VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY: BURLA
(Formerly University College of Engineering, Burla-Established by Govt. of Odisha in 1956 & Upgraded in 2009 to A State Govt. University Covered under Section 2(f) & 12(B) of UGC Act.)
P.O.: Engineering College, Burla (Siddhi Vihar), Dist.: Sambalpur – 768018, Odisha, INDIA
Phone No.: 0663-2430211, Fax: 0663-2430204 Websit : www.vssut.ac.in

No. VSSUT/PGSR/1562/2019 Date: 22.01.2019

NOTICE

Sub: **List of candidates shortlisted for Written Test and Interview for admission into Ph.D Programme Spring 2018.**

This is for information of all concerned that the **Written Test and Interview for admission into Ph.D Programme Spring 2018 shall be held from 28.01.2019. to 31.01.2019 at VSSUT, Burla as per detailed given below.** Further, it is to inform that the following candidates have been shortlisted for the Written Test and Interview as applicable. The eligible candidates are required to bring their original documents as mentioned in the list and one set of attested copy of the same for verification.

The interview of the qualified candidates in the Written Test shall be conducted on the same day. Moreover, the candidates, those are exempted from the Written Test as per the regulation, shall also appear interview directly on the same day afternoon. The candidates who fail to produce the original documents shall not be allowed for the interview. **No separate intimation for appearing the Written Test and/or Interview as applicable shall be sent to the candidates. Candidates are required to bring their Photo Identity card issued by Government/Institution for verification at the Examination Hall. Those who have not submitted their original GATE/NET Score Cards are required to submit the same at the time of Interview positively.** The Entrance questions consisting of 75 numbers of multi choice Questions having one correct answer (Group-A contains: 50 questions each of one marks and Group-B contains: 25 questions each of 2 marks) two hours duration as per the syllabus available (Given below) in our University website (www.vssut.ac.in). The candidate has to secure minimum of 50 marks to appear the interview. The candidates are required to report at least 30 minutes before the commencement of examination. No candidate will be allowed to appear the test after commencement of Written Test.

PROGRAMME (FOR WITTEN TEST AND/OR INTERVIEW)

Date of Written Test/ Interview	Time of Written Test	Time of Interview	Name of the Departments
28.01.2019	10.00 A.M.	03.00 P.M.	Civil Engineering, Mechanical Engineering, Production Engineering, Mathematics, Computer Applications
30.01.2019	09.00 A.M	2.30 P.M	Computer Science and Engineering, , Metallurgy and Materials Engineering, Physics, Chemistry, English,Chemical Engineering
	11.30 AM.	3.30PM.	Information Technology
31.01.2019	10.00 A.M	2.30 P.M	Electrical Engineering,
		3.30 PM	Electronics and Telecommunication Engineering

SHORTLISTED CANDIDATES FOR WRITTEN TEST AND/OR INTERVIEW FOR ADMISSION INTO Ph.D PROGRAMME SPRING 2018

CHEMICAL ENGINEERING

Non-exempted From Written Test	
CHEM-1	Sushanta Kumar Pradhan

CIVIL ENGINEERING

Exempted From Written Test		
SL. No.	**Ref. No.**	**Name**
1	CE-9	Abhayaa Nayak
Non-exempted From Written Test		
1	CE-1	Bibekananda Naik
2	CE-2	Sarmilee Patnaik
3	CE-3	Subhalaxmi Jena
4	CE-4	Bibhu Prasad Mishra
5	CE-5	Snehalata Padhy
6	CE-6	Chandan Kumar
7	CE-7	Prbhat Ku Singh
8	CE-8	Bhakta Ranjan Mohanty

COMPUTER APPLICATION

Non-exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	CA-1	Uma Maheswar Rao Mogili
2	CA-2	Trilochan Rout
3	CA-3	Rasmita Panigrahi
4	CA-4	Paraselli Ramarao
5	CA-5	Sonali Dash
6	CA-6	Swgatika Panda
7	CA-7	Swati Dash
8	CA-8	Akankshya Rani Nayak

SHORTLISTED CANDIDATES FOR WRITTEN TEST AND/OR INTERVIEW FOR ADMISSION INTO Ph.D PROGRAMME SPRING 2018

COMPUTER SCIENCE AND ENGINEERING

Exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	CSE-01	Devender Nayak
2	CSE-02	Dukka Karun Kumar Reddy
3	CSE-03	Swapna Rekha Hanumantha
Non-exempted From Written Test		
1	CSE-04	K. K. Raju
2	CSE-05	Amiya Bhusan Bagjabad
3	CSE-06	P. Rama Rao
4	CSE-07	J. Bhargav
5	CSE-08	Sushama Rath
6	CSE-09	Alok Kumar Jena
7	CSE-10	Burada Chakradhar
8	CSE-11	Venkata Lakshmi Narayana
9	CSE-12	Sunil Kumar Nahak
10	CSE-13	Yosoda Krishna Kuppili
11	CSE-14	H. V. Bhagyashri
12	CSE-15	Sagarika Mohanty
13	CSE-16	P. M. Sinduri
14	CSE-17	S. S. Tripathy
15	CSE-18	Sanjay Kumar Giri
16	CSE-19	D. K. Burma
17	CSE-20	Mukesh Bathre
18	CSE-21	Shrabani Sangeeta
19	CSE-22	Sudeepa Das
20	CSE-23	Hemant Kumar Apat
21	CSE-24	Banazir Neha
22	CSE-25	Uma Maheswara Rao

SHORTLISTED CANDIDATES FOR WRITTEN TEST AND/OR INTERVIEW FOR ADMISSION INTO Ph.D PROGRAMME SPRING 2018

ELECTRICAL ENGINEERING AND EEE

Exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	EE-08	Rakesh Ranjan Shukla
2	EE-11	Prabodha Kumar Rath
3	EE-15	Sarmistha Panda
Non-exempted From Written Test		
1	EE-01	Umesh Chandra Prusty
2	EE-02	Sahasranshu Das
3	EE-03	Sudhadhara Sarangi
4	EE-04	Boyina Muralidhar
5	EE-05	Sreenivasa Marthyt
6	EE-06	Asima Sabat
7	EE-07	Shaik Ahfat Ahemmed
8	EE-09	Venkatesh Tadi Valasa
9	EE-10	Gottapu Tirupati Naidu
10	EE-12	Subinay Vajpayee
11	EE-13	Shaswat Chirantan
12	EE-14	Tentu Papi Naidu
13	EE-16	Bibhu Prasad Nanda
14	EE-17	Shirisha Undrajavarapu
15	EE-18	Sangram Sekhar

ELECTRONICS & TELECOMMUNICATION ENGINEERING

Exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	ETC-3	Radhashyam Patra
2	ETC-4	Bibekananda Jena
3	ETC-6	Amaresh Kumar Sahu
Non-exempted From Written Test		
1	ETC-2	Shaik Azeez
2	ETC-5	Sunkuna Ramakrishna
3	ETC-7	Pedapudi Vijaya Bhaskar
4	ETC-8	Monalisa Rout
5	ETC-9	Busani Venkateswar Rao

SHORTLISTED CANDIDATES FOR WRITTEN TEST AND/OR INTERVIEW FOR ADMISSION INTO Ph.D PROGRAMME SPRING 2018

INFORMATION TECHNOLOGY

Exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	IT-01	Dukka Karan Kumar Reddy
2	IT-03	K. K. Raju
3	IT-04	Amiya Bhusan Bagjodab
Not Exempted From Written Test		
1	IT-05	Sushma Rath
2	IT-06	Hanumahantu Venkata Bhagyasri
3	IT-07	Pujasuman Tripathy
4	IT-08	Paraselli Ramarao
5	IT-09	Subhra Priyadarshini Biswal
6	IT-10	Sunil Kumar Nahak
7	IT-11	Sudeepa Das
8	IT-12	Banazir Neha
9	IT-13	Yasoda Krishna Kuppili
10	IT-14	Polumahanti Sindauri
11	IT-15	Venkata Lakshmi Narayana
12	IT-16	Arabinda Dash
13	IT-17	Mukesh Bathre
14	IT-18	Swapna Rekha Hanumantha
15	IT-19	Sagarika Mohanty
16	IT-20	Trilochan Rout

METALLURGY AND MATERIALS ENGINEERING

Exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	MME-1	Adiraj Behera
Non-exempted From Written Test		
1	MME-2	Saroj Kumar Sahu
2	MME-3	Siddharth Patel

SHORTLISTED CANDIDATES FOR WRITTEN TEST AND/OR INTERVIEW FOR ADMISSION INTO Ph.D PROGRAMME SPRING 2018

MECHANICAL ENGINEERING

Exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	ME-01	Ramaknta Behera
2	ME-03	Sourabh Kumar Singh
Non-exempted From Written Test		
1	ME-2	Ranjit Kumar Amanta
2	ME-4	Basanta Kumar Nayak
3	ME-5	Sanat Kumar Sahu
4	ME-6	Himadri Tanata Mahanta
5	ME-7	Sumit Prasad Patnaik
6	ME-8	Sudhir Kumar Mahanta
7	ME-9	Kurmana Prema Kumar
8	ME-10	Maaz Ansari
9	ME-11	Pranab Kumar Pattanaik
10	ME-12	Sateesh Yalavarthi
11	ME-13	Kolusu Ramu
12	ME-14	Pavan Kumar Rajeti
13	ME-15	Sidharth Patel

PRODUCTION ENGINEERING

Non-exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	PE-1	Sambeet Kumar Sahu
2	PE-2	Reena Ray
3	PE-3	Siddha Sankalpa Pattnaik
4	PE-4	Pradeep Kumar Nayak
5	PE-5	Pratyush Kumar Sahu

