SYMBIOSIS
INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

❖ Chemistry

Section 1: Physical Chemistry

Structure: Postulates of quantum mechanics. Time dependent and time independent Schrödinger equations. Born interpretation. Particle in a box. Harmonic oscillator. Rigid rotor. Hydrogen atom: atomic orbitals. Multi-electron atoms: orbital approximation.
Variation and first order perturbation techniques. Chemical bonding: Valence bond theory and LCAO-MO theory. Hybrid orbitals. Applications of LCAO-MOT to H2+, H2 and other homonuclear diatomic molecules, heteronuclear diatomic molecules like HF, CO, NO, and to simple delocalized π– electron systems. Hückel approximation and its application to annular π – electron systems. Symmetry elements and operations. Point groups and character tables. Origin of selection rules for rotational, vibrational, electronic and Raman spectroscopy of diatomic and polyatomic molecules. Einstein coefficients. Relationship of transition moment integral with molar extinction coefficient and oscillator strength.
Equilibrium: Laws of thermodynamics. Standard states. Thermochemistry. Thermodynamic functions and their relationships: Gibbs-Helmholtz and Maxwell relations, van't Hoff equation. Criteria of spontaneity and equilibrium. Absolute entropy. Partial molar quantities. Thermodynamics of mixing. Chemical potential. Fugacity, activity and activity coefficients. Chemical equilibria. Dependence of equilibrium constant on temperature and pressure. Non-ideal solutions. Ionic mobility and conductivity. Debye-Hückel limiting law. Debye-Hückel-Onsager equation. Standard electrode potentials and electrochemical cells. Potentiometric and conductometric titrations. Phase rule. Clausius- Clapeyron equation. Phase diagram of one component systems: CO2, H2O, S; two component systems: liquid-vapour, liquid-liquid and solid-liquid systems. Fractional distillation. Azeotropes and eutectics.
Kinetics: Transition state theory: Eyring equation, thermodynamic aspects. Potential energy surfaces and classical trajectories. Elementary, parallel, opposing and consecutive reactions. Steady state approximation. Mechanisms of complex reactions. Unimolecular reactions. Kinetics of polymerization and enzyme catalysis. Fast reaction kinetics: relaxation and flow methods. Kinetics of photochemical and photophysical processes.
Surfaces and Interfaces: Physisorption and chemisorption. Langmuir, Freundlich and BET isotherms. Surface catalysis: Langmuir-Hinshelwood mechanism. Surface tension, viscosity. Self-assembly. Physical chemistry of colloids, micelles and macromolecules.

Section 2: Inorganic Chemistry

Main Group Elements: Hydrides, halides, oxides, oxoacids, nitrides, sulfides – shapes and reactivity. Structure and bonding of boranes, carboranes, silicones, silicates, boron nitride, borazines and phosphazenes. Allotropes of carbon. Chemistry of noble gases, pseudohalogens, and interhalogen compounds. Acid-base concepts.

Transition Elements: Coordination chemistry – structure and isomerism, theories of bonding (VBT, CFT, and MOT). Energy level diagrams in various crystal fields, CFSE, applications of CFT, Jahn-Teller distortion. Electronic spectra of transition metal complexes: spectroscopic term symbols, selection rules, Orgel diagrams, charge-transfer spectra. Magnetic 15 of 72 properties of transition metal complexes. Reaction mechanisms: kinetic and thermodynamic stability, substitution and redox reactions.

Lanthanides and Actinides: Recovery. Periodic properties, spectra and magnetic properties.

Organometallics: 18-Electron rule; metal-alkyl, metal-carbonyl, metal-olefin and metalcarbene

complexes and metallocenes. Fluxionality in organometallic complexes. Types of organometallic reactions. Homogeneous catalysis - Hydrogenation, hydroformylation, acetic acid synthesis, metathesis and olefin oxidation. Heterogeneous catalysis - Fischer- Tropsch reaction, Ziegler-Natta polymerization.

Radioactivity: Decay processes, half-life of radioactive elements, fission and fusion processes.

