivens, "Paint and Surface Coatings", Theory and Practice, 1999, Woodhead Publishing
2. J.M. West ., "Electrodeposition and Corrosion processes", Van Nostrand Reinhold Publisher, 1970.
3. Wolf Riedel., "Electroless coatings" ASM International, Ohio1991

4. Sunderland E. Nylen Paul, 1965, “Modern Surface Coatings A textbook of the chemistry and technology of paints, varnishes, and Lacquers”, John Wiley & Sons
5. F.Fancutt and J C Hudson., “Protective painting of structural steel”. Chapman and Hall Ltd
6. J Boxall and J A Von Fraunhofer., “Paint formulation” Principle and practice,

Note:*Question Paper consists of Part A and Part B.Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus. Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

08. 805 EL 4(D) ENGINEERING OF CATALYSTS AND CATALYTIC PROCESSES (H)

Credits: 4 **L/T/P: 2/2/0**

Module I

Basic concepts in heterogenous catalyst preparation and characterization, poisoning and regenerated. Industrially important catalysts and processes such as oxidation, processing of petroleum and hydocarbons, synthesis gas and related processes, commercial reactors (adiabetic, fluidized bed, trickle-bed, slurry, etc.).Heat and mass transfer and its role in heterogeneous catalysis. Calculations of effective diffusivity and thermal conductivity of porous catalysts.

Module II

Reactor modeling. Emphasizes the chemistry and engineering aspects of catalytic processes along with problems arising in industry. Catalyst deactivation kinetics and modelling.Principle of catalytic reaction engineering; mechanism of contact catalysis; kinetics of chemical reaction in homogeneous and heterogeneous catalysis; selecting catalytic agents. Fluid catalytic cracking;

Module III

Design and developing industrial catalysts: preparation of catalysts; characterization of catalysts; analytical instruments, monitors and controllers that are used to prepare and characterize catalysts and to conduct detailed kinetic studies. Practical examples of industrial catalysts: Zeolite catalyst applications: Transformation and Synthesis of Zeolite using by experimental apparatus for characterization, reactivity test; Heavy oil cracking, Development of Clay Adsorbent for KeroMerox Refining Process, Dimethylamine synthesis using mordenite catalyst.

Text books:

1. J. J. Carberry, "Chemical and Catalytic Reaction Engineering", Dover, 2001.
2. J. Weitkamp, and L. Puppe (Eds.), "Catalysis and Zeolites: Fundamentals and Applications", Springer Verlag, 1999.
3. S. S. E. H. Elnashaie, and S. S. Elshishini, Dynamic Modelling, Bifurcation and Chaotic Behaviour of Gas-Solid Catalytic reactors, Taylor and Francis, 1996.
4. Lee, H. H., “Heterogeneous Catalytic Reactors,” Butterworth
5. Tarhan, M. O., “Catalytic Reactor Design,” McGraw-Hill, NY, 1983
6. Anderson, J. R. and Boudart, M., “Catalysis, Science and Technology,” Vol. 7, Springer Verlag,NY.
7. Thomas, J. M. and Thomas, W. J., “Introduction to the Principles of Heterogeneous Catalysis,” Academic Press, 1967.

Note:

The question paper consists of Part A and Part B.

Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.

Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module

08. 805 EL 4(E) MATERIAL SCIENCE (H)

Credits: 4 **L/T/P: 2/2/0**

Module I

Atomic Structure - atomic bonding, atomic arrangements, coordination number. Crystal systems: crystal structure, noncrystalline structure and crystal defects. Metallic phases and their properties: Single phase metals and alloys, binary equilibria involving solid solutions,- eutectic and peritectic systems. Iron - carbon diagram, plastic deformations, recrystallization, cold and hot working of metals, control microstructure, heat treatments, failure of metals. Elementary study of various metals and alloys: cast iron, carbon steel, alloy steel and copper alloys.

Module II

Material testing for mechanical characteristics: tensile, compression, impact, hardness, bend, torsion and creep testing. Organic Polymers: properties, classification, comparison of properties and their relationships with chain structure. Ceramics: Comparison of ceramic and non-ceramic phases, structure, properties and application of ceramics. Composite materials: Classification, reinforcement, fillers and additives, processing and application, characteristics of composite material, theory of composites.

Module III

Stability of materials in service environments: a) *Corrosion* - types, mechanism and factors influencing corrosion, corrosion prevention, inhibiters and their application. b) *Oxidation* - aging of rubber, oxidation of metals and radiation damages. Selection of suitable material for construction in chemical industry lining and surface treatment.

