

### Module I

**Probability distributions:** random variables (discrete & continuous), probability density, mathematical expectation, mean and variance of a probability distribution, binomial distribution, Poisson approximation to the binomial distribution, uniform distribution, normal distribution.

**Curve fitting:** method of least squares, correlation and regression, lines of regression.

### Module II

**Sampling distributions:** population and samples, the sampling distribution of the mean (unknown  $\sigma$ , known  $\sigma$ ), the sampling distribution of the mean ( $\sigma$ ), the sampling distribution of the variance, point estimation, interval estimation, tests of hypotheses, null hypotheses and significance tests, hypothesis concerning one mean, type I and type II errors, hypotheses concerning two means. The estimation of variances: Hypotheses concerning one variance - Hypotheses concerning two variances.

### Module III

**Finite difference Operators:**  $\nabla, \Delta, E, \delta, \mu, x^{(n)}$

Newton's Forward and Backward differences interpolation polynomials, central differences, Stirlings central differences interpolation polynomial. Lagrange interpolation polynomial, divided differences, Newton's divided differences interpolation polynomial

**Numerical differentiation:** Formulae for derivatives in the case of equally spaced points.

**Numerical integration:** Trapezoidal and Simpson's rules, compounded rules, errors of interpolation and integration formulae. Gauss quadrature formulae (No derivation for 2 point and 3 point formulae)

**Module IV Numerical solution of ordinary differential equations:** Taylor series method, Euler's method, modified Euler's method, Runge-Kutta formulae 4th order formula,

**Numerical solution of boundary value problems:** Methods of finite differences, finite differences methods for solving Laplace's equation in a rectangular region, finite differences methods for solving the wave equation and heat equation.

#### Text Books:

1. Irvin Miller & Freind, *Probability and Statistics for Engineers*, Prentice-Hall India Ltd, 6th ed.
2. S. S. Sastry, *Numerical Methods*, Prentice-Hall India Ltd, 4<sup>th</sup> ed.

#### References:

1. P. Kandaswamy K. Thilagavathy, K. Gunavathy, *Numerical Methods*, S. Chand & Co., 2005
2. A. Papoulis, *Probability, Random Variables And Stochastic Processes*, McGraw Hill, 4<sup>th</sup> ed.

#### Type for questions for University Exams

**Question (1) - Eight short answer question of five marks with two questions from each of four modules**

**Question (2-5) - Two questions A & B of 15 Marks from each module with options to answer either A or B.**

**EE 502ELECTRICAL MACHINES II**

**Module I**

Alternators- constructional features of high speed cylindrical rotor and low speed salient pole machines, synchronous speed AC windings - different types (detailed drawing not required) emf equation- distribution factor- coil span factor- field mmf and gap flux density distribution – harmonics in induced emf - remedial measures - mmf of AC windings- space harmonics- revolving magnetic field.

**Module II**

Theory of cylindrical rotor machines- armature reaction- synchronous impedance- voltage regulation-determination of regulation by mmf, emf and Potier methods- Principles of operation of automatic voltage regulators - determination of  $X_d$ ,  $X_q$  by slip test.

Parallel operation of alternators - performance of two machines in parallel-synchronising power - effect of speed regulation on load sharing -methods of synchronizing-synchroscope- methods of automatic synchronizing-synchronous machines on infinite bus bars.

**Module III**

Synchronous motor-torque and power relationship-phasor diagram starting of synchronous motors-losses and efficiency calculations-V curves-synchronous condenser-load angle

**Module IV**

Power angle diagrams -power flow equation for cylindrical and salient pole machines-reluctance power-maximum power transfer-stability limit-control of active and reactive power in synchronous machines on infinite bus bars.

Symmetrical short circuits (only qualitative analysis) - steady state, transient and subtransient reactance - time constants- Hunting in synchronous machines- natural frequency of oscillations - damper windings.

**Text Book:**

1. Nagrath I.J. and Kothari D.P. : Theory of AC machines, Tata McGraw Hill
2. Bimbra P.S. : Electrical Machinery, Khanna Publications

**References:**

- 1) Say M.G ELBS & Pitman : Performance and design of AC Machines,
- 2) Langsdorf A.S : Theory of AC machines, Tata McGraw Hill
- 3) Gupta B.R & Vandana Singhal : Fundamentals of Electrical Machines, New Age International ,1990

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## EE 503 FIELD THEORY

### Module I

Overview of vector analysis – Co-ordinate systems – rectangular, cylindrical, spherical - transformations. Divergence theorem, Stokes theorem, Div, Grad, Curl.