Bioinorganic Chemistry: Ion (Na+ and K+) transport, oxygen binding, transport and utilization, electron transfer reactions, nitrogen fixation, metalloenzymes containing magnesium, molybdenum, iron, cobalt, copper and zinc.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, structures of AX, AX2, ABX3 type compounds, spinels, band theory, metals and semiconductors.

Instrumental Methods of Analysis: UV-visible spectrophotometry, NMR and ESR spectroscopy, mass spectrometry. Chromatography including GC and HPLC. Electroanalytical methods- polarography, cyclic voltammetry, ion-selective electrodes. Thermoanalytical methods.

Section 3: Organic Chemistry

Stereochemistry: Chirality of organic molecules with or without chiral centres and determination of their absolute configurations. Relative stereochemistry in compounds having more than one stereogenic centre. Homotopic, enantiotopic and diastereotopic atoms, groups and faces. Stereoselective and stereospecific synthesis. Conformational analysis of acyclic and cyclic compounds. Geometrical isomerism. Configurational and conformational effects, and neighbouring group participation on reactivity and selectivity/specificity.

Reaction Mechanisms: Basic mechanistic concepts – kinetic *versus* thermodynamic control, Hammond's postulate and Curtin-Hammett principle. Methods of determining reaction mechanisms through identification of products, intermediates and isotopic labeling. Nucleophilic and electrophilic substitution reactions (both aromatic and aliphatic). Addition reactions to carbon-carbon and carbon-heteroatom (N,O) multiple bonds. Elimination reactions. Reactive intermediates – carbocations, carbanions, carbenes, nitrenes, arynes and free radicals. Molecular rearrangements involving electron deficient atoms.

Organic Synthesis: Synthesis, reactions, mechanisms and selectivity involving the following classes of compounds – alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, nitriles, halides, nitro compounds, amines and amides. Uses of Mg, Li, Cu, B, Zn and Si based reagents in organic synthesis. Carbon-carbon bond formation through coupling reactions - Heck, Suzuki, Stille and Sonogoshira. Concepts of asymmetric synthesis – resolution (including enzymatic), desymmetrization and use of chiral auxilliaries. Carbon-carbon bond forming reactions through enolates (including boron enolates), enamines and silyl enol ethers. Michael addition reaction. Stereoselective addition to C=O groups (Cram and Felkin-Anh models).

Pericyclic Reactions and Photochemistry: Electrocyclic, cycloaddition and sigmatropic reactions. Orbital correlations - FMO and PMO treatments. Photochemistry of alkenes, arenes and carbonyl compounds. Photooxidation and photoreduction. Di-π-methane rearrangement, Barton reaction.

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

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: Applications of UV-visible, IR, NMR and Mass spectrometry in the structural determination of organic molecules.

SYMBIOSIS
INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

Sample questions

Discipline: Chemistry

Q.	Question	
1)	The geometry of XeF_2 is	
	a)	sp^3d *
	b)	sp^3d^2
	c)	sp^3d^3
	d)	sp
2)	Which of the following involves multilayer adsorption	
	a)	Chemisorption
	b)	Physisorption*
	c)	Both Physisorption and Chemisorption
	d)	Neither Physisorption nor Chemisorption

Please mark * against the correct answer.

SYMBIOSIS
INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

❖ Civil Engineering

Section 1: Structural Engineering

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations; internal forces in structures; Friction and its applications; Kinematics of point mass and rigid body; Centre of mass; Euler's equations of motion; Impulse-momentum; Energy methods; Principles of virtual work.

Solid Mechanics: Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Theories of failures; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, buckling of column, combined and direct bending stresses.

Construction Materials and Management: Construction Materials: Structural steel - composition, material properties and behavior; Concrete - constituents, mix design, short-term and long-term properties; Bricks and mortar; Timber; Bitumen. Construction Management: Types of construction projects; Tendering and construction contracts; Rate analysis and standard specifications; Cost estimation; Project planning and network analysis - PERT and CPM.

Concrete Structures: Working stress, Limit state and Ultimate load design concepts; Design of beams, slabs, columns; Bond and development length; Pre-stressed concrete; Analysis of beam sections at transfer and service loads.