SHORTLISTED CANDIDATES FOR WRITTEN TEST AND/OR INTERVIEW FOR ADMISSION INTO Ph.D PROGRAMME SPRING 2018

CHEMESTRY

Non-exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	CHY-1	Baishali Rout

HUMANITIES (ENGLISH)

Non-exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	HUM-1	Asutosh Mallick
2	HUM-2	Sadhna Swayamsidha
3	HUM-3	Rajesh Nayak

MATHEMATICS

Non-exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	MATH-1	Ritanjali Behera
2	MATH-2	Biswanath Meher
3	MATH-3	Rajashree Sahu
4	MATH-4	Balaram Sahu
5	MATH-5	Prabhu Prasad Nayak
6	MATH-6	Sandhya Priya Baral
7	MATH-7	Kisan Bhoi
8	MATH-8	H. Dipali Singh
9	MATH-9	Md. Jawed

PHYSICS

Exempted From Written Test		
Sl. No.	**Ref. No.**	**Name**
1	PHY-2	Prabati Naik
Non-exempted From Written Test		
2	PHY-1	Abhilash Kumar Sahoo

LIST OF DOCUMENTS TO BE PRODUCED AT THE TIME OF INTERVIEW

Sl. No.	Documents for Verification
1	Proof of Identity (Voter ID/PAN/Aadhaar Card/Passport/Driving License/Govt. ID Card)
2	HSC or equivalent Examination certificate showing Date of Birth
3	Pass Certificate of the +2 Science/Diploma Examination
4	Pass Certificate of the +3 Science/Arts
5	Pass Certificate of B.Tech./BE/B.Sc.(Engg.)/MCA/M.Sc. Examination
6	Pass Certificate of M.Tech./ME/M.Sc.(Engg.) Examination
7	Pass Certificate of M.Phil/MA/MBA Examination
8	Memorandum of Marks of HSC Examination or equivalent Examination
9	Memorandum of Marks of +2 Science/Diploma Examination
10	Memorandum of Marks of +3 Science/Arts
11	Memorandum of Marks of B.Tech./BE/B.Sc.(Engg.)/MCA/M.Sc. Examination
12	Memorandum of Marks of M.Tech./ME/M.Sc.(Engg.) Examination
13	Memorandum of Marks of M.Phil/MA/MBA Examination
14	Certificate in support of SC/ST category (as the case may be)
15	Original GATE/NET/Inspired Fellowship/Letter of any other Fellowship from Government Agencies
16	Synopsis of the Proposed Research Work (One Page)
17	Hard Copy of Publications (if any)

Sd/-
Dean, PGS&R

Memo No. VSSUT/PGSR/1563(3)/2019 Date:22.01.2019

Copy to :

1. All HODs for information and necessary action.
2. Dean, Faculty & Planning with a request to display in the notice of University website.
3. PA to V.C. for kind information of Hon'ble Vice Chancellor

Sd/-
Dean, PGS&R

SYLLABUS FOR WRITTEN TEST

CIVIL ENGINEERING

1. Engineering Mechanics, Strength of Materials and Structural Analysis

Engineering Mechanics: Principle of virtual work, equivalent force system. First and Second Moment of area, Mass moment of Inertia. Static Friction. Kinematics and Kinetics: Kinematics in Cartesian Co-ordinates, motion under uniform and non-uniform acceleration, motion under gravity. Kinetics of particle: Momentum and Energy principles, collision of elastic bodies, rotation of rigid bodies.

Strength of Materials: Simple Stress and Strain, Elastic constants, axially loaded compression members, Shear force and bending moment, theory of simple bending, Shear Stress distribution across cross sections, Beams of uniform strength. Deflection of beams: Macaulay's method, Mohr's Moment area method, Conjugate beam method, unit load method. Torsion of Shafts, Elastic stability of columns, Euler's Rankine's and Secant formulae.

Structural Analysis: Castiglianio's theorems, Slope deflection, moment distribution, Rolling loads and Influences lines: Influences lines for Shear Force and Bending moment at a section of beam. Criteria for maximum shear force and bending Moment in beams traversed by a system of moving loads. Influences lines for simply supported plane pin jointed trusses. Arches: Three hinged, two hinged and fixed arches. Matrix methods of analysis Plastic Analysis of beams and frames: Theory of plastic bending, plastic analysis, statical method, Mechanism method. Unsymmetrical bending: Moment of inertia, product of inertia, Neutral Axis and Principle axes, bending stresses.

2. Design of Structures: Steel, Concrete

Structural Steel Design: Structural Steel: Riveted, bolted and welded joints and connections. Design of tension and compression member, beams of built up section, riveted and welded plate girders, gantry girders, stancheons with battens and lacings.

Design of Concrete : Concept of mix design. Reinforced Concrete: Working Stress and Limit State method of design-Recommendations of I.S. codes Design of one way and two way slabs, stair-case slabs, simple and continuous beams of rectangular, T and L sections. Compression members under direct load with or without eccentricity, Cantilever and Counter fort type retaining walls. Prestressed concrete: Methods and systems of prestressing, anchorages, Analysis and design of sections for flexure based on working stress, loss of prestress.

3. Fluid Mechanics, Open Channel Flow, Hydraulic Machines, Hydrology, Water Resources and Engineering:

Fluid Mechanics: Fluid properties and their role in fluid motion, fluid statics, Kinematics and Dynamics of Fluid flow, Continuity, momentum and energy equation, Navier-Stokes equation, Euler's equation of motion, application to fluid flow problems, pipe flow, sluice gates, weirs. Laminar flow between parallel, stationary and moving plates, flow through tube. Laminar and turbulent boundary layer on a flat plate, laminar sub layer, smooth and rough boundaries, drag and lift. Turbulent flow through pipes: Characteristics of turbulent flow, velocity distribution and variation of pipe friction factor, hydraulic grade line and total energy line. Uniform and non-uniform flows, Hydraulic turbines, types classification, Choice of turbines, performance parameters, controls, characteristics, specific speed.

Hydrology: Hydrological cycle, precipitation, evaporation, transpiration, infiltration, overland flow, hydrograph, flood frequency analysis, flood routing through a reservoir, channel flow routing-Muskingam method.

Water Resources Engineering: Ground and surface water resource, single and multipurpose projects, storage capacity of reservoirs, reservoir losses, reservoir sedimentation.

Irrigation Engineering: (i) Water requirements of crops: consumptive use, duty and delta, irrigation methods and their efficiencies. (ii) Canals: Distribution systems for canal irrigation, canal capacity, canal losses, alignment of main and distributary canals, most efficient section,

lined canals, their design, regime theory, critical shear stress, bed load. (iii) Canal structures (iv) Diversion headwork: Principles and design of weirs of permeable and impermeable foundation, Khosla's theory, energy dissipation. (v) Storage works (vi) Spillways (viii) River training.

4. Geotechnical Engineering: Soil Type and structure - gradation and particle size distribution - consistency limits. Water in soil - capillary and structural - effective stress and pore water pressure - permeability concept - field and laboratory determination of permeability - Seepage pressure - quick sand conditions - Shear strength determination - Mohr Coulomb concept. Compaction of soil - Laboratory and field tests. Compressibility and consolidation concept - consolidation theory - consolidation settlement analysis. Earth pressure theory and analysis for retaining walls, Application for sheet piles and Braced excavation. Bearing capacity of soil - approaches for analysis - settlement analysis - stability of slope of earth walk. Subsurface exploration of soils - methods Foundation - Type and selection criteria for foundation of structures - Design criteria for foundation - Analysis of distribution of stress for footings and pile - pile group action-pile load test. Ground improvement techniques.

5. Transportation Engineering:

Railway Engineering: Permanent way - components, types and their functions - Functions and Design of turn and crossings - Necessity of geometric design of track - Design of station and yards.

Highway Engineering: Principles of Highway alignments - classification and geometrical design elements and standards for Roads. Design principles and methodology of flexible and rigid pavements. Typical construction methods and standards of materials for stabilized soil, WBM, Bituminous works and CC roads. Surface and sub-surface drainage arrangements for roads. Pavement distresses and strengthening by overlays. Traffic surveys and their applications in traffic planning - Typical design features for channelized, intersection, rotary etc - signal designs - standard Traffic signs and markings.

6. Environmental Engineering:

Water Supply: Predicting demand for water, impurities of water and their significance, physical, chemical and bacteriological analysis, waterborne diseases, standards for potable water. Water treatment: principles of coagulation, flocculation and sedimentation; slow-; rapid-, pressure-, filters; chlorination, softening, removal of taste, odor and salinity.

Sewerage systems: Domestic and industrial wastes, storm sewage-separate and combined systems, flow through sewers, design of sewers.BOD, COD, solids, dissolved oxygen, nitrogen and TOC. Standards of disposal in normal watercourse and on land.

Sewage treatment& Solid waste: Working principles, units, chambers, sedimentation tanks, trickling filters, oxidation ponds, activated sludge process, septic tank, disposal of sludge, recycling of wastewater. Collection and disposal in rural and urban contexts, management of long-term ill effects.

SYLLABUS FOR WRITTEN TEST

MECHANICAL ENGINEERING

Section 1: Applied Mechanics and Design

Engineering Mechanics: Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.

Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

Section 2: Fluid Mechanics and Thermal Sciences

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

Applications: Power Engineering: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines.

Section 3: Materials, Manufacturing and Industrial Engineering

Engineering Materials: Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials. Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and

cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.

Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-raditional machining processes; principles of work holding, design of jigs and fixtures.

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control: Deterministic models; safety stock inventory control systems.

Operations Research: Linear programming, simplex method, transportation, assignment, network flow models, simple models, PERT and CPM.