Static Electric field: Coulomb's law, superposition, electric flux, electric field, electric scalar potential, dipole, method of images – Gauss law for electric flux, boundary conditions – capacitance of isolated sphere, concentric sphere, co-axial cylinder/cable two wire transmission line- energy stored in electric field / capacitor, energy density. Laplace equation, Poisson's equation, Uniqueness theorem.

### Module II

Static magnetic field of steady electric currents – magnetic flux, Biot -Savart law, Ampere's law, Gauss law for magnetic flux –boundary conditions, magnetic vector potential, inductance of a coaxial cable, two wire transmission line, solenoid, toroid. Electromagnetic induction – Faraday's law, self & mutual inductance. Continuity equation – displacement current – Maxwell's equations integral & differential form.

### Module III

Uniform plane waves –general solution –TEM waves – relation between electric and magnetic fields, phase and group velocity – plane waves in lossy medium, skin depth, propagation constants and intrinsic impedance – Harmonically varying field, Poyntings theorem-interpretation, application. Wave polarization – linear, elliptic and circular polarization, wave guides – rectangular - modes of propagation- cylindrical wave guides.

### Module IV

Reflection of plane waves at boundaries – normal and oblique incidence – refraction – transmission – Snell's law – critical angle – Brewster angle – total internal reflection. Transmission lines: - Uniform transmission line – VI solution- characteristic impedance – VSWR – impedance matching – quarter wave and half wave length transformer – stub matching – single and double – Smith chart – impedance matching using Smith Chart.

### Text Book

1. Sadiku MNO - *Elements of Electromagnetics*, Addison Wesley 2002.
2. Premlet B - *Electromagnetic theory with applications*, Phasor Books 2002.

### Reference

1. W. H. Hayt - *Engineering Electromagnetics*, Mc Graw Hill 2001.
2. Nannapaneni Narayana Rao - *Elements of Engineering Electromagnetics* – Prentice –Hall, 1998
3. Cheng D.K - *Electromagnetic Fields & Wave*, Addison Wesley 2002.

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## EE 504 ELECTRICAL MATERIAL SCIENCE

### Module I

Conducting materials: Review of metallic conduction on the basis of free electron theory- Fermi-Dirac distribution – variation of conductivity with temperature and composition, Materials for electric resistances- general electric properties: brushes of electrical machines, lamp filaments, fuses and solder.

Semiconductors: Compound semiconductors – basic ideas of amorphous and organic semiconductor – preparation of semiconductor materials – zone-refining technique – fabrication of p-n-p junction.

Magnetic materials: Classification of magnetic materials – origin of permanent magnetic dipoles – ferromagnetism - hysteresis curve – hard and soft magnetic materials – magnetic material used in electrical machines, instruments and relays.

### Module II

Dielectrics: dielectric polarization under static fields – electronic, ionic and dipolar polarizations – behavior of dielectrics in alternating fields – mechanism of breakdown in gases, liquids and solids - factors influencing dielectric strength – capacitor materials Insulating materials – complex dielectric constant – dipolar relaxation dielectric loss insulator materials used – inorganic materials (mica, glass, porcelain, asbestos) – organic materials (paper, rubber, cotton silk, fibre, wood, plastics, bakelite)- resins and varnishes – liquid insulators (transformer oil) – gaseous insulators (air, SF<sub>6</sub>, and hydrogen ) – ageing of insulators.

### Module III

Materials for special applications: materials for solar cells/fuels cells/battery- materials for coatings for enhanced solar thermal energy collection – solar selective coatings- cold mirror coatings- heat mirror coatings – antireflection coatings, Sintered alloys for breaker/switch contacts – arcing tips.

### Module IV

Modern techniques for Material Studies: optical microscopy – electron microscopy – photoelectron spectroscopy – atomic absorption spectroscopy – magnetic resonance – nuclear magnetic resonance – electron spin resonance – ferromagnetic resonance.

