Teaching and Examination Scheme for B. Tech. (Four Year Course)								
Branch	**Electrical Engineering**			**Branch Code**		**EE**		
Year	II	Semester	III					
		Hrs./Week			Duration of Exam. (Hrs)	Maximum Marks		**Total**
Code	Subject	Lecture	Tutorial	Practical		IA	Exam	
3EE1	Power Electronics-I	2	1		3	20	80	**100**
3EE2	Computer Programming-I	3			3	20	80	**100**
3EE3	Circuit Analysis-I	3	1		3	20	80	**100**
3EE4	Electrical Machines-I	3	1		3	20	80	**100**
3EE5	Electrical Measurements	3	1		3	20	80	**100**
3EE6.1	Mathematics	3	1		3	20	80	**100**
3EE6.2								
3EE6.3								
3EE6.4								
3EE7	Power Electronics Lab-I			2	2	45	30	**75**
3EE8	Computer Programming Lab-I			2	2	45	30	**75**
3EE9	Electrical Circuit Lab			2	2	45	30	**75**
3EE10	Electrical Machines Lab-I			2	2	45	30	**75**
3EE11	Electrical Measurement Lab			2	2	30	20	**50**
3EEDC	Discipline/Extra-Curricular Activities							**50**
	Total	17	5	10		330	620	**1000**
	Total Teaching hours	32						
Year	**II**	**Semester**	**IV**					
4EE1	Power Electronics-II	3	1		3	20	80	**100**
4EE2	Digital Electronics	3			3	20	80	**100**
4EE3	Electrical Machines-II	3	1		3	20	80	**100**
4EE4	Computer Programming -II	3			3	20	80	**100**
4EE5	Circuit Analysis-II	3	1		3	20	80	**100**
4EE6.1	Advanced Mathematics	3	1		3	20	80	**100**
4EE6.2								
4EE6.3								
4EE6.4								
4EE7	Power Electronics Lab-II			2	2	45	30	**75**
4EE8	Digital Electronics Lab			2	2	45	30	**75**
4EE9	Electrical Machines Lab-II			2	2	45	30	**75**
4EE10	Computer Programming Lab-II			2	2	45	30	**75**
4EE11	Humanities & Social Sciences			2	2	30	20	**50**
4EEDC	Discipline/Extra-Curricular Activities							**50**
	Total	18	4	10		330	620	**1000**
	Total Teaching hours	32						

Year	**III**	**Semester**	**V**					
5EE1	Power Electronics-III	3	1		3	20	80	**100**
5EE2	Microprocessors & Computer Architecture	3			3	20	80	**100**
5EE3	Control Systems	3	1		3	20	80	**100**
5EE4	Generation of Electrical Power	3	1		3	20	80	**100**
5EE5	Transmission & Distribution of Electrical Power	3	1		3	20	80	**100**
5EE6.1	Advanced Distribution System	3			3	20	80	**100**
5EE6.2	Principle of Communication Systems							
5EE6.3	Introduction to VLSI							
5EE6.4								
5EE7	Power Electronics Lab-III			2	2	45	30	**75**
5EE8	Microprocessor Lab			2	2	45	30	**75**
5EE9	MATLAB Programming Lab			2	2	45	30	**75**
5EE10	Power System Design			2	2	45	30	**75**
5EE11	Entrepreneurship Development			2	2	30	20	**50**
5EEDC	Discipline/Extra-Curricular Activities							**50**
	Total	18	4	10		330	620	**1000**
	Total Teaching hours	32						
Year	**III**	**Semester**	**VI**					
6EE1	Modern Control Theory	3	1		3	20	80	**100**
6EE2	High Voltage Engineering	3			3	20	80	**100**
6EE3	Protection of Power System	3	1		3	20	80	**100**
6EE4	Advanced Power Electronics	3	1		3	20	80	**100**
6EE5	Data Structures in C	3			3	20	80	**100**
6EE6.1	Advanced Microprocessors	3	1		3	20	80	**100**
6EE6.2	Power System Instrumentation							
6EE6.3	Digital Communication and Information Theory							
6EE6.4								
6EE7	Control System Lab			2	2	45	30	**75**
6EE8	Power System Lab			2	2	60	40	**100**
6EE9	Data Structures Lab			2	2	45	30	**75**
6EE10	Advanced Power Electronics Lab			2	2	60	40	**100**
6EE11								
6EEDC	Discipline/Extra-Curricular Activities							**50**
	Total	18	4	8		330	620	**1000**
	Total Teaching hours	30						