SYLLABUS FOR WRITTEN TEST

ELECTRICAL ENGINEERING

Networks: Network topology, Node-pair and loop analysis of networks containing independent and dependent sources, Sinusoidal steady state analysis of single-phase and 3-phase circuits, Resonance, Symmetrical components, Magnetically coupled circuits. Fourier series and transform, Laplace transform, Analysis of RLC networks using Laplace transform, Network functions for one-port and two-port networks, Impulse response and superposition integral, Network theorems, State variables, Formulation of state equations of RLC-networks and solutions, Discrete systems.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT, z-transform. Sampling theorem, Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems.

Electromagnetic Field Theory: Vector fields. Divergence and Stokes theorems. Overview of Electrostatics and Magnetostatics. Poisson's Equation: Derivation, applications, existence and uniqueness. Dielectrics, Displacement vector. Capacitance matrix, Energy in the field. Ampere's Law: B Field calculations. Vector potential. The magnetic dipole. Magnetization of materials.Faraday's Law: Induced EMF in stationary and moving coils. Inductance. Inductance matrix. Energy in the magnetic field. Maxwell's Equation: The wave equation. Poynting theorem. Poynting theorem for phasors.

Electrical Machines: Single phase transformer, three phase transformers, instrument transformers, energy conversion principles, DC machines, induction motors, synchronous machines, parallel operation of generators, motor starting, characteristics and applications, servo and stepper motors, special machines, electrical drives.

Power Systems and High Voltage: Basic power generation concepts, transmission line models and performance, cable performance, insulation, corona and radio interference, distribution systems, per-unit quantities, bus impedance and admittance matrices, load flow, voltage control, power factor correction, economic operation, symmetrical components, fault analysis, power system protection and switch gear, HVDC transmission and FACTS concepts, power quality, Harmonics in power systems, Renewable energy systems. Power System Stability -Swing equation, single generator infinite bus model, and equal area criterion. Importance of High Voltages and HV tests; general requirements of HV testing, testing of internal and external insulation systems. Generation of High alternating, direct and impulse voltages; measurements of alternating direct and impulse voltages and dielectric loss. Insulating materials: solids, liquids and gases; their electrical properties and applications; breakdown mechanisms in solid, liquid and gaseous dielectric; measurement of Radio interference Voltage (RIV) and partial discharges; generation and Measurement of impulse currents.

Power Electronics: Semiconductor Devices in switched mode - Diode, SCR, BJT, IGBT, MOSFET - drivers, protection, thermal aspects – ratings Figures of merit - ripple factor, average value, Harmonic factor, Distortion factor, THD, Power factor, Crest factor Power in switching circuits - 2-pulse Midpoint converter - analysis for R load, infinite inductive load, R-L load - implications of commutation overlap - use in DC drives. 3-pulse converter - analysis for R load, infinite inductive load, R-L load - implications of commutation overlap -

use in DC drives. Bridge converters - three phase and single phase - analysis for R load, infinite inductive load, R-L load - implications of commutation overlap - use in DC drives.
Buck, Boost, Buck-Boost and Cuk Converters - circuit steady state analysis - current and voltage ripple estimation - discontinuous and continuous modes of operation. Use of SCR in buck converters - commutation circuit. Inverters - 120 deg. and 180 deg. conduction operation – selective harmonic elimination - McMurray inverter - SPWM, unipolar and bipolar switching Single phase AC Voltage Controller - analysis and operation Snubbers - turn on, turn off, snubbers - RCD snubber Power Electronic Converters, Vector Control/Direct control /Torque Control of Motors, Simulation of PE systems, DSP Applications, Permanent Magnet Machines and Special Machines.

Control Systems & Instrumentation: Representation of continuous and discrete-time signals, shifting and scaling operations, linear, time invariant and causal systems, Fourier series representation of continuous periodic signals, sampling theorem, Principles of feedback, transfer function, block diagrams, steady -state errors, Routh and Niquist techniques, Bode plots, root loci,lag, lead and lead-lag compensation, state space model, state transition matrix, controllability and observability, Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments, measurement of voltage, current, power, energy and power factor, digital voltmeters and multimeters, phase, time and frequency measurement, Q-meters, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, amplifiers -biasing, equivalent circuit and frequency response, oscillators and feedback amplifiers, operational amplifiers-characteristics and applications, simple active filters, VCOs and timers,combinationaland sequential logic circuits, multiplexer, Schmitt trigger, multi-vibrators, sample and hold circuits,A/D and D/A converters, 8-bitmicroprocessor basics, architecture, programming and interfacing. Semiconductor power diodes, transistors, hyristors, triacs, GTOs, MOSFETs and IGBTs,Converter.

SYLLABUS FOR WRITTEN TEST

ELECTRONICS & TELECOMMUNICATION ENGINEERING

Module-1

Linear Wave Shaping Circuits, Hall effects, Rectifiers, Clippers, Clampers, Semiconductor technology, Small Signals Modeling of BJT, MOSFETs, Feedback Amplifiers & Oscillators, OP-Amps, Current Source Circuits, BJT and JFET Frequency Response, Power Amplifiers(A, B, C types), Distortion analysis, Push-pull configuration, Transients, Resonance, Network theorems, Network Functions: Poles And Zeros, Stability of Networks, Two-Port Parameters, Positive Real Function, Driving-Point Synthesis With LC Elements, Two Terminal-Pair Synthesis By Lader Development Gate level Minimization, K Map, POS, SOP, Combinational Circuits, Sequential Circuits, Memory & Programmable Logic, Digital Integrated logic Circuits, State machine Active filter design, Instrumentation Amplifier, Wideband amplifiers, Bistable Multivibrator, Schmitt trigger Circuit, Monostable Multivibrator, Tunnel diode & UJT, VCO, PLL Spectral Analysis, Power Spectral Density, AM, DSB-SC, SSB-SCand VSB, M, PM, Preemphasis and Deemphasis, Noise in AM & FM

Module-II

Anti-aliasing Filter, PAM, PWM, PPM, PCM, DPCM, DM, ADM, Line Coding**,** ISI, Equalizer, Eye diagram, Timing Jitter, White Noise, BPSK, BFSK, DE-PSK, QPSK, MSK, M-ary PSK, M-ary FSK Co-ordinate transformation, Electrostatics, Magnetostatics, Steady Electric Currents, Maxwall's Equations, Helmholtz wave equation. Plane wave solution, Polarization of EM wave, Radio Wave Propagation CMOS p-Well and n-Well Processes, CMOS Inverter, Layout of an Inverter, Combinational & Sequential Logic Circuits in VLSI, Semiconductor Memories, Design Capture Tools, VHDL, Testing and Verification LTI System, z-transform DFT, IDFT, FFT,DIT & DIF algorithms, Convolution, Correlation, FIR & IIR FiltersIntel 8085 Microprocessor, Memory Interfacing, Stack &Subroutines, Interrupts,8253, 8255, 8257, 8259, Intel 8086, Intel 80386 and 80486

Module-III

DC & AC bridges, True- RMS responding meter, Storage Oscilloscope, Sampling Oscilloscope, Sweep frequency Generator, Spectrum Analyzer, Strain Gages, Displacement Transducers, Instrumentation Amplifier, Isolation Amplifier, IEEE-488 GPIB Bus High Frequency Transmission line and Wave guides, Smith chart, Field solution for TE and TM modes, Cylindrical waveguides, Microwave Resonator, Power divider and Directional Couplers, Reflex Klystron, Multi-Cavity Magnetron, Microwave Propagation 8051 Microcontroller, Arithmetic Instructions and Programs, Single- Bit Instructions And Programming, Interfacing of 8051

Module-IV

Optical Fiber Modes and Configurations, Attenuation and Distortion in optical Fibers, LED and LASER Diodes, Optical Fiber System Link Budget

Satellite Orbits, Spacing and Frequency Allocation, Satellite Sub-systems, Satellite System Link Models, Direct Broadcast Satellite Services, Application of LEO, MEO and GEO Satellites Image Digitization, Image Enhancement, Restoration, Compression,Segmentation, Processing of color images Methods for Speech Processing, Digital Representation of speech Waveform, Linear Predictive Speech Coding Block codes, Waveform coding, Cyclic Codes, Convolutional Encoding, Fuzzy Logic , Neural Networks, Evolutionary Computing Radar Equation, Radar Block Diagram, Radar Frequencies, Applications and Limitations of Radar TV Transmitters & its Block Diagram, Resolution, Scanning, Resolution, Sync Signal Cellular Concept & System Design, Mobile Radio Propagation, DS-SS and FH-SS, GSM, CDMA Antenna Basics & Fundamentals, Horn Antenna, Aperture Antenna, Dipole antenna, Yagi antenna.

SYLLABUS FOR WRITTEN TEST

COMPUTER SCIENCE & ENGINEERING

Digital Logic: Logic functions, Minimization, Design and synthesis of combinational and sequential circuits; Number representation and computer arithmetic (fixed and floating point).

Computer Organization and Architecture: Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface (Interrupt and DMA mode), Instruction pipelining, Cache and main memory, Secondary storage.

Programming and Data Structures: Programming in C; Functions, Recursion, Parameter passing, Scope, Binding; Abstract data types, Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Binary

Algorithms: Analysis, Asymptotic notation, Notions of space and time complexity, Worst and average case analysis; Design: Greedy approach, Dynamic programming, Divide-and-conquer; Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching. Asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, Basic concepts of complexity classes – P, NP, NP-hard, NP-complete.

Theory of Computation: Regular languages and finite automata, Context free languages and Pushdown automata, Recursively enumerable sets and Turing machines, Undecidability.

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environments, Intermediate and target code generation, Basics of code optimization.

Operating System: Processes, Threads, Inter-process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security.