### Text Book

1. Indulkar C.S. & Thirivengadam S- *An Introduction to Electrical Engineering Materials*, S Chand Co, 1998.

### Reference:

1. Yu Koristky - *Electrical Engineering Materials*, MIR, 1970.
2. Arumugam M - *Materials Science*, Anuradha Publishers, 1990.
3. Meinal A.B & Meinal M.P- *Applied Solar Energy – An Introduction*, Addition Wesley Publications.
4. Kapoor P.L- *Electrical Engineering Materials*, Khanna Publications.
5. Hutchison T.S & Baird D.C - *The Physics of Engineering Solids*, John Wiley Publications.
6. A.J Dekker - *Electrical Engineering Materials*, Prentice Hall of India.

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## EE 505 MICROPROCESSOR BASED SYSTEMS

### Module I

Intel 8085 and 8086 processors – architecture – memory addressing – addressing modes – instruction set – assembly language programming – assemblers – interrupts – pin configuration - timing diagrams – minimum and maximum mode – multiprocessor configuration.

### Module II

Interfacing – address decoding – interfacing chips – programmable peripheral interface (8255) – programmable communication interface (8251) – programmable timer (8253) – DMA controller (8259) – programmable interrupt controller (8257) – keyboard display interface (8279).

### Module III

Introduction to 80386 – memory management unit – descriptors, selectors, description tables and TSS – real and protected mode – memory paging – special features of the Pentium processor – branch prediction logic – super scalar architecture.

### Module IV

8051 Micro controller – Architecture Basic Assembly Language Programming Concepts – Moving data – Logical Operations- Arithmetic Operations – Jump and call Instructions- / An 8051 Micro controller Design- Applications- Serial data Communication.

### Text Books

1. Gaonker R.S. - *Microprocessor Architecture, Programming and applications.*
2. Hall D.V.- *Microprocessors & Interfacing*, McGraw Hill.

### Reference

1. Brey B.B. - *The Intel Microprocessors – Architecture, Programming & Interfacing*, Prentice Hall.
2. Liu Y.C & Gibsen G.A - *Microcomputer System - The 8086/8088 family*. Prentice Hall of India.
3. Uffenbeck J.E - *The 8086/8088 Family: Design, Programming & Interfacing*, Prentice Hall of India (P) Ltd.
4. Ray A.K, & Bhurchandi K.W - *Advanced Microprocessors and Peripherals*, Tata McGraw Hill.

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## EE506 LINEAR INTEGRATED CIRCUITS

### MODULE I

Integrated Circuits- Introduction to operational amplifiers – basic differential amplifier – dual input balanced output and unbalanced output – Internal block schematic of op amp - Biasing used in IC – Constant current source - current mirror Circuits – Op – amp parameters – ideal op amp – transfer curve – equivalent circuit – internal circuit analysis of a typical op – amp- frequency response frequency compensation. Slew rate and its effect, typical data sheet 741.

### MODULE II

Input bias current – off set – drift – compensating networks CMRR,SVRR, finite gain bandwidth and its effect in opamp circuits performance Open loop configurations Op amp in closed loop configuration : Different feed back configurations – voltage follower – V/I converters, I/V converters and its applications – Differential amplifiers with one op amp and 3 op amps. Instrumentation amplifier IC and its application.

### MODULE III

Op amp applications – Summer – Sub tractor –Log amplifier –Antilog amplifier – Integrator and differentiator Comparators : zero crossing – using voltage references – regenerative (Schmitt trigger ) comparators : window detector application – OP as comparators – Astable and monostable multivibrators – Triangular and tooth wave generators – RC phase shift and Wien bridge oscillators – Sample and hold circuit – peak detector circuit. Precision rectifiers. Voltage regulators – 723 (block diagram, typical low voltage regulator circuit). 78XX, 79XX, 371.

### MODULE IV

Specialized ICs and applications: 555 timers – Functional block diagram – A stable multi vibrator , mono stable , multi vibrator and its applications – Voltage to Frequency converter – Automobile tachometer : 566 VCO chip 565 PLL: - PLL applications . ADC and DAC – performance specification – weighted, R – 2R ; successive approximation , flash, integrating ,Filters: Transfer functions – LPF,HPF,BPF,BRF Approximation methods Butter worth – Chebyshev – Active Filters – I order filters, Quality factor Design – Universal Active Filters – All Pass filters. Switched Capacitive Filters.