Year	**IV**	**Semester**	**VII**					
7EE1	Data Base Management System	3			3	20	80	**100**
7EE2	Power System Analysis	3	1		3	20	80	**100**
7EE3	Artificial Intelligence Techniques	3			3	20	80	**100**
7EE4	Utilization of Electrical Power	3	1		3	20	80	**100**
7EE5	Power System Engineering	3	1		3	20	80	**100**
7EE6.1	Electromagnetic Field Theory	3			3	20	80	**100**
7EE6.2	Computer Aided Design of Electrical Machines							
7EE6.3	Economic Operation of Power Systems							
7EE6.4								
7EE7	DBMS Lab			2	2	45	30	**75**
7EE8	Power System Modelling & Simulation Lab			2	2	45	30	**75**
7EE9	Industrial Economics & Management			2	2	30	20	**50**
7EE10	Project Stage I			2	2	50		**50**
7EE11	Practical Training & Industrial Visit			2	2	60	40	**100**
7EEDC	Discipline/Extra-Curricular Activities							**50**
	Total	18	3	10		350	600	**1000**
	Total Teaching hours	31						
Year	**IV**	**Semester**	**VIII**					
8EE1	EHV AC/DC Transmission	3	1		3	20	80	**100**
8EE2	Electric Drives and Their Control	3	1		3	20	80	**100**
8EE3	Switchgear & Protection	3			3	20	80	**100**
8EE4.1	Non Conventional Energy Sources	3			3	20	80	**100**
8EE4.2	FACTS Devices & Their Applications							
8EE4.3	Power System Transients							
8EE4.4								
8EE5	Computer Based Power System Lab			3	2	60	40	**100**
8EE6	Electrical Drives and Control Lab			3	2	60	40	**100**
8EE7	High Voltage Engineering Lab			2	2	30	20	**50**
8EE8	Seminar			2	2	60	40	**100**
8EE9	Project Stage II			4	2	120	80	**200**
8EEDC	Discipline/Extra-Curricular Activities							**50**
	Total	12	2	14		410	540	**1000**
	Total Teaching hours	28						
	Grand Total	100	23	62		2080	3620	6000

B. TECH. III- SEMESTER

3EE1 POWER ELECTRONICS - I

Unit-1 **PN Junction Diodes:** Open-circuited p-n junction and space charge region. The biased p-n junction, volt-ampere characteristics, cutin voltage and effect of temperature on V-I characteristics. Minority carrier density distribution in (i) a forward biased junction and (ii) a reverse biased junction, diode capacitances, junction diode switching times and characteristics. **Other Diodes:** Avalanche breakdown and zener breakdown, working principles of zener diodes, photo-diodes, light emitting diodes, solar cell and varactor diodes.

Unit-2 **Analysis of Diode Circuits: D**iode as a circuit element, load line, small signal diode model and large signal diode model, analysis of half wave and full wave single-phase rectifiers, peak inverse voltage, various types of filters, their analysis and applications, voltage multipliers, clipping and clamping circuits.

Unit-3 **Bipolar Junction Transistors (BJT):** P-N-P and N-P-N transistors, transistor current components, common base (CB) and common emitter (CE) configurations: input & output characteristics, current Gains: alpha & beta, transistor operating regions: active region, saturation region and cutoff region, common collector configuration, BJT biasing and DC models, thermal stability and stabilization Techniques, small signal models: h-parameters and hybrid pie models, BJT as a switch, minority carrier concentration in the base for cutoff, active and saturation conditions, transistor switching times and characteristics, transistor ratings.