Text Books:

1. Lawrence H. Van Vlack., "Elements of Material Science", Addison Wesley.
2. B.C. Bhattacharrya., "Selection of material and fabrication for chemical process equipments", CEED, IIT Madras.
3. V.Raghavan., "Material Science & Engineering', A first course, PHI Publications.
4. O.P.Khanna., "A Text book of Material Science & Metallurgy", Dhanpat Rai publications.
5. A.K.Gupta & R.C.Gupta., "Material Science" S. Chand & Company Ltd.

Note:

Question Paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus. Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

08.805 EL 4 (F) PROCESS UTILITIES AND PIPELINE DESIGN (H)

Credits: 4 **L/T/P: 2/2/0**

Module I

Importance of process utilities in chemical industries and plants. Introduction to the use of various utilities. Water as a utility in process industries, treatment and cooling. Storage and distribution of water, recycle and conservation of water, cooling tower, spray pond. Compressors and vacuum pumps – performance characteristics of compressors and vacuum pumps, Boosters, Air receivers, Piping network, Air leaks, Lubrication. Oil and moisture removal. Refrigeration systems and their characteristics. Production of cryogenic temperatures. Characteristics of Air-water systems. Humidification and Dehumidification equipment. Exhaust. Ventilation.

Module II

Steam generation in chemical process plants. Properties of steam. Boilers and power generation equipments. Steam engines and turbines. Steam handling and distribution. Steam economy. Electric power distribution in process plants.

Classification of pipes and tubes, IS & BS codes for pipes used in chemical process industries and utilities. Pipe line insulation. Pipes for Newtonian and non-Newtonian fluids, sudden expansion and contraction effects, Pipe surface roughness effects, pipe bends, Shearing characteristics. Pipe connections and fittings, Rail fittings, welded and flanged fittings, pipe system layout, tube fastening and attachment, non ferrous tube fittings, ducts and elbows. Pressure drop for flow Newtonian and non-Newtonian fluids through pipes. Resistance to flow and pressure drop. Effect of Reynolds and apparent Reynolds number.

Module III

Pipes of circular and non-circular cross section – velocity distribution, average velocity and volumetric rate of flow. Flow through curved pipes (Variable cross sections). Effect of pipe-fittings on pressure losses. Non-Newtonian fluid flow through process pipes, Shear stress, Shear rates behavior, apparent viscosity and its shear dependence, Power law index, Yield Stress in fluids, Time dependant behavior, Thixotropic and rheopetic behavior, mechanical analogues, velocity pressure relationships for fluids, line. Power losses in compressible fluid flow, Multiphase flow, gas-liquid, solid-fluid, flows in vertical and horizontal pipelines, Lockhart Martinelli relations, Flow pattern regimes. Pipe line design: Pipe and tube design data, design of drainage piping, design of steam piping, design of oil piping, design of cast iron pipe. Pipe expansion, pipe line flexibility, expansive forces in pipe lines, pipe anchors and supports.

Text books:

1. Bhasin, S.D.: “Project Engineering of Process Plants”, Chemical Engineering Education Development Centre, I.I.T., Madras,1979.
2. Davidson, P.J. & West, T.F: ”Services for the Chemical Industry”, Pergamon Press, Oxford,1968.
3. “Process Utilities”, Chemical Engineering Development Centre, I.I.T., Madras,1986

References:

1. Cremer, H.W & Watkins, S.B , "Chemical Engineering Practice", Vol.10,Butterworths, London, 1960
2. Rase, H.F & Barrow, M.H, "Project Engineering of Process Plants", John Wiley,New York, 1957
3. Milter, L.M: "Students Text Book of Heating", Ventilating & Air Conditioning, Technitrade Journals, London, 1976.
4. Mcquiston, F.C & Parker, J: "Heating, Ventilating & Air conditioning – Analysis and Design",John Wiley, New York , 3rd Edition, 1988.
5. Coulson JM and Richardson J.F. – Chemical Engineering – Vol I , VI Edition, Butterworth Heinemann, British Library, Publications, Oxford, 1999.
6. Govier, G.W. and Aziz K. – The flow of Complex Mixtures In Pipe – Krieger Publication, Florida, 1982.