Databases: ER-model, Relational model (relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B and B^+ trees), Transactions and concurrency control.

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Computer Networks: ISO/OSI stack, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP(v4), Application layer protocols (icmp, dns, smtp, pop, ftp, http); Basic concepts of hubs, switches, gateways, and routers. Network security – basic concepts of public key and private key cryptography, digital signature, firewalls.

Web Technologies: HTML, XML, basic concepts

SYLLABUS FOR WRITTEN TEST

INFORMATION TECHNOLOGY

Engineering Mathematics

Discrete Mathematics: Propositional and first order logic. Sets, relations, functions, partial orders and lattices. Groups. Graphs: connectivity, matching, coloring. Combinatorics: counting, recurrence relations, generating functions.

Linear Algebra: Matrices, determinants, system of linear equations, eigenvalues and eigenvectors, LU decomposition.

Calculus: Limits, continuity and differentiability. Maxima and minima. Mean value theorem. Integration.

Probability: Random variables. Uniform, normal, exponential, poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.

Digital Logic: Boolean algebra. Combinational and sequential circuits. Minimization. Number representations and computer arithmetic (fixed and floating point).

Computer Organization and Architecture: Machine instructions and addressing modes. ALU, data- path and control unit. Instruction pipelining. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).

Programming and Data Structures: Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

Algorithms: Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide- and- conquer. Graph search, minimum spanning trees, shortest paths.

Theory of Computation: Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and contex-free languages, pumping lemma. Turing machines and undecidability.

Compiler Design: Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation.

Operating System: Processes, threads, inter- process communication, concurrency and synchronization. Deadlock. CPU scheduling. Memory management and virtual memory. File systems.

Databases: ER- model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.

Computer Networks: Concept of layering. LAN technologies (Ethernet). Flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state). TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP, HTTP). Basics of Wi-Fi. Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.

SYLLABUS FOR WRITTEN TEST

PRODUCTION ENGINEERING

Metal Casting: It include topics- Casting processes – applications and types; patterns – materials and types; allowances; cores and moulds – materials, making and testing; casting techniques of cast iron, steels and nonferrous alloys and metals; solidification; design of casting, rise ring and gating; casting inspection, remedies and defects.

Metal Forming: Stress-strain relations in plastic and elastic deformation; concept of flow stress, deformation mechanisms; cold and hot working – forging, extrusion, rolling, wire and tube drawing; sheet metal working processes such as piercing, blanking, bending, deep drawing, embossing and coining; analysis of rolling, extrusion, forging and rod/wire drawing; metal working defects.

Metal Joining Processes: manual metal arc, TIG, MIG, plasma arc, submerged arc, thermit, electro slag, resistance, friction, forge and explosive welding; other joining processes – soldering, braze welding, brazing; inspection of welded joints, remedies and decfects; introduction to advanced welding processes – ultrasonic, laser beam; electron beam ;thermal cutting.

Machining and Machine Tool Operations: Basic machine tools; machining processes-turning, drilling, milling, boring, planning, shaping, gear cutting, broaching, thread production, grinding, lapping, honing, super finishing; mechanics of machining – geometry of cutting tools, cutting forces, chip formation and power requirements, selection of machining parameters; Merchant's analysis; tool materials, tool life and tool wire, economics of machining, thermal aspects of machining, machinability, cutting fluids; principles and applications of nontraditional machining processes – AJM,USM, EDM, WJM and Wire cut LBM, EDM, EBM, CHM, PAM, ECM.

Tool Engineering: fixtures and jigs – applications, principles and design; press tools – configuration, design of punch and die; principles of forging die design.

Metrology and Inspection: Fits, Limits and tolerances, selective assembly, interchangeability; linear and angular measurements by optical and mechanical methods, comparators; design of limit gauges; measurement of straightness, flatness, squareness, roundness and symmetry; surface finish measurement; inspection of gears and screw threads; alignment testing of machine tools.

Polymers and Composites: Introduction to composites and polymers; plastic processing – injection, blow molding and Compression, extrusion, calendaring and thermoforming; molding of composites.

Manufacturing Analysis: Sources of errors in manufacturing; tolerance analysis in manufacturing and assembly; process capability; process planning; comparison of production alternatives and parameter selection, time and cost analysis; manufacturing technologies – selection and strategies.

Computer Integrated Manufacturing: Basic concepts of CAM, CAD, CAPP, cellular manufacturing, NC, DNC, CNC, Robotics, CIM and FMS.

Operation Research: Linear programming – problem formulation, duality, simplex method and sensitivity analysis; assignment and transportation models; constrained optimization and Lagrange multipliers; network flow models, simple queuing models; dynamic programming; simulation – manufacturing applications; CPM and PERT, resource leveling, time-cost trade-off.

Quality Assurance and Reliability: Costs and concepts, quality assurance; quality circles, statistical quality control, zero defects, acceptance sampling, total quality management, six sigma; ISO 9000; design of experiments – Taguchi method. vailability, Reliability and maintainability; distribution of failure and repair times; determination of MTTR and MTBF, system reliability determination; reliability models; preventive maintenance and replacement, total productive maintenance – applications and concepts.

SYLLABUS FOR WRITTEN TEST

PHYSICS

Mathematical Physics: Linear vector space; matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces, Kepler problem and planetary motion; collisions and scattering in laboratory and centre of mass frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; special theory of relativity – Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Solution of electrostatic and magnetostatic problems including boundary value problems; dielectrics and conductors; Biot-Savart's and Ampere's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; Electromagnetic waves and their reflection, refraction, interference, diffraction and polarization. Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves; radiation from a moving charge.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one, two and three dimensional potential problems; particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momenta; time independent perturbation theory; elementary scattering theory.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates and microstates; phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Atomic and Molecular Physics: Spectra of one- and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Nuclear radii and charge distributions, nuclear binding energy, Electric and magnetic moments; nuclear models, liquid drop model – semi-empirical mass formula, Fermi gas model of nucleus, nuclear shell model; nuclear force and two nucleon problem; Alpha decay, Beta-decay, electromagnetic transitions in nuclei; Rutherford scattering, nuclear reactions, conservation laws; fission and fusion; particle accelerators and detectors; elementary particles, photons, baryons, mesons and leptons; quark model.

Electronics: Network analysis; semiconductor devices; Bipolar Junction Transistors, Field Effect Transistors, amplifier and oscillator circuits; operational amplifier, negative feedback circuits ,active filters and oscillators; rectifier circuits, regulated power supplies; basic digital logic circuits, sequential circuits.

SYLLABUS FOR WRITTEN TEST

CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory: principles and techniques; applications to a particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories, Hückel approximation; approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR, and ESR spectroscopy

Equilibrium: Kinetic theory of gases; First law of thermodynamics, heat, energy, and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams – one, two, and three component systems; activity, activity coefficient, fugacity, and fugacity coefficient; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties;

Kinetics: Rates of chemical reactions, temperature dependence of chemical reactions; elementary, consecutive, and parallel reactions; steady state approximation; theories of reaction rates – collision and transition state theory, relaxation kinetics, kinetics of photochemical reactions and free radical polymerization, homogeneous catalysis, adsorption isotherms and heterogeneous catalysis.

INORGANIC CHEMISTRY

Main Group Elements: General characteristics, allotropes, structure and reactions of simple and industrially important compounds: boranes, carboranes, silicones, silicates, boron nitride, borazines and phosphazenes. Hydrides, oxides and oxoacids of pnictogens (N, P), chalcogens (S, Se & Te) and halogens, xenon compounds, pseudo halogens and interhalogen compounds. Shapes of molecules and hard- soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal- ligand bonding (CFT and LFT), mechanisms of substitution and electron transfer reactions of coordination complexes. Electronic spectra and magnetic properties of transition metal complexes, lanthanides and actinides.

Instrumental Methods of Analysis: Atomic absorption and emission spectroscopy including ICP-AES, UV- visible spectrophotometry, NMR, mass, Mossbauer spectroscopy (Fe and Sn), ESR spectroscopy, chromatography including GC and HPLC and electro-analytical methods (Coulometry, cyclic voltammetry, polarography–amperometry, and ion selective electrodes).

ORGANIC CHEMISTRY

Stereochemistry: Chirality of organic molecules with or without chiral centres. Specification of configuration in compounds having one or more stereogeniccentres. Enantiotopic and diastereotopic atoms, groups and faces. Stereoselective and stereospecific synthesis. Conformational analysis of acyclic and cyclic compounds. Geometrical isomerism. Configurational and conformational effects on reactivity and selectivity/specificity.

Reaction Mechanism: Methods of determining reaction mechanisms. Nucleophilic and electrophilic substitutions and additions to multiple bonds. Elimination reactions. Reactive intermediates- carbocations, carbanions, carbenes, nitrenes, arynes, free radicals. Molecular rearrangements involving electron deficient atoms.

Organic Synthesis: Synthesis, reactions, mechanisms and selectivity involving the following alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives, halides, nitro compounds and amines. Use of compounds of Mg, Li, Cu, B and Si in organic synthesis. Concepts in multistep synthesis- retrosynthetic analysis, disconnections,

synthons, synthetic equivalents, reactivity umpolung, selectivity, protection and deprotection of functional groups.

Pericyclic Reactions: Electrocyclic, cycloaddition and sigmatropic reactions. Orbital correlation, FMO and PMO treatments.

Photochemistry: Basic principles. Photochemistry of alkenes, carbonyl compounds, and arenes. Photooxidation and photoreduction. Di-π- methane rearrangement, Barton reaction.

Heterocyclic Compounds: Structure, preparation, properties and reactions of furan, pyrrole, thiophene, pyridine, indole and their derivatives.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physicochemical properties of amino acids, chemical synthesis of peptides, structural features of proteins, nucleic acids, steroids, terpenoids, carotenoids, and alkaloids.