Section 2: Geotechnical Engineering

Soil Mechanics: Origin of soils, soil structure and fabric; Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Darcy's law; Seepage through soils - two-dimensional flow, flow nets, uplift pressure, piping; Principle of effective stress, capillarity, seepage force and quicksand condition.

Section 3: Water Resources Engineering

Fluid Mechanics: Properties of fluids, fluid statics; Continuity, momentum, energy and corresponding equations; Potential flow, applications of momentum and energy equations; Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth.

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, ground water hydrology -steady state well hydraulics and aquifers; Application of Darcy's law.

Section 4: Environmental Engineering

Water and Waste Water: Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water.

Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).

Section 5: Transportation Engineering

Transportation Infrastructure: Highway alignment and engineering surveys; Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments.

Highway Pavements: Highway materials - desirable properties and quality control tests; Design of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible pavement using IRC: 37-2012; Design of rigid pavements using IRC: 58-2011; Distresses in concrete pavements.

SYMBIOSIS
INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

Format for question paper

Discipline: Civil Engineering

Q.	Question	
1)	The pre-stressed concrete beam of rectangular cross section of 200mm x 400mm is pre-stressed with a force of 400 KN at the eccentricity of 100mm. What should be the maximum compressible stress?	
	a)	12.5 KN/m^2 *
	b)	7.5 KN/m^2
	c)	5 KN/m^2
	d)	2.5 KN/m^2
2)	The 7 days BOD reading at 20^0 was found to be 150mg/l. What should be 5 days BOD at 20^o. Assume the BOD rate constant (k) at standard temperature of 20 ^{0} as 0.23 /day (base e)	
	a)	128*
	b)	475
	c)	187.39
	d)	190
3)	A saturated soil mass has a total density 22kN /m3 and water content of 10%. The bulk density and dry density of this soil are	
	a)	12 kN/m^3 and 20 kN/m^3 respectively.
	b)	22 kN/m3 and 20 kN/m3 respectively*
	c)	19.8kN/m^3 and19.8 N/m^3 respectively.
	d)	23.2kN/m^3 and 19.8kN/m^3 respectively.

Please mark * against the correct answer.

SYMBIOSIS
INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

❖ COMPUTER SCIENCE

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.

Statistics

Research Statistics like measures of central tendency, dispersion and correlation and regression, Sampling distributions, Design of Experiment

Data Structures and Algorithms

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 context-free languages, pumping lemma. Turing machines and undecidability.

Operating System and advanced computing

Inter process synchronization. Uni-processor Deadlock, Memory management and virtual memory. Distributed System: Distributed Deadlocks, Mutual Exclusion, Shared Memory and Distributed File system, Introductory concepts to Advanced computing methodologies like cloud computing, cluster, grid computing and Map-Reduce strategy

Databases

Relational model: RDBMS and SQL, Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.
Data mining techniques and data ware housing,
Denormalization, Big Data basics, No-SQL basics

SYMBIOSIS
INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

Computer Networks

Concept of layering. LAN technologies (Ethernet). Flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state), Subnetting, TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP, HTTP).

Basics of Wi-Fi. Network security: authentication, key cryptography, digital signatures and certificates, firewalls.

Software Engineering:

Software Development Models, Estimation, Project planning, Software Testing

Object oriented Software Development: Object oriented concepts, UML diagrams and notations, OO modelling, introduction to the concepts of design patterns

Programming Skills

C, C++, Java basics, Advanced java concepts like JSP, Servlets, Working with Databases including RDBMS and No-SQL data stores

Basics of statistical programming languages like R and Matlab

SYMBIOSIS
INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

Sample questions

Discipline: Computer Science

Q.	Question	
1)	Map the algorithms to the design paradigms A) Kruskal — i)Divide and Conquer B) QuickSort — ii) Greedy C) Floyd-Warshall — iii) Dynamic Programming	
	a)	A-i, B-ii, C-iii
	b)	A-ii, B-iii, C-i
	c)	A-iii, B-i, C-ii
	d)	A-ii, B-i, C-iii (*)
2)	Factors which affect the performance of learner system does not include	
	a)	Representation scheme used
	b)	Training scenario
	c)	Type of feedback
	d)	Good data structures (*)
	e)	Learning algorithm
3)		

Please mark * against the correct answer.