Note:
The question paper consists of Part A and Part B.
*Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.*
*Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module*

08.805 EL IV (G) ADVANCED PROCESS CONTROL (H)

Credits: 4 **L/T/P: 2/2/0**

Module 1

Review of dynamics of Single Input Single output (SISO) systems: first, second and higher order systems, closed loop and open loop responses. Controller tuning and Ziegler Nichols tuning, Cohen and Coon's Tuning. Process identification: Step testing, Pulse testing. Direct sine wave testing, ATV identification, Control valves: Valve characteristics, design of control valves. Analysis of Control of complex systems: steam jacketed kettle- Gas absorbers- Heat conduction into solids- Heat exchangers. Material balance and product quality control of Hydrodealkylation Plant.

Module 2

Analysis and design of Dead-time compensator (Smith Predictor Controller), Cascade control systems, Selective control, Split-Range Control, Feedforward controller, Combination controllers, Ratio control, Computed variable control, Override control, Dynamic Matrix Control, Internal Model Controller, Adaptive control: Self Tuning Regulator, Model Reference Adaptive Control.

State space models, Advantages and disadvantages of State Space representation. State Space model Building examples. Representation of Multivariable systems, Transfer function matrix, State variable representation, Analysis of multivariable systems: stability, resiliency, interaction, Robustness. Controller design for multivariable systems.

Module 3

Concept of State Variable Feedback: General properties, Steady state error analysis, Controllability, Observability, State estimators, All pole plant, Complex poles plant, Pole-Zero Plant. Inaccessible states.

Sampled Data Control Systems: Inherently sampled systems in chemical Engineering, Sampling mechanisms, The sampling theorem, reconstruction, Aliasing, Sampling of input out models. Z-transforms, Z-transform theorems, Inversion of Z-transforms, Pulse Transfer Functions, Poles and Zeros, Open loop and closed loop responses, Stability analysis, Design of digital controllers.

References:

1. COUGHANOWR D. R., *Process Systems Analysis and Control*, 2nd Edition, McGraw Hill Inc., 1991
2. LUYBEN W. L., *Process modeling, Simulation and Control for Chemical Engineers*, Second Edition, McGraw Hill Book Co. 1990
3. ASTROM K. J. and WITTENMARK B., *Computer Controlled Systems*, Prentice Hall of India, 1990.
4. D'AZZO J. J. and HOUPIS C. H., *Linear Control System Analysis and Design Conventional and Modern*., McGraw Hill Book Co. 1988
5. ISERMANN R., *Digital Control Systems*, Second Revised Edition, Narosa Publishers, New Delhi, 1993

6. G. STEPHANOPOULOSE, *Chemical Process Control, An Introduction to Theory and Practice*, Prentice Hall of India, 1993

Notes:

The question paper shall contain two parts: Part A and Part B. In Part A, there shall be 10 questions each carrying 4 marks, evenly distributed over the whole syllabus. Part B shall contain two questions each carrying 20 marks, from each module of the syllabus. The candidates should answer all questions in Part A and any one question from each module in Part B.

08.805 EL IV (H) **ECONOMICS AND MANAGEMENT FOR PROCESS ENGINEERS (H)**

Credits: 4 **L/T/P: 2/2/0**

MODULE: 1

Introduction to Engineering economy,- Engineering Decision - makers, Problem solving Decision making. Interest and Interest Factors - Interest rate, simple interest & Compound interest factors.

Equivalence and cost comparisons : Time value of money and equivalence, Equations that are used in economic analysed, Compound interest as an operator, Unacost, Hoskolds formula, Cost comparisons, Present Worth Comparison, Conditions for present worth comparisons, Basic Present worth comparisons, Present worth equivalence, Net Present worth, Assets with unequal lives, infinite lives, Future worth comparison, Unacost and capitalised cost.

Depreciations and taxes: Purpose of Depreciation as cost, Nature of depreciations - Methods for determining depreciation - Straight line method - sinking fund method - Declining balance method - Double declining balance method - Sum of digits methods - Units of production method.

Taxes and depreciation method - Comparison of depreciation methods - Cost comparison after taxes, Present worth after taxes three continuous interest and discounting, Logic for continuous interest, Continuous interest as an operator, Uniform flow, Flow changing at an exponential rate, flow declining in a straight line to Zero - Discounting with improving performance, Unaflow - Capital recovery factor, Capitalised cost-taxes.

MODULE 2

Technical advancement and inflation : Displacement Vs replacement, One year more of existence, More than one year of existence, Uniform gradient series delay value of an existent inflation, Cost comparison under inflation, unaburden, high inflation rates, Inflation and technological advancements.

Capital requirements and cost of production for process plants - Equipment for process plants, cost index, Nelson refinery construction index - Material cost indices - Process equipment cost index - Material cost indices - Process equipment cost index - Labour cost index - equipment costs - Williams six-tenths factor.