Spectroscopy: Principles and applications of UV-visible, IR, NMR and Mass spectrometry in the determination of structures of organic molecules

SYLLABUS FOR WRITTEN TEST

MATHEMATICS

Real Analysis: Axioms of Choice, Countability, Bolzano-Weiestrass theorem, Heine-Borel theorem, Convergence of sequences and series of real numbers, Tests of Convergence, Cauchy Test, Uniform continuity, Sequences and series of functions, Uniform convergence. Power series, Weiestrass approximation theorem, Differentiation, Reimann-Stieltjes Integration, Function of several variables, Differentiability, Inverse function theorem, Implicit function theorem, Constrained maxima and minima.

Complex Analysis: Analytic functions, Power Series, Exponential and trigonometric functions, Conformal mapping, Riemann-Stieltjes integral, Power Series representation of Analytic functions, The index of a closed curve, Cauchy's theorem for rectangle, Cauchy theorem for disc, Cauchy's integral formula, Liouville's theorem, Fundamental theorem of Algebra, Morera's theorem, Open mapping theorem, Zeros, Poles, Classification of Singularities, Laurent Series, Residues, The Maximum Modulus theorem.

Functional Analysis: L^p – spaces, Inequalities in L^p – spaces, Completeness of L^p, Normed linear spaces, inner product spaces examples, properties of Normed linear spaces and inner product spaces, Hilbert spaces, Examples, orthonormal sets, Gram-Schmidt orthonormalizations, Orthonormal polynomials, Orthonormal basis, Fourier Expansion, Hahn Banach Theorem, Baire's category theorem ,Open mapping Theorem ,Closed graph theorem, Uniform boundedness Principle.

Numerical Analysis: Root finding for non-linear equations, Lagrange and Newton interpolations, Interpolating polynomials using finite differences, Hermite interpolation, Piecewise and Spline interpolation, Numerical differentiation, Numerical integration, Numerical Solution of system of linear equations, Numerical solution of ordinary differential equation.

Linear Algebra: Vector spaces over fields, subspaces, bases and dimension, Systems of linear equations, matrices, rank, rank-nullity theorem, duality and transpose, Eigenvalues and eigenvectors, characteristic polynomials, minimal polynomials, Cayley-Hamilton Theorem, triangulation, diagonal-lization, rational canonical form, Jordan canonical form.

Modern Algebra: Groups, Subgroups, Normal Subgroups, Quotient groups, Homomorphism, Isomorphism, Cyclic groups, Permutation groups, Symmetric groups, Cayley's Theorem, Sylow theorem, Application of Sylow Theorem, Free Abelian groups, Free Groups, Vector Spaces, Subspaces, Quotient spaces, Linear independence, bases, Dimension, Projection, Algebra of matrices, Rank of a matrix, Characteristic roots and Vectors, Matrix representation of a linear transformation.

Ordinary Differential Equation: System of first order equations, Existence and Uniqueness theorems, Successive approximation Picard's Theorem, Non Uniqueness of solutions, Existence and uniqueness of solution of systems, Strum Liouville's Problem green's functions, Picard's theorem.

Partial Differential Equation: Classification of first order Partial differential equations, Pfaffian differential equations, Lagrange's method, Compatible systems, Charpit's method, Jacobi's method, Integral surfaces passing through a given curve, Monge cone, characteristic strip, Classification of Second order Partial Differential Equations., One dimensional Wave equation, Vibration of an infinite string, origin of the equation, D'Alembert's solution, Vibrations of a semi finite string, Vibrations of a string of finite length, Laplace equation , Boundary value problems, Maximum and minimum principles.

Measure Theory: Sigma Algebra of Sets, Borel sets of R, Lebesgue outer measure and its properties, Sigma Algebra of Measurable sets in R, Non-measurable sets, Lebesgue measure and its properties, Cantor set and its properties, Measurable functions, Simple functions, Integration of Nonnegative functions, Riemann and Lebesgue Integration, Monotone convergence theorem, Fatou's Lemma, and Dominated convergence theorem.

Topology: Bases, Subbases, Countability, closed sets, Limit Points, Continuous functions, Subspace topology, Product topology, and Quotient topology, Connectedness, Local connectedness, Path-connectedness, compact Spaces, compactness in metric spaces, locally compacts spaces, Regular and completely regular space, normal spaces.

Discrete Mathematical Structures: Permutation, Combination, Graphs: Basic terminology, Multi graph and Weighted graphs, Paths and circuits, Eulerian Paths and circuits, Hamiltonion Paths and circuits, Trees: Rooted trees, binary search trees, Spanning trees, Cut sets, Recurrence relations and recursive Algorithms, Boolean Algebras.

Linear Programming: Simplex Method, Primal and Dual Problem, Duality & Simplex method, Dual Simplex Method, Transportation Problem, Properties of transportation matrix, N-W corner rule, Vogel's approximation method, and Transportation algorithm, Assignment Problem, Two person zero sum games, Maxmin and Minmax principle.

SYLLABUS FOR WRITTEN TEST

ENGLISH

Concepts in Literature:

Literature: culture, context, convention, its practice and relevance
Genres of literature: poetry, fiction, drama
Literary devices and literary forms
Ballad,Comedy, Elegy, Epic, Novel, Ode, Romance, Sonnet, Tragedy, Tragicomey, Short Story)

Classical and Neo-classical Critical Theories:

Classical Theory & Criticism, Aristotle's Poetics, Longinus' On the Sublime
Neoclassical theory and criticism
Samuel Johnson's "Preface" to Plays of William Shakespeare

Literature and Social history-I:

Medieval Period**:** Feudalism and Role of the Church
Early Modern**:** Humanism and the English Renaissance and the Print Revolution
The Beginnings of Colonialism
The Enlightenment**:** Ideas of the Enlightenment & The Beginnings of Modern Democracy
Colonialism to Imperialism

The novel in 18^{th} – 19^{th} Centuries:

Daniel Defoe's Moll Flanders
Jane Austen's Persuasion
Emily Brontë's Wuthering Heights
Jonathan Swift's Gullive's Travels
Richardson Pamela:

Theory- Romantic & Victorian theory & Criticism:

Romantic Theory & Criticism
Wordsworth's 'Preface' to Lyrical Ballads (Second Edition)
Coleridge's Biographia Literaria (Chapter XIII)
Victorian Theory & Criticism
Arnold's "The Study of Poetry"

Modern Drama:

Introduction to Modern Drama, George Bernard Shaw's Pygmalion, Modern Drama and the Absurd, Samuel Beckett's Waiting for Godot, Harold Pinter's The Birthday Party

Modern Poetry:

Poetry in the Modern World
Yeats's "Sailing to Byzantium"
Eliot's The Waste Land
Auden's "In Memory of W.B.Yeats"
William Carlos Williams' "Autumn and All"

20^{th} Century Criticism:

New Criticism
Literary Theory: A Composite View
Structuralism to Post-structuralism
Roland Barthes
Psychoanalysis and Jacques Lacan
Feminism

SYLLABUS FOR WRITTEN TEST

COMPUTER APPLICATION

Computer Architecture: representation of numbers; Octal, Hexadecimal, and Binary 2's complement and 1's complement arithmetic, Floating point representation. Combinational Circuit Design, Sequential Circuit Design, Hardware and Microprogrammed processor design, Instruction formats, Addressing modes, Memory types and organization, interfacing peripheral devices, Interrupts.

Data Structures & Algorithms: Arrays, stacks, queues, lists, linked, trees, graphs priority queues, heaps, Binary tree, AVL tree, B-tree and Hash tables. Graphs: connected graphs, regular and bipartite graphs, cycles and circuits. Tree and rooted tree. Spanning tree of a graph, Eccentricity of a vertex, radius and diameter of a graph. Hamiltonian, Eulerian graphs and Planar graphs. Sorting and Searching Algorithms, Binary Search, Analysis of Algorithms, Asymptotic notations – big oh, omega and theta. Average case analysis of simple programmes like finding of a maximum of n elements. Recursion and its systematic removal. Techniques for Designing Algorithms: Divide and Conquer, Greedy method, Dynamic programming, Back tracking, Branch and Bound. NP-hard and NP-complete problems.

Programming language concepts and paradigms: Data types, Operators, expressions, Assignment. Flow of control-control structures, I/O statements, User-defined and built-in functions. Parameter passing. Language Design: Syntax and semantics of a programming language and related concepts. Programming Paradigm and related concepts: Imperative, Object-oriented. Functional Logic paradigms

Operating Systems Main functions of operating system, Multiprogramming multiprocessing and multitasking. Memory Management: Virtual memory, paging fragmentation. Concurrent Processing: Mutual exclusion. Critical regions, lock and unlock. Scheduling: CPU scheduling, I/O scheduling, Resource scheduling. Scheduling algorithms. Banker's algorithm for deadlock handling.

Database Concepts: ER diagrams, Data Models. Design of Relational Database, Normalisation, 1NF, 2NF, 3NF, BCNF and 4NF. Limitations of the normal forms. SQL and QBE, query Processing and Optimisation. Centralised and Distributed Database Security, Object Oriented Database Management Systems with RDBMS applications.

Computer Networks & Data Communication: Channel capacity. Transmission media twisted pair, coaxial cables, fibre-optic cables, wireless transmission–radio, microwave infrared and millimeter waves. Light wave transmission. Telephone–local loop, unit multiplexing, switching, narrowband ISDN, broadband ISDN, ATM. High speed LANS Cellular Radio. Communication satellites– geosynchronous and low-orbit. Analog and Digital Transmission, Asynchronous and Synchronous transmission Transmission media, Multiplexing and Concentration, Switching techniques, Polling. Topologies, Networking Devices, OSI Reference Model: Protocols for – Data link layer Network layer, and Transport layer; TCP/IP protocols, Network security, Network administration.