SYMBIOSIS
INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

❖ Electronics and Telecommunication

Section 1: Engineering Mathematics

Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra, eigen values and eigen vectors, rank, solution of linear equations – existence and uniqueness.
Calculus: Mean value theorems, theorems of integral calculus, evaluation of definite and improper integrals, partial derivatives, maxima and minima, multiple integrals, line, surface and volume integrals, Taylor series.
Differential Equations: First order equations (linear and nonlinear), higher order linear differential equations, Cauchy's and Euler's equations, methods of solution using variation of parameters, complementary function and particular integral, partial differential equations, variable separable method, initial and boundary value problems.
Vector Analysis: Vectors in plane and space, vector operations, gradient, divergence and curl, Gauss's, Green's and Stoke's theorems.
Complex Analysis: Analytic functions, Cauchy's integral theorem, Cauchy's integral formula; Taylor's and Laurent's series, residue theorem.
Numerical Methods: Solution of nonlinear equations, single and multi-step methods for differential equations, convergence criteria.
Probability and Statistics: Mean, median, mode and standard deviation; combinatorial probability, probability distribution functions - binomial, Poisson, exponential and normal; Joint and conditional probability; Correlation and regression analysis.

Section 2: Networks, Signals and Systems

Network solution methods: nodal and mesh analysis; Network theorems: superposition, Thevenin and Norton's, maximum power transfer; Wye-Delta transformation; Steady state sinusoidal analysis using phasors; Time domain analysis of simple linear circuits; Solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; Linear 2-port network parameters: driving point and transfer functions; State equations for networks.
Continuous-time signals: Fourier series and Fourier transform representations, sampling theorem and applications; Discrete-time signals: discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, interpolation of discrete-time signals; LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay, digital filter design techniques.

Section 3: Electronic Devices

Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; Generation and recombination of carriers; Poisson and continuity equations; P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell; Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography and twin-tub CMOS process.

Section 4: Analog Circuits

Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; Single-stage BJT and MOSFET amplifiers: biasing, bias stability, mid-frequency small signal analysis and frequency response; BJT and MOSFET amplifiers: multi-stage, differential, feedback, power and operational; Simple op-amp circuits; Active filters; Sinusoidal oscillators: criterion for oscillation, single-transistor and op-amp configurations; Function generators, wave-shaping circuits and 555 timers; Voltage reference circuits; Power supplies: ripple removal and regulation.

Section 5: Digital Circuits

Number systems; Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders and PLAs; Sequential circuits: latches and flip-flops, counters, shift-registers and finite state machines; Data converters: sample and hold circuits, ADCs and DACs; Semiconductor memories: ROM, SRAM, DRAM; 8-bit microprocessor (8085): architecture, programming, memory and I/O interfacing.

Section 6: Control Systems

Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

Section 7: Communications

Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems; Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers, circuits for analog communications; Information theory: entropy, mutual information and channel capacity theorem; Digital communications: PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error correction, Hamming codes; Timing and frequency synchronization, inter-symbol interference and its mitigation; Basics of TDMA, FDMA and CDMA.

Section 8: Electromagnetics

Electrostatics; Maxwell's equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector; Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth;

Transmission lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart; Waveguides: modes, boundary conditions, cut-off frequencies, dispersion relations; Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays; Basics of radar; Light propagation in optical fibers.

SYMBIOSIS
INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

Sample questions

Discipline: Electronics & Telecommunication

Q.	Question	
1)	A transmission line has a characteristic impedance of 50 Ω and a resistance of 0.1 Ω/m, if the line is distortion less, the attenuation constant (in Np/m) is	
	a)	500
	b)	5
	c)	0.014
	d)	0.002*
2)	A radar receiver has a noise figure of 10 dB at 300 K having a bandwidth of 2.5 MHz. The minimum power it can receive is	
	a)	3.45 x 10-15 W
	b)	1.38 x 10-15 W
	c)	7.5 x 10-15 W
	d)	93.15 x 10-15 W*
3)		

Mark * against the correct answer.