Cost Estimation: Capital investments, Factors affecting investment & production costs, Fixed capital investment and working capital, Estimation of capital investment, direct cost and indirect costs, Types of capital cost estimates, Order of magnitude estimates, study estimates, preliminary estimate definitive estimate and detailed estimate,

Cost factors in capital investment, Cost and installation of purchased equipment, Estimating equipment costs by scaling 6/10 Factor Rule,. insulation costs, Instrumentation and controls, Piping, Electric installation, Building, Yard improvements, Service facilities, Land design engineering and supervision, construction expenses contractors fee, Contingencies, Start up expenses, Methods for estimating capital investment. Estimation of total product cost, Different costs involved in the total product for a typical Chemical Process plant. Estimation of total product cost, Manufacturing costs, general expenses - Direct production costs, Fixed costs, plant over head cost, administration expenses - Distribution and marketing expenses.

MODULE 3

Financial statements: Balance sheet and profit and loss accounts - Ratios used for comparing the balance sheet and profit and loss account.

Break even and minimum cost analysis, Types of costs, Cost analysis, Economic production charts, Differential analysis of economic production charts, criteria in the use of break-even and minimum cost analysis.

Profitability: Investment evaluation, Profitability standards, mathematical methods for profitability evaluation: pay out time, pay out time with interest, rate of return on original investment, return on average investment, discounted cash flow, Net Present worth, Venture worth.

REFERENCES :

1. **Peters and Timmerhaus,** *"Plant Design and Economics for Chemical Engineers"* McGraw Hill , New York , 4th Edition (2003)
2. **Davies, G.S.** *Process Engineering Economics"* CEED IIT Madras.
3. **Kenneth King Humphrey,** *Jelen's Cost and Optimization Engineering,* McGraw Hill, Third Edition, 1991
4. **Robert S. Aries and Robert D.Newton,** *"Chemical Engineering Cost Estimation "* Chemonomics, New York, 1951
5. **John Happel and Donald G. Jordan,** *"Chemical Process Economics"*, Marcel Decker (1975)
6. **Vibrandt, F C,** *Chemical engineering plant design,* McGraw Hill
7. **Holand , E.A., Watson, F.A. and Wilkinson, J.K.,** *" Introduction to Process Economics",* John Wiley & Sons.
8. **Paneerselvam R,** *Engineering Economics,* PHI, Eastern Economy Edition
9. **Tuesen.G.** *Engineering economy*, PHI, 2002
10. **Ulrich , G D,** *"A Guide to Chemical Engineering Process Design and Economics",* John Wiley (1984)
11. **Guthrie K M,** *" Process Plant Estimation, Evaluation and Control",* Craftsman Solano Beach, California (1974)
12. **Douglas,** " *Conceptual Design of Chemical Processes",* McGraw Hill (1998)
13. **Valle Riestra ,** *"Project Evaluation in Chemical Process Industries",* McGraw Hill
14. **Schweyer,** "Process Engineering Economics", McGraw Hill, 1955

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10 compulsory** *short answer questions each carrying 4 marks covering the entire syllabus.*

Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.

Note: No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.806 EL V(A) BIOINFORMATICS (H)

Credits: 4 **L/T/P: 2/2/0**

Module I

Biology for Bioinformatics :- Basic concepts - cells- Archaebacteria, Biomembranes, Nucleus, Organelles, Mitochondria, Chloroplasts, Viruses, Bacteriophage, Genetic contents of a cell - Viral Proteins - Amino acid, DNA and RNA - Forms of DNA.

Genetic Code :- Genome - Gene Expressions - Protein Synthesis - Transcription RNA - Processing- Capping- Splicing - Editing, Cell Signalling, DNA cloning Genomic library - cDNA library - Probes - Screening.

Bioinformatics basics: Computers in biology and medicine; Importance of Unix and Linux systems and its basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD's; Pattern matching algorithm basics; Computational tools for DNA sequence analysis: GCG: The Wisconsin package of sequence analysis programs; Web-based interfaces for the GCG sequence analysis programs.

Module II

Databases and search tools: Biological back ground for sequence analysis; Identification of protein sequence from DNA sequence; Searching of databases similar sequence; The NCBI; Publicly available tools; Resources at EBI; Resources on the web; Database mining tools.

DNA sequence analysis: The gene bank sequence database; Submitting DNA sequence to the databases and database searching; Sequence alignment; Pair wise alignment techniques; Multiple sequence analysis; Multiple sequence alignment; Flexible sequence similarity searching with the FAST3 program package; Use of CLUSTAL W and CLUSTAL X for the multiple sequence alignment; Submitting DNA protein sequence to databases: Where and how to submit, SEQUIN, genome centres; Submitting aligned set of sequences, updates and internet resources.