Theory of computation: Models of computation: Deterministic Finite Automation (DFA), Non-deterministic Finite Automaton (NFA), Regular languages, Equivalences of DFA and NFA, Equivalence of DFA/NFA and regular languages, minimizing the number of states of DFA. Non-regular languages, and Pumping lemma.

Context-free Grammars & Pushdown Automata (PDA): Deterministic Pushdown Automation (DPDA), Non-deterministic Pushdown Automation (NDPDA) Non-equivalence of DPDA and Non-deterministic Pushdown Automation (NDPDA). Context free grammar (CFG). Equivalence of PDA's ad CFG's: Ambiguity, Parse Representation of Derivations. Simplification of CFGs: Greibach Normal Form GNF and Chomsky Normal Form (CNF). Parsing techniques for parsing of general CEG Cook-Kassami-Younger (CKY) algorithm.

Turing Machine (TM): One tape, multitape. The notions of time and space complexity in terms of TM, Construction of TM for simple problems. Computational complexity, Non-computability and Examples of non-computable problems.

Hierarchy of languages: Grammars, Languages – types of grammars – type 0, type 1, type 2, type 3. The relationship between types of grammars, and finite machine Pushdown automation and Context Free Grammars. Lexical Analysis regular expressions and regular languages. Recursive and recursively-enumerable languages.

Compiler Design: Compiler structure, compiler construction tools, compilation phases, Context free grammars. Paring and parse trees. Representation of parse (derivation) trees as rightmost and leftmost derivations. Bottom up parser – shift – reduce, operator precedence, and LR. Topdown parsers – left recursion and its removal. Recursive descent parser, Predictive parser, Intermediate code generation, Code generation, Code optimisation.

Artificial Intelligence:

Elements of Symbolic Logic: Propositional (Boolean) Logic, Predicate Logic, Well-formed-formulae (WFF), Deduction, Satsifiability and Tautology, Refutation method. Applications in problem solving. State space representation of problem. Search techniques: breadth-first, depth-first. A, A* Knowledge representation: Frames, scripts, semantic nets, production systems, Fuzzy Systems: Definition of a Fuzzy set, Fuzzy relation, Fuzzy function, Fuzzy reasoning Applications to problem solving.

Software Engineering:

System Development Life Cycle (SDLC): Steps, Water fall model, Prototypes, Spiral model. Software Metrics: Software Project Management. Software Design: System design, detailed design, function oriented design, object oriented design, user interface design. Design level metrics. Coding and testing: Testing level metrics, Software quality and reliability, Clean room Approach, software reengineering.

Metallurgy & Materials Engineering

Structure: Atomic structure and bonding in materials. Crystal structure of materials, crystal systems, unit cells and space lattices, determination of structures of simple crystals by x-ray diffraction, miller indices of planes and directions, packing geometry in metallic, ionic and covalent solids. Concept of amorphous, single and polycrystalline structures and their effect on properties of materials. Crystal growth techniques. Imperfections in crystalline solids and their role in influencing various properties

Diffusion: Fick's laws and application of diffusion in sintering, doping of semiconductors and surface hardening of metals. Metals and Alloys: Solid solutions, solubility limit, phase rule, binary phase diagrams, intermediate phases, intermetallic compounds, iron-iron carbide phase diagram, heat treatment of steels, cold, hot working of metals, recovery, recrystallization and grain growth. Microstructure, properties and applications of ferrous and non-ferrous alloys

Ceramics: Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: Classification, polymerization, structure and properties, additives for polymer products, processing and applications.

Composites: Properties and applications of various composites.

Advanced Materials and Tools: Smart materials, exhibiting ferroelectric, piezoelectric, optoelectric, semiconducting behavior, lasers and optical fibers, photoconductivity and superconductivity, nanomaterials – synthesis, properties and applications, biomaterials, superalloys, shape memory alloys. Materials characterization techniques such as, scanning electron microscopy, transmission electron microscopy, atomic force microscopy, scanning tunnelling microscopy, atomic absorption spectroscopy, differential scanning calorimetry

Mechanical Properties: stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, tensile strength, toughness, elongation, plastic deformation, viscoelasticity, hardness, impact strength, creep, fatigue, ductile and brittle fracture.

Thermal Properties: Heat capacity, thermal conductivity, thermal expansion of materials.
Electronic Properties: Concept of energy band diagram for materials – conductors, semiconductors and insulators, electrical conductivity – effect of temperature on conductivity, intrinsic and extrinsic semiconductors, dielectric properties.
Optical Properties: Reflection, refraction, absorption and transmission of electromagnetic radiation in solids.
Magnetic Properties: Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, anti-ferro magnetism, ferromagnetism, ferrimagnetism, magnetic hysteresis. Environmental Degradation: Corrosion and oxidation of materials, prevention.

SYLLABUS FOR WRITTEN TEST

CHEMICAL ENGINEERING

Characterization of Materials

Preamble:

Information on a synthesized material remains incomplete unless it is thoroughly analyzed to understand its various characteristics and its suitability in desired applications. The course Characterization of Materials is aimed at such target. It is a combined course of both lecture and laboratory components. The fundamental principles of various instrumentation techniques viz. microscopy, spectroscopy, surface characterization, thermal stability analysis and mechanical stability analysis for synthesized materials will be discussed through this course. The students
will be exposed to real hands-on laboratory experiments to impart the knowledge of experimental methods for characterization of various synthesized materials. Upon successful completion of this course, students are expected to be conversant with various characterization techniques and will be competent to carry out such experiments in future endeavors to find out the structural, thermal, chemical and mechanical properties of materials of concern.

Course contents:

Materials characterization: importance and applications; principles of X-ray diffraction (XRD)
methods; microscopy techniques: optical and electrons (SEM and TEM) microscopy; Introduction to spectroscopy (UV-vis, IR and Raman); thermal stability analysis:
thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC); mechanical propertycharacterisation: principles and characterization of tensile, compressive, hardness, fatigue, and fracture toughness properties; principles of characterization of other materials properties: BET surface area; chemisorption; particle size; zeta potential; rheology; and interfacial tension

Texts/References:

1. Y. Leng, Materials Characterization: Introduction to microscopic and spectroscopic methods, 1st Ed., JohnWiley& Sons, 2008.
2. A.W. Adamson and A.P. Gast, Physical Chemistry of Surfaces, JohnWiley, New York, 1997.
3. D.G. Baird and D.I. Collias, Polymer Processing Principles and Design, Butterworth-Heinemann, Massachusetts, 1995.
4. A.J. Milling, Surface Characterization Methods: Principles, techniques, and applications, Marcel Dekker, 1999.
5. G. Ertl, H. Knozinger and J. Weitkamp, Handbook of Heterogeneous Catalysis, Vol. 2,

Wiley-VCH, 1997.
6. W.D. Callister (Jr.), Material Science and Engineering: An introduction, 8th Ed., John Wiley &Sons, 2010.

Energy Resources

Preamble:

Energy is vital to all our endeavours and, indeed, to the maintenance of life itself. Energy exists in many forms such as chemical energy, nuclear energy, solar energy, mechanical energy, electrical energy, internal energy in a body, bio-energy in vegetables and animal bodies, thermal energy etc. We also observe the various activities around us are 'energy transformations'. The objective of this course is to provide a comprehensive coverage of energy resources and conversion.

Course contents:

Introduction, major sources of energy: renewable and nonrenewable, primary and secondary energy sources, energy scenario, prospects/need of alternate energy sources, conventional and non- conventional energy sources; solar energy; wind energy; nuclear energy; geo-thermal, hydro energy sources; tidal energy; energy from biomass; energy from coal; and other energy resources: hydrogen, fuel cells; environmental aspects of energy utilization-renewable energy resources and their importance; combustion process: combustion stoichiometry and combustion thermodynamics; gas burners; oil burners; coal burning equipment; Integrated energy system:
concept of integration of conventional and non-conventional energy resources and systems; energy conservation & management.

Texts/References:

1. S. Sarkar, Fuel & combustion, Orient Longman, 2nd Ed., 1990.
2. J. G. Speight, Fuel Science & Technology Handbook, Dekker, 1990.
3. R. E. Haytes, and S.T. Kocaczkowski, Introduction to catalytic combustion, Gordon Beach, 1997.
4. B. H. Khan, Non-conventional energy resources, McGraw Hill, New Delhi.
5. C. S. Solanki, Renewable energy Technology, Prentice Hall Publication, 2008.
6. S. P. Sukhatme, Solar Energy, Tata McGraw Hill, New Delhi, 1996.
7. W. C. Turner, Energy management handbook,Wiley Press, 1982.

Catalysts and Adsorbents

Preamble:

Catalysts and adsorbents are integral part of chemical industries, which are associated with all major sectors of world economy. Therefore it is essential for chemical engineers to have comprehensive knowledge about catalyst and adsorbent materials. This course teaches the basic theories of catalysis and adsorption along with types, preparation, physicochemical properties and application of the materials in details. This course also acquaints the students with latest developments in catalyst and adsorbent materials in different sectors.

Course contents:
Fundamentals of catalysis and adsorption; types of catalysts and adsorbents, preparation methods: conventional and novel; surface area and porosity; bulk and surface characterizations, diffusion in porous material, kinetics and mechanisms; transport effect; deactivation; major applications; recent developments in catalysts and adsorbents.