SYMBIOSIS
INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

❖ MATHEMATICS

1) Analysis:

Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, types of discontinuity, functions of bounded variation,. Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems. Metric spaces, compactness, connectedness. Normed linear Spaces. Spaces of continuous functions as examples.

2) Linear Algebra:

Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis. Quadratic forms, reduction and classification of quadratic forms

3) Complex Analysis:

Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations.

4) Algebra:

Permutations, combinations, pigeon-hole principle, inclusion
-exclusion principle, derangements. Fundamental theorem of arithmetic, Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups,

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Cayley's theorem, class equations,. Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain. Fields, finite fields, field extensions, Topology: basis, dense sets, subspace and product topology, separation axioms, connectedness and compactness.

5) Ordinary Differential Equations (ODEs):

Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs. General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function.

6) Partial Differential Equations (PDEs):

Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs. Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations.

7) Numerical Analysis:

Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

8) Calculus of Variations:

Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema. Variational methods for boundary value problems in ordinary and partial differential equations.

9) Classical Mechanics:

Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle and principle of least action, Two-dimensional motion of rigid bodies, Euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.

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10) Probability and Statistics

Probability space, conditional probability, Bayes theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties (Discrete uniform, Binomial, Poisson, Geometric, Negative binomial, Normal, Exponential, Gamma, Continuous uniform, Bivariate normal, Multinomial), expectation, conditional expectation, moments; likelihood estimators; Interval estimation; measures of central tendencies, measures of dispersion, skewness, kurtosis, correlation, rank correlation, Simple linear regression.

11) Linear programming

Linear programming problem and its formulation, convex sets and their properties, Graphical method, basic feasible solution, simplex method, big-M and two phase methods; infeasible and unbounded LPP's, alternate optima; Dual problem and duality theorems, dual simplex method

SYMBIOSIS
INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

Sample questions

Discipline: Mathematics

Q.	Question	
1)	If $z = a$ is an isolated singularity of f and $f(z) = \sum_{-\infty}^{\infty} a_n (z-a)^n$ is its Laurent expansion in an $(a; 0, R)$. Also if $a_n \neq 0$ for infinitely many negative integers n then-	
	a)	$z = a$ is removable singularity
	b)	$z = a$ is a pole of order m
	c)	$z = a$ is an essential singularity *
	d)	None of these
2)	For any real numbers $a \; and \; b, a \leq b$ the probability distribution function of a continuous variable X is given by	
	a)	$P(a \leq X \leq b) = \int_a^b f(x)dx$ *
	b)	$P(a \leq X \leq b) = \int_b^a f(x)dx$
	c)	$P(a \leq X \leq b) = 1 - \int_a^b f(x)dx$
	d)	$P(a \leq X \leq b) = \int_a^b f(x)dx - 1$

* is against the correct answer.

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INTERNATIONAL UNIVERSITY

Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

❖ MECHANICAL ENGINEERING

DESIGN

1. Types of simple stresses, principal stresses, compound stresses in machine parts, stress-strain relationship**, stress concentration factor**
2. Static loading, theories of failures, allowable stress, factor of safety, Fluctuating stresses, fatigue failure, endurance limit, fatigue strength, modified Goodman diagram, Gerber line, Soderberg line, **design for combined fatigue loading**
3. **Shafts: s**tatic loading: stresses, design principle, types and uses of key, design of keys.
4. Couplings: Types and uses, design of rigid and flexible couplings, Introduction to design of helical springs, design of helical springs for variable load, design of leaf springs
5. Multi disk clutches, cone clutches, centrifugal clutches, block brake, internal expanding brake, band brake, disc brake ,solid disk flywheel, rimmed flywheel, Analysis of belt tension, condition of maximum power, flat belts, v-belts, chain drives, Helical spring design
6. Spur, Helical, Bevel gear design, Force analysis, Beam strength of gears, Cylinders and pressure vessels design, Thin cylinders, thick cylinders, cylindrical and spherical shells