Module III

Protein Modeling: Introduction; Force field methods; Energy, Buried and exposed residues; Side chains and neighbours; Fixed regions; Hydrogen bonds; Mapping properties onto surfaces; Fitting monomers; rms fit of conformers; Assigning secondary structures; Sequence alignment-methods, evaluation, scoring; Protein completion: backbone construction and side chain addition; Small peptide methodology; Software accessibility; Building peptides; Protein displays; Substructure manipulations, Annealing.

Peptidomimetics: Introduction, classification; Conformationally restricted peptides, design, pseudopeptides, peptidomimetics and transition state analogs; Biologically active template; Amino acid replacements; Peptidomimetics and rational drug design; CADD techniques in peptidomimetics; Development of non peptide peptidomimetics.

Protein Structure Prediction: Protein folding and model generation; Secondary structure prediction; Analyzing secondary structures; Protein loop searching; Loop generating methods; Loop analysis; Homology modeling: potential applications, description, methodology, homologous sequence identification; Align structures, align model sequence; Construction of variable and conserved regions; Threading techniques; Topology fingerprint approach for prediction; Evaluation of alternate models; Structure prediction on a mystery sequence; Structure aided sequence techniques of structure prediction; Structural profiles, alignment algorithms, mutation tables, prediction, validation, sequence based methods of structure prediction, prediction using inverse folding, fold prediction; Significance analysis, scoring techniques, sequence-sequence scoring. *The virtual library:* Searching MEDLINE, Pubmed, current content, science citation index and current awareness services, electronic journals, grants, and funding information.

REFERENCES:

1. David W. Mount, Bioinformatics: Sequence and Genome Analysis 2nd Edition, CSHL Press, 2004.
2. Baxevanis A. and Ouellette F. B. F., Bioinformatics: a practical guide to the analysis of genes and proteins, 2nd Edition, John Wiley, 2001.
3. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss, 2003.
4. Bourne P. E. and Weissig H., Structural Bioinformatics, 2nd Edition, Wiley, 2008.
5. Branden C. and Tooze J., Introduction to Protein Structure, 2nd Revised Edition Garland Publishing, 1998.

Note

The question paper consists of Part A and Part B. Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.
Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.

08. 806 EL 5 (B) CORROSION ENGINEERING (H)

Credits: 4 **L/T/P: 2/2/0**

Module I

Basic concepts: Definition and importance; Electrochemical nature and forms of corrosion; Corrosion rate and its determination. Electrochemical thermodynamics and kinetics: Electrode potentials; Potential-pH (Pourbiax) diagrams; Reference electrodes and experimental measurements; Faraday's laws; Electrochemical polarization; Mixed potential theory; Experimental polarization curves; Instrumentation and experimental procedure. Galvanic and concentration cell corrosion: Basic concepts; Experimental measurements, and determination of rates of galvanic corrosion; Concentration cells. Corrosion measurement through polarization techniques: Tafel extrapolation plots; Polarization resistance method; Instrumental methods and Errors in measurement of polarization resistance;

Module II

Commercial corrosion probes; Other methods of determining polarization curves.
Passivity: Basic concepts of passivity; Properties of passive films; Experimental measurement; Applications of Potentiostatic Anodic Polarization; Anodic protection. Pitting and crevice corrosion: Basic concepts; Mechanisms of pitting and crevice corrosion; Secondary forms of crevice corrosion; Localized pitting. Metallurgical features and corrosion: Inter-granular corrosion; Weldment corrosion; De-alloying and dezincification.

Module III

Environmental induced cracking: Stress corrosion cracking; Corrosion fatigue cracking; Hydrogen induced cracking; Some case studies; Methods of prevention and testing; Erosion, fretting and Wear. Environmental factors and corrosion: Corrosion in water and Aaqueous Solutions; Corrosion in sulphur bearing solutions; Microbiologically induced corrosion; Corrosion in soil; Corrosion of concrete; Corrosion in acidic and alkaline process streams. Atmospheric and elevated temperature corrosion: Atmospheric corrosion and its prevention; Oxidation at elevated temperatures; Alloying; Oxidising environments. Prevention and control of corrosion: Cathodic protection; Coatings and inhibitors; Material selection and design

Text Books:

1. Fontana, M.G., "Corrosion Engineering", McGraw-Hill.
2. Jones, D.A., "Principal and Protection of Corrosion", Prentice-Hall
3. S.N.Banerjee, "An Introduction to Corrosion Science and Corrosion Inhibition", Oxonian Press P.Ltd.,New Delhi, 1985.
4. Zaki Ahmad, "Principles of Corrosion Engineering & Corrosion Control", Butterworth Heinemann, 2006

References:

1. L. L. Shrier "Corrosion", Butterworth Heinemann, Vol. I & II, 1994
2. H.H.Uhlig and R.W.Revie, "Corrosion and Corrosion Control", A Wiley – Inter Science. Publication JohnWiley & Sons, New York, 3rd Edition, 1985

3. C.G. Munger, Vincent, L.D, "Corrosion prevention by protective coatings," NACE Press, Texas, Houston, USA, 2nd Edition 2002

Note:

The question paper consists of Part A and Part B.
*Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.*

*Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module*

08.806 ELV(C) SOLID WASTE MANAGEMENT AND ENGINEERING(H)

Credits: 4 **L/T/P: 2/2/0**

Module I

Introduction- Solid wastes- definition, types, sources, characteristics, and impact on environmental health. Waste generation rates. Waste Management Practices: Municipal, Hazardous, and Industrial Concepts of waste reduction, recycling and reuse. Collection, segregation and transport of solid wastes Handling and segregation of wastes at source. Collection and storage of municipal solid wastes; analysis of Collection systems. Transfer stations - labelling and handling of hazardous wastes. Public participation and the role of NGOs.

Module II

Solid waste processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: composting. vermicomposting, fermentation. Incineration of solid wastes. Pyrolysis. Disposal in landfills: site selection, design, and operation of sanitary landfills; secure landfills and landfill bioreactors; leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation.

Module III

Hazardous wastes: definition, sources and characteristics: handling, collection, storage and transport. Hazardous waste treatment technologies. Physical, chemical and thermal treatment of hazardous waste: solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: site selection, design and operation. Biomedical, plastic and e-waste: waste categorization, generation, collection, transport, treatment and disposal. Legislation on solid waste handling- Elements of integrated waste management: Waste Minimization Technologies, Environmental and Health Impact of Solid Waste Management Activities Legislations on management and handling of municipal solid wastes, biomedical wastes, and other hazardous wastes.

Textbook

- F. Kreith, G. Tchobanoglous, "Handbook of Solid Waste Management",2nd edition.
- M. D. LaGrega, P. L Buckingham, J. C. Evans, ''Hazardous Waste Management", McGraw-Hill, 2000.
- **Reference Reading**
  Dr Nicholas P. Cheremisinoff, "Handbook of Solid Waste Management and Waste Minimization Technologies", Butterworth-Heinemann 2002-12-27

Note: *Question Paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus .Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

08.806 EL 5 (D) COMPOSITE TECHNOLOGY (H)
Credits: 4 L/T/P: 2/2/0

Module I
Introduction to composites: General Introduction and Concept of Composite materials, Basic definitions, need and types. Classification- based on Matrix Material: Organic matrix composites Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites and Particulate composites. Comparison of composites with metals, applications of various types of composites, advantageous and limitations of composites.

Module II
Polymer matrix composites: Polymer matrix resins – Thermosetting resins, thermoplastic resins, Reinforcement fibres – Rovings Woven fabrics, Non woven random mats, various types of fibres. PMC processes - Hand lay up processes, Spray up processes, Compression moulding, reinforced reaction injection moulding, Resin transfer moulding. Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GRP). Metal matrix composites:- Characteristics of MMC, Various types of Metal matrix composites. Alloy vs MMC, Advantages of MMC, Limitations of MMC, Metal Matrix, Reinforcements – particles – fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

ModuleIII
Ceramic matrix composites:- Engineering ceramic materials – properties, advantages, limitations, Monolithic ceramics. Need for CMC Ceramic matrix - Various types of Ceramic Matrix composites- oxide ceramics, non oxide ceramics, aluminium oxide, silicon nitride, reinforcements – particles, fibres, whiskers. Sintering - Hot pressing, Cold isostatic pressing (CIPing), Hot isostatic pressing (HIPing). Advances in composites: - Carbon /carbon composites, advantages of carbon matrix, limitations of carbon matrix. Carbon fibre, chemical vapour deposition of carbon on carbon fibre perform. Solgel technique. Composites for aerospace applications.