### REFERENCE:

1. Op amps and Linear Integrated circuits : RF Coughlin – Pearson Education /PHI
2. Design with operational Amplifiers Analog Ics: Sergio Franko – 2<sup>nd</sup> Edition McGraw Hill
3. Linear Integrated Circuits : d roy Chaudary , Shail B Jain
4. Integrated circuits : K.R Botkar
5. Analog Integrated Circuits : Gray John wiely 2 nd edition

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### EE 507 ELECTRICAL MACHINES I LAB

Plotting of the open circuit characteristics of the given d.c. shunt generator at rated speed. Pre-determination of o.c.c. at other speeds and critical resistances of various speeds. Finding the voltage built-up with a given field circuit resistance and the critical speed for a given field circuit resistance.

Load test on the given DC shunt generator and plotting external characteristics – Deduce the internal characteristics and armature reaction curve.

Brake test on DC shunt and series motor and plot the following characteristics:

- Output Vs Efficiency
- Output Vs Line current
- Output Vs Speed
- Speed Vs Torque
- Line current Vs Torque

- a) Study of 3 point and 4 point starters for DC shunt motor
- b) Swinburne's test on DC shunt machine and pre-determination of armature current and percentage efficiency when the machine operates as a motor and as a generator delivering  $\frac{1}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$ , full and  $\frac{5}{4}$ <sup>th</sup> rated output.

Hopkinson's Test on a pair of DC Machines and pre-determining of the efficiency of the machine working as motor and as a generator under various conditions of load on the generator.

Separation of losses in a d.c. machine by conducting a retardation test and determination of the moment of inertia of the rotating system.

Separation of losses in d.c. shunt machine by conducting no load test at different excitations and plotting the variations of these losses at various speeds.

#### Transformers

- a) Polarity test on single phase transformers.
- b) Connect three single phase transformers to form a 3 phase transformer with YY and DYI connection. Perform the load test, under balanced upf conditions – Plot the efficiency Vs output and % regulation Vs output characteristics.

O.C and S.C test on the single phase transformer and Pre-determination of the following:

Efficiency at various loads and power factors.

Regulation at various loads and lagging and leading power factors.

Equivalent circuits referred to H.V and L.V sides.

Calculation of performance using equivalent circuit and given load connection to the equivalent circuit.

Upf load at which efficiency is maximum.

Separation of losses of single phase transformer into hysteresis and eddy current loss components at normal voltage and frequency.

Sumpner's test on a pair of identical single phase transformers and pre-determination of the efficiency and regulations at various loads and power factor.

Scott connection of the single phase transformers and the performance under various load conditions at Upf and plotting the efficiency curves with

Main transformer secondary alone loaded.

Teaser transformer secondary alone loaded.

Balanced loading.

Unbalanced loading.

Student shall present his/her fair record, notebook duly certified by the Head of the Department, to the examiners at the time of University practical examination.

**Note: 50% Mark is earmarked for continuous evaluation and 50% mark for end semester examination, to be assessed by two examiners. A candidate shall secure a minimum of 50% marks for two components to be eligible for pass in that subject.**

## **EE 508 POWER ELECTRONICS LAB**

### **Part A - Power Electronics**

Study of Power devices – power BJT, SCR, power MOSFET, IGBT etc.

Characteristics of SCR and Triac

Characteristics of power MOSFET

Triggering circuits for SCRs – R, RC and UJT triggering

Single phase fully controlled SCR bridge circuit – R load, RL load – effect of free wheeling diode.

Triggering circuits for SCR chopper

Triac triggering

Speed control DC motor using SCR

Study of V/F control of induction motor.

AC controller using Triac

Study of UPS/SMPS

### **Part B - Op-Amps**

#### **Study of Op-Amps**

Op-Amp inverter – scale changer – summer – integrator – differentiator – comparator and instrumentation amplifier

#### **Design and setup of low pass – high pass and band pass filters using Op- Amps**

Voltage Regulation using 723

PLL measurement of lock range and capture range

Circuits using Op-Amps for wave form generation

Astable, monostable multivibrators

Wein Bridge Oscillator

Triangular and square wave form generation

Precision rectifiers

Schmitt trigger using Op-Amps

According to the facility available in the laboratory any 15 experiments can be conducted.

**Note: 50% Mark is earmarked for continuous evaluation and 50% mark for end semester examination, to be assessed by two examiners. A candidate shall secure a minimum of 50% marks for two components to be eligible for pass in that subject.**