MANUFACTURING TECHNOLOGY

1. METAL CUTTING THEORY AND PRACTICE
   Geometry of single-point cutting tool: Tool-in hand system, ASA system, Significance of various angles of single point cutting tools, Orthogonal Rake System (ORS), Conversions between ASA and ORS systems, Normal Rake System (NRS) & relation with ORS. Orthogonal and Oblique cutting, Mechanics of Chip formation: Types of chips, chip-breakers, Chip reduction coefficient, shear angle, shear strain, Built-Up-Edge and its effect in metal cutting.
2. ADVANCED MANUFACTURING PROCESSES
   Introduction to solid state welding processes, Advantages and applications and imitations, Classification of solid state welding processes and describe each processes ,friction welding processes, advantages ,limitations and applications, processes parameters, Friction welding of similar and dissimilar metals, Friction stir welding process. Introduction forming processes, advantages ,limitations and applications, Vacuum forming and hydro forming, advantages and applications.
3. MICRO AND NANO MANUFACTURING
   Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology. Methods for creating Nanostructures;

Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nanomaterials- sol-gel process.

4. MANUFACTURING MANAGEMENT
   Introduction, Historical perspective of manufacturing management, Competitive priorities and operational strategy, Functional area strategy and Capability, Case Study. Quantitative Methods introduction, Time series and moving averages method, Exponential Smoothing method, Regression Analysis Method, Qualitative Methods. Introduction and History, Product design and process selection, Capacity planning, Plant location and Plant layout.
5. PRODUCT DESIGN FOR MANUFACTURING AND ASSEMBLY
   How Does DFMA Work?, Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design?, Typical DFMA Case Studies, Overall Impact of DFMA on Industry. General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency.
6. FLEXIBLE MANUFACTURING SYSTEMS
   Evolution of Manufacturing Systems, FMS: Definition, objective and Need, FMS: components, Merits, Demerits and Applications, Flexibility in Pull and Push type. FMS: Layouts and their Salient features, Single line, dual line, loop, ladder, robot centre type etc. Processing stations- Machining Centers, Turning centre, Coordinate measuring machine (CMM), Washing/ Deburring station. Material Handling System Conveyor, Robots, Automated Guided Vehicle (AGV), Automated Storage Retrieval System (ASRS).
   Tool Management, tool magazine, Tool preset, identification, Tool monitoring and fault detection, FMS: Configuration planning and routing, FMS: Production Planning and Control.

THERMAL ENGINEERING SYLLABUS

1. Thermodynamics- Laws of thermodynamics, thermodynamic system and processes, behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion.
2. Heat Transfer- Modes of heat transfer, steady & unsteady heat conduction, dimensionless parameters in free and forced convective heat transfer, thermal boundary layer; effect of turbulence; radiative heat transfer, heat exchanger performance, LMTD and NTU methods.
3. Fluid mechanics- Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy, differential equations of continuity and

momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

4. Power Plant Engineering: Steam Tables, Rankine, Brayton cycles with regeneration and reheat.
5. I.C. Engines: air-standard Otto, Diesel and dual cycles.
6. Refrigeration and air-conditioning: Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; moist air: psychrometric chart, basic psychrometric processes.
7. Turbo machinery: Pelton-wheel, Francis and Kaplan turbines - impulse and reaction principles, velocity diagrams. Centrifugal, Reciprocating pumps and compressor.

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Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

Sample questions
Discipline: Mechanical Engineering

Q.	Questions	
1)	Which of the following can be regarded as gas so that gas laws could be applicable, within the commonly encountered temperature limits?	
	a)	O2, N2, Steam, C02
	b)	Oz, N2, Water Vapour
	c)	SO2, NH3, C02, moisture
	d)	O2, N2, H2, air*
2)	Work done in a free expansion process is	
	a)	+ve
	b)	-ve
	c)	Zero*
	d)	maximum
3)	Which theory of failure is used for ductile materials?	
	a)	Maximum normal stress theory
	b)	Maximum distortion energy theory *
	c)	Maximum shear stress theory
	d)	Mohr theory
4)	Ratio of a force required to bend a hollow cylinder and force required to bend a solid cylinder of same outer diameter and length will be	
	a)	Less than 1
	b)	Greater than 1 *
	c)	Equal to 1
	d)	Insufficient data
5)	Internal gears can be made by	
	a)	hobbing
	b)	shaping with pinion cutter *
	c)	shaping with rack cutter
	d)	milling
6)	When the cutting edge of the tool is dull, then during machining	
	a)	continuous chips are formed
	b)	discontinuous chips are formed
	c)	continuous chips with built-up edge are formed *
	d)	no chips are formed