Text Books:
1. Mathews F.L. and Rawlings R.D., “Composite materials: Engineering and Science”, Chapman and Hall, London, England, 1st edition, 1994.
2. Chawla K.K., “Composite materials”, Springer – Verlag, 1987.
3. T.W. Clyne and P.J. Withers, “Introduction to Metal Matrix Composites”, Cambridge University Press, 1993.
4. A.B. Strong, “Fundamentals of Composite Manufacturing”, SME, 1989.
5. S.C. Sharma, “Composite materials”, Narosa Publications, 2000.
6. “Short Term Course on Advances in Composite Materials”, Composite Technology Centre, Department of Metallurgy, IIT- Madras, December 2001.

Note: *Question Paper consists of Part A and Part B. Part A is for 40 marks and comprises of 10 compulsory short answer questions, each carrying 4marks, covering the entire syllabus .Part B is for 60 marks, comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

08.806 EL5 (E) PROJECT ENGINEERING (H)

Credits: 4 **L/T/P: 2/2/0**

MODULE 1

Introduction-Development of project-Research and development: Bench scale of experiments - pilot plant studies- Semi commercial plant Process design and Engineering : Process flow chart material and energy balance process design and building designs-equipment specifications- Selection of Equipments and materials-Plant layout- Scale modelling- piping design and layout.

MODULE 2

Plant location and site selection- preliminary dates construction projects - site development foundation - Erection and site fabrication –Construction- Alignment and insulation- Startup & commissioning- Trial runs- Guarantees sums and hand over- Company formation process license- Technology Transfer- statutory sanctions- contracts and contractors- financing with special reference to financial institutions in India, personnel recruitment and training.

MODULE 3

Economic evaluation of projects- Capital requirements and cost of production-profitability-Break even analysis and minimum cost analysis- Budgeting and financial control- Depreciation and Taxes- Insurances- Technical advancement and inflation-Financial statements
Project scheduling: Bar chart, CPM, PERT methods

TEXT BOOKS:

1. Peters and Timmerhaus - Plant design and economics for chemical engineers 1980.
2. Vilbrent and Dryden-Chemical engineering plant design - TMH, 1975.
3. Bhasin S.D-Project Engineering of process plants

REFERENCE :

1. Process engineering economics - G.S. Davies Chemical engineering curriculum development Centre, IIT Madras.
2. Anilkumar, Chemical process synthesis and engineering design, TMH 1981.

Note:

The question paper consists of Part A and Part B
Part A is for 40 marks and comprises of ten compulsory short answer questions each carrying 4 marks, covering the entire syllabus.
Part B is for 60 marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module

08.806 EL V (F) MATHEMATICAL METHODS IN CHEMICAL ENGINEERING

Credits: 4 **L/T/P: 2/2/0**

Module 1

Models in Chemical Engineering: Modeling and simulation. Linear equations. Nonlinear equations. vectors, vector spaces, Metrics, Norms, Inner products, Linear dependence and dimension. Gram- Schmidt Orthonormalisation. Matrices, Eigen values, Eigen vectors, Fredholm alternative. Applications to Chemical Engineering: Linear algebraic equations, Systems of first order homogeneous Ordinary Differential Equations (initial value problems). First order nonhomogeneous ordinary differential Equations (Initial Value Problems). Geometric basis of the method. Implications in process control. non self- adjoint systems. Partial differential Equations: Classification of Second order partial differential equations. Linearity and superposition.

Module 2

Sturm- Louiville Theory: Infinite dimensional spaces, Eigen value problems, Classical Eigen value problems, Fourier Series, Rayleigh's Quotient. Separation of variables and Fourier Transforms: Rectangular Cartesian Coordinates. Cylindrical coordinates, Spherical coordinates, Fourier series and finite Fourier Transforms, Fourier Transform and unbounded domains. Laplace Transform. Green's Function: Ordinary Differential Equations. Green's function for partial differential equations. Unbounded domains

Module 3

Uniqueness conditions for Linear and Nonlinear Systems. Maximum principle, Energy methods, Fredholm alternative, Monotone iteration method. Steady State Characteristics of Nonlinear Dynamical Systems: Dynamic systems, Steady state, Continuation methods. Linear Stability and Limit Cycles: Linear Stability of Dynamical Systems. Bifurcation Theory, Maps. Secondary bifurcation and chaos: Landau- Hopf Scenario, Period Doubling Cascade, Ruelle- Takens Scenario, Characterization of Trajectory.