Texts/References:

1. J. M. Smith, Chemical Engineering Kinetics, McGraw-Hill Book Company, 1981
2. D. M. Ruthven, Principles of adsorption and adsorption processes, JohnWiley& Sons, 1984.
3. R.T. Yang, Adsorbents: Fundamentals and Applications,Wiley-Interscience, 2003.
4. K.P. de Jong, Synthesis of solid catalysts,Wiley–VCH, 2009
5. H. S. Fogler, Elements of Chemical reaction engineering, Prentice Hall of India., 1999
6. C. H. Bartholomew and R. J. Farrauto, Fundamentals of Industrial catalytic Processes, Wiley-
VCH, 2006
7. J. M. Thomas and W. J. Thomas, Principles and Practice of Heterogeneous Catalysis, Wiley-VCH, 1996
8. R.T. Yang, Gas Separation By Adsorption Processes, World Scientific Publishing Company,
1997
9. G. Ertl, H. Knozinger and J. Weitkamp, Handbook of Heterogeneous Catalysis, Vols. 1-2, Wiley-VCH, 1997

Membranes

Preamble:
Membranes are becoming the most important, practically useful and popular materials for applications to modern separation technique in chemical, biochemical, food, petrochemical and several allied process industries. Some of the membrane based separation processes have attained considerable maturity to successfully compete with the traditional separation processes due to theadvantages like: low energy consumption, easy scale-up, non-requirement of any additives or usefulness as a part of hybrid processes. Membranes are manufactured from different materials like polymeric, ceramic, zeolite and can be accommodated in different kind of modules like tubular,
spiral, capillary, plate-and-frame, and hollow fibre. However, syntheses of target specific and highly selective membranes with narrow pore size distribution are some of the present day challenges. Concentration polarization and fouling are also the biggest problems of membrane processes. The present course aims at familiarizing the students with the various methods of synthesis of different kinds of membrane along with their characterization procedures and applications. They will also be acquainted with the latest developments of new membrane materials and processes.

Course contents:

Introduction to membranes; membrane materials: polymeric, inorganic and liquid; membrane preparation:phase inversion, immersion precipitation, track-etch method, sol-gel process, interfacial polymerization, dip-coating process, film stretching and template leaching; characterization of membranes; transport in membranes; various membrane processes and applications; concentration polarization and fouling; membrane modules and process design; membrane reactors and membrane bioreactors.

Texts/References:

1. M. H. Mulder, Basic Principles of Membrane Technology, Springer, 2004.
2. B. K. Dutta, Mass Transfer and Separation Processes, PHI, 2007.
3. M. Cheryan, Ultrafiltration & Microfiltration Handbook, Technomic, 1998.
4. K. Nath, Membrane Separation Processes, PHI, 2008

Composite Materials

Preamble:

Composites science and technology is an emerging area of materials science because certain inherent advantages of composites. Aircraft and spacecraft are typical weight sensitive structures in which composite materials are cost effective. Polymer-clay nano composite is one of the thrust areas of research in the field of composites. Thus, a course on composite materials is highly relevant in the curriculum while studying materials science and technology. The objective of this course is to provide the basic concepts of composite materials. This course involves manufacturing processes, anisotropic elasticity, strength of anisotropic materials, etc. A comprehensive introduction to composite materials and motivation for their use in current
structural applications is covered in detail. Stress-strain relations for a lamina are demonstrated with engineering material constants, too. Lamination theory is presented with the aid of new laminate classification scheme. Moreover, the subject will reveal a high level of comparison between theory and experimental results in order to create the confidence in the derived theory.

Course contents:

Definition of composites; classification; particulate filled and fibre reinforced composites; ceramic composites, resin based composites, composite semiconductors, polymer-metal composites; polymer nanocomposites; theory of reinforcement; concept of microfibril; effect of orientation and adhesion; composite properties; lamination theory; mechanical behaviour of composites: stress-strain relationship, strength, fracture, toughness and fatigue; composites fabrication.

Texts/References:

1. R.M. Jones, Mechanics of Composite Materials, Second Edition, 1st Indian Reprint, Taylor &
Francis, 2010.
2. F. L. Matthews and R. D. Rawlings, Composite Materials: Engineering and Science, CRC Press, Woodhead, 1999.
3. B.D. Agarwal, and J.D. Broutman, Analysis and Performance of Fiber Composites, John Willey and Sons, New York, 1990.
4. P.K. Mallik, Fiber reinforced composites: materials, manufacturing and design, 2nd Ed., Marcel and Dekker, New York, 1993.
5. K.K. Arthur, Mechanics of Composite Materials, CRC Press, 1997.

6. P.K. Mallik, Composite Engineering Hand Book, 2nd Ed., Marcel and Dekker, New York, 1997.

ADVANCED MASS TRANSFER

Characteristic of Equilibrium stage and Flash calculations, Study of different types of equilibrium cascade configurations and its degrees of freedom analysis, Algebraic method to determine the number of equilibrium stages, Calculation of stage efficiency, tray diameter, pressure drop and mass transfer, Rate based method to design a packed column, Scale up of a column from laboratory data, Estimation of distillation column efficiency using performance data and to develop its empirical correlation, Scale up of distillation column, Rate based method for packed distillation column, Approximate methods for Multicomponent, multistage separations, Use of residue curve for the conceptual design of distillation columns, Pressure swing and azeotropic distillation, Rate based models for distillation, Modeling of batch distillation, Modeling and simulation of absorption and leaching processes. Diffusion in non-ideal system and development of generalized Maxwell-Stefan formulation, Study of Generalized Fick's law, Estimation of binary and multicomponent Diffusion Coefficients, Study of
interphase mass and energy transfer.

Essential Reading:

Supplementary Reading:

1. J.D Seader, E. J. Henly, "Separation Processes and principles", John Willey, 2nd edition, 2006.
2. R. Taylor, R. Krishna. "Multicomponent Mass Transfer", John Wiley, 1993.
3. J. Bendaitez "Principles and Modern Applications of Mass Transfer Operations", Willey, 2002.
4. A.K. Datta, "Biological and Bioenvironmental Heat and Mass Transfer", C R C Press, 2002.
5. N Hallale, "Supertargeting for Mass Exchange Networks", American Institute of Chemical Engineers, 1998.

Pre-requisite: Knowledge in under graduate "Mass Transfer"

ADVANCED HEAT TRANSFER

Conduction: Steady and unsteady state heat conduction, Unsteady state heating and cooling of solid objects:Transient heat conduction in bodies with finite internal and surface resistance, Transient heat conduction charts, Insulation design and selection. ; Convection: Heat transfer coefficient, Dimensional analysis in convective heat transfer, Heat transfer during laminar and turbulent flow in closed conduits, empirical correlation, Heat transfer in laminar and turbulent flow over a flat plate, Heat transfer in liquid metals, Analogy between momentum and heat
transfer, Heat transfer with phase change: Boiling and condensation heat transfer. ; Recent developments in heat exchangers: Heat Transfer Augmentation, Recent developments in the design of compact heat exchangers: Features of Plat Fin and Tube Fin heat exchangers, Construction, Heat transfer and pressure drop, Analysis of plate fin and tube fin heat exchangers.

Essential Reading:

Supplementary Reading:

1. C.P. Gupta and R. Prakash, Engineering Heat Transfer, Nem Chand & Bros., Roorkee, 6th Edn, 1994.
2. B.K. Dutta, Heat Transfer: Principles and Applications, Prentice Hall of India Pvt. Ltd. New Delhi, 2001.
3. S.K. Das and A.R. Balakrishan, Process Heat Transfer, Alpha Science International Ltd., 2005.
4. J.P. Holman, Heat Transfer, McGraw-Hill Science/Engineering/Math, 2001.

Pre-requisite: Knowledge in under graduate "Heat Transfer"

PINCH TECHNOLOGY

Process Integration and its Building Blocks: Definition of Process Integration (PI), School of thoughts, Areas of application and Techniques available for PI, Onion diagram. ; Pinch Technology – An Overview: Introduction, Basic concept, How it is different than energy auditing, Role of thermodynamic laws, Problem addressed by Pinch technology. ; Key Steps of Pinch Technology: Data extraction, Targeting, Designing, Optimization- Supertargteing. ; Basic Elements of Pinch Technology: Grid diagram, Composite curve, Problem table algorithm, Grand composite curve. ; Targeting of Heat Exchanger Network (HEN): Energy targeting, Area
targeting, Number of units targeting, Shell targeting, cost targeting. ; Designing of HEN: Pinch design methods, Heuristic rules, Stream splitting, Design of maximum energy recovery (MER), Design of multiple utilities and pinches, Design for threshold problem, Loops and Paths. ; Heat Integration of Equipments: Heat engine, Heat pump, Distillation column, Reactor, Evaporator, Drier, Refrigeration systems. ; Heat and Power Integration: Cogeneration, Steam turbine, Gas turbine.

Essential Reading:

Supplementary Reading:

1. V.U. Sheno, Heat Exchanger network synthesis, Gulf Publishing Co, USA, 1995
2. J.M. Douglas, Conceptual Design of Chemical Process, McGraw Hill, New York, 1988.
3. B. Linnhoff, D.W.Townsend, D. Boland, G.F. Hewitt, B.E.A. Thomas, A.R. Guy and R.H. Marsland, "A User's
guide on process integration for the efficient use of energy", Inst of Chemical Engineers, London (1982).
4. R. Smith, "Chemical Process Design", McGraw Hill (1995).