* Against the correct answer

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Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

❖ PHYSICS

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

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 articles; 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, oisson bracket; periodic motion, small oscillations, normal modes; special theory of relativity – Lorentz transformations,

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;

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; Xray 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, flip-flops, counters, registers, A/D and D/A conversion

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Ph.D. Entrance Test 2017

Faculty of Engineering

Syllabus & Questions for Entrance Test

Sample questions

Discipline: Physics

Q.		Question
1)	A free particle is moving in positive x direction with a linear momentum p. The wave function of particles is normalized in a length 2L is	
	a)	$\frac{1}{\sqrt{2L}} sin \frac{2\pi p}{h} x$
	b)	$\frac{1}{\sqrt{2L}} cos \frac{2\pi p}{h} x$
	c)	$\frac{1}{\sqrt{2L}} e^{-\frac{2\pi p}{h} x}$ *
	d)	$\frac{1}{\sqrt{2L}} e^{\frac{2\pi p}{h} x}$
2)	1. The mean internal energy of a one-dimensional classical harmonic oscillator in equilibrium with a heat bath of temperature T is	
	a)	$\frac{1}{2} k_B T$ *
	b)	$\frac{3}{2} k_B T$
	c)	$k_B T$
	d)	$3 k_B T$
3)		

Please mark * against the correct answer.

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Faculty of Engineering

Syllabus & Questions for Entrance Test

❖ Geoinformatics Syllabus

Fundamental of Remote Sensing

Definitions, History of Remote Sensing, TypeOf Remote Sensing

Remote Sensing Platforms And Sensors

Data Acquisition through various platforms such as aerial, Satellite Shuttle etc., cameras and sensor parameters

Elements of Satellite Images

Image formats, construction, concept of bands, pixel, digital number, metadata.

Multispectral Remote Sensing

Color theory Nature and construction of multispectral image, natural color composit, false color composit, interpretation of multispectral image, combination of sensors

Visual Image Interpretation

Image interpretation parameters, interpretation of arial photographs, satellite images and sensors, examples of interpretation key such as color, texture, pattern etc.

Projections and georeferencing

Concepts of projections, types of projections and their applications, projections in satellite images, georeferncing images,

Introduction to GIS

History of GIS, components of GIS, hardware and software

GIS functionality

Data capture, management, analysis and visualization, applications of GIS, overview of GIS software

Data Pre-processing

Georeferencing: data sources, data input, scanning systems, digitization, on-screen digitization

Data processing

Data editing, errors and quality control, choice between raster and vector

Data transformation

Tessellation data model, raster data models, grid data, TIN vector data model, spaghetti data model, whole polygon structure

Data models

Topological data model, entity relationship, overlay, data transformations, raster and vector data conversion

Photogrammetry

Application, history and cameras, Different geometrical relations for photogrammetry, Vertical and Tilted photographs, Errors in Photogrammetry, GCPS, Check Points and Tie Points,

The orthorectification Process

Data, Interior and Exterior Orientation, Geometric Model, Projections and Datum, Ingest of Data, Geometric Model, Fiducial Marks, Interior Orientation, Exterior Orientation, GCPS, Check Points and tie Points, Triangulation, Orthorectification, Visualisation

Map Projections

Concept of projections, various surfaces, types of projections

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Faculty of Engineering

Syllabus & Questions for Entrance Test

Sample questions

Discipline: Geo informatics

Q.	Question	
1)	What is remote sensing?	
	a)	It is the use of aerial photos and satellite images to locate sites on the ground. *
	b)	It is the practice of using the Internet to conduct ethnography
	c)	It is the study of extraterrestrial cultures.
	d)	It is the study of ancient life through the fossil record.
2)	In a satellite image tone refers to	
	a)	Shades of grey *
	b)	Changes in texture
	c)	Changes in pattern
	d)	None of the above