Text Book:

1. S. Pushpavanam, "Mathematical Methods in Chemical Engineering", Prentice Hall of India Pvt. Ltd. 1998.

References:

1. T. K. V. Iyengar, B. Krishna Gandhi et al. "Mathematical Methods", S. Chand & Company.
2. Gilbert Strang, "Linear Algebra and Applications", Holden Day Publishers.
3. Irvin Kreyszig, "Advanced Engineering Mathematics"**,** New Age International (Pvt) Ltd, New Delhi..

Note:

The question paper shall contain two parts. Part A shall contain ten compulsory short questions, evenly distributed over the whole syllabus and each carrying 4 marks. Part B shall contain three separate modules with two questions from each module of the syllabus. The candidate has to answer any one from each module. Questions in each module shall carry 20 marks each.

08.806 EL V (G) PROCESS ENGINEERING PRINCIPLES IN ELECTRONIC AND CERAMIC MATERIAL FABRICATION (H)

Credits: 4 **L/T/P: 2/2/0**

MODULE I

Introduction – Definition, classification and scope of ceramics, Ceramics Vs metals and organics, Historical perspective on the development of ceramics and ceramic industries. Elementary ideas about the raw materials used in pottery, Heavy clayweres, Refractoriers, Glass, Cement, Industries.

Raw materials – clays and their classification, Quartz, Polymorphism of quartz, Feldspar and its classification, Talc, Steatite and Mica. Conventional ceramics – Classification, Elementary ideas about whitewares, Cement, Glass, Refractories, Glaze and Enamels their manufacture and applications.

Newer ceramics – classification and scope of Cermets, Abrasives, Electro ceramics, Bio-ceramics, Space ceramics, Automotive ceramics, Superconducting ceramics, Elementary ideas of their preparation and their applications.

MODULE II

Fabrication methods: Classification and scope of various fabrication methods. Brief study of dry, semi dry pressing extrusion, Jiggering and jollying, Slip casting HP and HIP.

Drying of ceramics, biscuit firing and glost firing, fast firing technology, action of heat on triaxial body, Elementary ideas of various furnaces used is ceramic industries.

Applications of ceramic products in everyday life, in different fields such as metallurgy, civil engineering, electrical, electronics, automobiles, aerospace and energy engineering.

MODULE III

Atomic structure, introduction to semiconductor materials, solar cells, transistors, basic chemical and physical techniques used in the modern processing of materials at the micro and nanoscales particularly in the microelectronics industry, process sequence of fabrication, control of micro-contamination, Physical deposition, microlithography, doping, etching processes, oxidation, chemical vapour deposition, dielectric formation, Ion beam modification of materials, epitaxial growth, plasma processes, packaging materials, Reaction-diffusion based processing, reactor Design.

Design and Fabrication Technology: Resistors and capacitors: Fabrication techniques – bulk (wire, powder, flexes), thin film, thick films. Pn junction diode: Fabrication steps- crystal growth, doping, oxidation, diffusion, ion implantation, lithography, metallization and etching.

REFERENCES

1. **Singer F. and Singer S.S,** *Industrial Ceramics*, Hal Leonard Publishing Corporation
2. **Norton F.H,** *Elements of Ceramics*, Addison Wesley Series
3. **Kingery W.D**, *Introduction to Ceramics,* John Wiley
4. **Hummel R.E,** *Electronic Properties of Materials,* Springer Verlag
5. **David Jiles,** *Electronic Properties of Materials,* Nelson Thornes
6. **Ghandhi S.K,** *VLSI fabrication principles*
7. **Middleman S. and Hochberg A.K**,*Process Engineering Analysis in Semiconductor Device Fabrication,* McGraw-Hill.
8. **S. M. Dhir**, *Electronic components and materials principles, manufacturing, maintenance,* Tata McGraw Hill
9. **Kasap S. O,** *Principle of electronic material and devices*, Tata McGraw Hill
10. **Reed S,** *Introduction to the Principles of Ceramic Processing*, 2nd Ed., John Wiley & Sons.
11. **Rahaman M. N.** *Ceramic Processing*, CRC Press, 2007.
12. **Richerson D. W**, *Modern Ceramic Engineering: Properties, Processing, and Use in Design*, 3rd ed, CRC Press
13. **Brosan D. A and Robinson G. C,** *Introduction to Drying of Ceramics*, The American Ceramic Society, Ohio, USA
14. **Mehrer H.,** *Diffusion in Solids: Fundamentals, Methods, Materials, Diffusion Controlled Processes*, Springer, 2007.

Note

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus. Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.*

08.807 PROJECT AND COMPREHENSIVE VIVA-VOCE

Credits: 4 **L/T/P: 0/0/4**

Students should submit a project report of the actual work done during their course.
Credits: Project and Viva – 100 marks