BIOENERGY ENGINEERING

Biomass Sources and classification, Characteristics & preparation, Chemical composition and properties of different biomass materials and bio-fuels, Sugar cane molasses and other sources for fermentation ethanol, Sources and processing of oils and fats for liquid fuels, Energy plantations, Preparation of woody biomass: Size reduction, Briquette of loose biomass, drying, storage and handling of biomass. ; Biogas Technology: Feedstock for biogas production, Aqueous wastes containing biodegradable organic matter, animal residues, Microbial and biochemical aspects- Operating parameters for biogas production, kinetics and mechanism, Dry

and wet fermentation, Digesters for rural application, High rate digesters for industrial waste water treatment.; Bio-ethanol and Bio-diesel technology: Production of fuel ethanol by fermentation of sugars. Gasohol as a substitute for leaded petrol, trans-esterification of oils to produce Bio-diesel. ; Pyrolysis and gasification of biomass: Thermo-chemical conversion of ligno-cellulose biomass, biomass processing for liquid fuel production, - Pyrolysis of biomass, pyrolysis regime, effect of particle size, temperature, and products obtained. Thermo-chemical gasification principles: effect of pressure, temperature and introduction of steam and oxygen,
Design and operation of fixed and fluidized bed gasifiers. ; Combustion of biomass and cogeneration systems:Combustion of woody biomass: Theory, calculations and design of equipments. Cogeneration in biomass processing industries. Case Studies: Combustion of rice husk, Use of bagasse for cogeneration.

Essential Reading:

Supplementary Reading:

1. A.Chakraverthy, Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural
Wastes, Oxford & IBH publishing Co., New Delhi, 1989.
2. K.M. Mital, Biogas Systems: Principles and Applications, New Age International Publishers (p) Ltd., 1996.
3. P.V. Ramana and S.N.Srinivas, Biomass Energy Systems, Tata Energy Research Institute, New Delhi, 1996.
4. D.L. Klass and G.M. Emert, "Fuels from Biomass and Wastes", Ann Arbor Science publ. Inc. Michigan, 1985.
5. K.C. Khandelwal and Mahdi, Bio-gas Technology, Tata McGraw-Hill pub. Co. Ltd., New Delhi
6. O.P. Chawla, Advances in bio-gas Technology. I.C.A.R., New Delhi. 1970.

BIOPROCESS ENGINEERING

Bioprocess principles; kinetics of biomass production, substrate utilization and product formation; Batch and Continuous culture, Fed batch culture. ; Introduction: Fermentation Processes General requirements of fermentation processes, An overview of aerobic and anaerobic fermentation processes and their application in industry, Medium requirements for fermentation processes, examples of simple and complex media Design and usage of commercial media for industrial fermentation, Thermal death kinetics of micro-organisms, Heat Sterilization of liquid media, Filter sterilization of liquid media and air. ; Enzyme Technology, Microbial
metabolism enzymes: Classification and properties, Applied enzyme catalysis - Kinetics of enzyme catalytic reactions, Metabolic pathways, Protein synthesis in cells. ; Bioreactor design & operations, Selection, scaleup, operation of bioreactors, Mass transfer in heterogeneous biochemical reaction systems; Oxygen transfer in submerged fermentation processes; oxygen uptake rates and determination of oxygen transfer rates and coefficients; role of aeration and agitation in oxygen transfer, Heat transfer processes in biological systems, Recovery and purification of products. ; Introduction to instrumentation and process control in bioprocesses:
measurement of physical and chemical parameters in bioreactors, Monitoring and control of dissolved oxygen, pH, impeller speed and temperature in a stirred tank fermenter. Bioprocess patenting and economics

Essential Reading:

Supplementary Reading:

1. M.L. Shuler and F. Kargi, "Bio-process Engineering", 2nd Edition, Prentice Hall of India, New Delhi. 2002.
2. Rajiv Dutta, “Fundamentals of Biochemical Engineering”, 1st Edition, Springer, 2008.
3. J.E. Bailey and D.F. Ollis, "Biochemical Engineering Fundamentals", 2nd Edn, McGraw Hill, Publishing Co.
New York, 1986.

NANO SCIENCE & TECHNOLOGY

Professor-In-Charge: Dr. S. Pariass

Introduction to nanotechnology, definition, history. What makes the nanoscale so different from the other
lengthscales by considering the underpinning science (i.e. nanoscience) and some key examples of
nanotechnology. ; Properties in nanoscale: Extensive and Intensive properties, change in physical properties
like color, melting point, electrical, magnetic, and mechanical. Quantum mechanical approach to explain the
properties change in nanoscale. Theory of size dependent melting point, effect of grain size and grain boundary
on mechanical properties of nanomaterials. ; Methods of synthesis of nanometerials fabrication-“Top-down” vs.
“bottom-up” approaches. Equipment and processes needed to fabricate nanodevices and structures. ; Focous
on different nanomaterials: Carbon nanotubes (discovery, preparation, properties, applications), Inorganic
nanowires, Biological and bio-inspired materials, Metallic nanomaterials, Different shape nanomaterials.
; Nanomaterial based biosensors: biofunctionalization of nanomaterials, advantages over other sensors,
Field effect transistor based biosensors. Application in cholesterol, blood sugar, single virus detection. ;
Semiconductor nanoparticles, and Quantum dots. Application of quantum dots. Application of nanoparticles
in catalysis. ; Characterization of nano particles by Scanning probe microscopes (Atomic Force Microscopy,
Scanning Tunneling Microscopy), Transmission Electron Microscopy, Scanning Electron Microscopy.

Essential Reading:

Supplementary Reading:

1. T. Zikang and S. Ping, Nano science and technology: novel structures and phenomena, Taylor and Francis,
2003.
2. B. Rogers, S. Pennathur, J. Adams, Nanotechnology: Understanding small systems, Taylor and Francis,
2008.
3. M. Rieth, Nano-Engineering in Science and Technology: An Introduction to the World of Nano design,World
Scientific, 2003
4. R. Kelsall, I. Hamley and M. Geoghegan, Nanoscale Science and Technology, (Eds.), Wiley, 2005.

5. M.Di Ventra, S.Evoy and Jr. J. R. Heflin, Introduction to Nanoscale Science and Technology, (Eds.), Springer,
2004.
6. Jr. C. P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003.

CH 629 INTERFACIAL SCIENCE AND ENGINEERING 3 credits [3-0-0]

Professor-In-Charge: Dr. S. Paria

General introduction of colloids, interfaces, surfactants, and micellization. Intermolecular forces, Van der Waals
forces (Keesom, Debye, and London interactions), Colloidal systems and colloidal stability (van der Waals
attraction and potential energy curves), Brownian motion and Brownian flocculation. Surface and interfacial
tension and surface free energy, Surface tension for curved interfaces, Surface excess and Gibbs equation.
Theory of surface tension and contact angle, and wetting. Thermodynamics of interfaces, thermodynamics of
micelle and mixed micellar formation. Electrical phenomena at interfaces (Electrokinetic phenomena, Electrical
double layer). Emulsion and micro-emulsion; Application: General applications, Enhanced petroleum recovery,
Super hydrophobic and self cleaning surfaces, Novel fabrication of nanostructured particles ; Measurement
techniques of surface tension, Contact angle, Zetapotential, Particle size.

Essential Reading:

Supplementary Reading:

1. P.C. Hiemenz, and R. Rajagopalan, Principles of Colloid and Surface Chemistry, 3rd Edition, Marcel Dekker,
N.Y., 1997.
2. M.J. Rosen, Surfactants and Interfacial Phenomena, Wiley-Interscience Publication, New York, 2004.
3. A.W. Adamson, A. P. Gast, Physical Chemistry of Surfaces, Wiley-Interscience, New York, 1997.
4. J. Israelachvili, Intermolecular and Surface Forces, Academic Press, New York, 1992
5. D.J. Shaw, Colloid & Surface Chemistry, Butterworth Heinemann, Oxford, 1991.

CH 638 ADVANCED REACTION ENGINEERING & REACTOR DESIGN 3 credits [3-0-0]

Professor-In-Charge: Dr. R. K. Singh

Homogeneous reactor design and analysis-I: Ideal reactors, Review of isothermal design for batch, semi-batch
and flow reactors, multiple reactions and reaction networks: Yield-selectivity concepts, Wei-Prater analysis for
first order networks, reaction networks of general order, Reactor energy balance and its applications to reactor
design and analysis. ; Homogeneous reactor design and analysis-II: Non-ideal reactors- Review of the basic
concepts of residence time distributions, single parameter models for real reactor behavior, macromixing and
micromixing, segregated flow model and Zweitering's analysis of maximum mixedness, IEM and other models for
micromixing. ; Heterogeneous reactors-I: Gas-solid systems- Review of kinetics of gas-solid catalytic reactions

with and without diffusion limitations, Reactor design for fixed and fluidized bed reactors, Selected case studies,
Non-catalytic gas-solid reactions: review of kinetics; reactor design case studies. ;
Heterogeneous reactors-II:
Gas-liquid systems- Basic theories of mass transfer with chemical reaction model systems and model reactors,
Reactor design for mechanically agitated and bubble column reactors. Selected case studies.

Essential Reading:Supplementary Reading:

1. F.G.Froment, and K.B. Bischoff, Chemical Reactor Analysis and Design, Wiley, 1990.
2. J.B. Rawlings, and J.G. Ekerdt, Chemical Reactor Analysis and Design Fundamentals, Nob Hill, 2002.
3. J.J. Carberry, Chemical and Catalytic Reaction Engineering, McGraw Hill, 1976.
4. O. Levenspiel, Chemical Reaction Engineering, Third edition, Wiley, 1999.
5. J.M. Smith, Chemical Engineering Kinetics, McGraw Hill, 1981.
6. L.K. Doraiswamy, and M.M. Sharma, Heterogeneous Reactions, Vol. I and II, Wiley, 1984.
7. P.V. Danckwerts, Gas-Liquid Reactions, McGraw Hill, 1970.

Pre-requisite: Knowledge in under graduate “Reaction kinetics” and