Unit-4 **Field Effect Transistors:** Construction, working, V-I characteristics and transfer characteristics of JFET. MOSFET: Enhancement type and depletion type: construction, working, V-I characteristics, and transfer characteristics. DC analysis of FETs. FET as a voltage variable resistor. FET small signal models. FET as a switch. CMOS.

Unit-5 **Small Signal Amplifiers:** Analysis of BJT and JFET amplifiers at low frequency: input and out resistances, voltage and current gains, frequency response of common emitter transistor amplifier at high frequency. Miller's theorem and its dual. Cascaded BJT amplifiers. Darlington pair and Bootstrapped Darlington circuit.

Reference/Suggested Books

1. J. Millman's & C. Halkias–Integrated Electronics: Analog & Digital Circuits Systems,2/e TMH
2. David A. Bell – Electronic Devices and Circuits, 5th Ed Oxford.
3. Millman & Halkias- Millmans Electronic Devices & Circuits 2/e TMH
4. Robert L. Boylested & Louis Nashelshky– Electronic Devices and Circuit theory, PHI
5. Allen Mottershed – Electronic Devices and Circuits, PHI.
6. Jacob Millman, Arvin Grabel, Microelectronics, TMH.
7. Salivahanan: Electronic Devices and Circuits, TMH

3EE2 COMPUTER PROGRAMMING -I

Unit-1 **PROGRAMMING IN C:** Review of basics of C, structure & pointer type, variables, singly and doubly linked lists, I/O and text file handling, command line arguments.

Unit-2 **OOP FUNDAMENTALS:** Concept of class and object, attributes, public, private and protected members, derived classes, single & multiple inheritance.

Unit-3 **PROGRAMMING IN C++:** Enhancements in C++ over C in data types, operators and functions. Inline functions, constructors and destructors. Friend function, function and operator overloading.

Unit-4 Working with class and derived classes. Single and, multiple and multilevel inheritances and their combinations, virtual functions, pointers to objects.

Unit-5 Working with text files, templates, file handling in C++, Input output flags and formatting operations.

Reference/Suggested Books

1. E. Balaguruswamy: Programming in ANSI C 4/e TMH
2. E. Balaguruswamy: Object Oriented Programming in C++ 4/e TMH
3. SAHAY: OBJECT ORIENTED PROGRAMMING WITH C++ , Oxford
4. HUBBARD : Programming with C++ 3/e (SIE) (Schaum's Outline Series)
5. C Gottfried: Programming in C, Schaum Series
6. Rambaugh James etal, "Object Oriented Design and Modeling",PHI-1997
7. Budd, Timothy, "An Introduction to Object Oriented Programming", Pearson 2000

3EE3 CIRCUIT ANALYSIS-I

Unit-1 **Introduction:** Introduction to circuit elements and their characteristics. Current and voltage reference. Response of single element, double element and triple element circuits. Resonance, selectivity & Q-factor in ac circuits.

Network Analysis: Network voltages. Mesh & node systems of network equations and their comparison. Graph of network, tree, incidence matrix, fundamental circuit functions, cut sets, f-circuits analysis and f-cut set analysis, node and node pair analysis. Duality. Method of obtaining dual network.

Unit-2 **Network Theorems:** Thevenis's, Norton's, Superposition, Reciprocity, Compensation, Millman's, Tellegen's, Maximum power transfer and Miller`s theorems.

Unit-3 **Polyphase Circuits:** General Circuit Relations: Three Phase Star, Three Phase Delta, Star and Delta Combination, Four Wire Star Connection, Balanced Three Phase Voltages And Unbalanced Impedances. Power and Reactive Volt-Amperes in a 3-Phase System. Power Relations in AC Circuits: Instantaneous Power in AC Circuits, Power Factor, Apparent Power, Reactive Power, Power Triangle, Complex Power.

Unit-4 **Non-Sinusoidal Waves:** Complex Periodic Waves And Their Analysis By Fourier Series. Different Kinds of Symmetry, Determination of Co-Efficients. Average and Effective Values of a Non-Sinusoidal Wave, Power in a Circuit of Non-Sinusoidal Waves of Current and Voltage, Form Factor, Equivalent Sinusoidal Wave and Equivalent Power Factor. Response of Linear Network to Non-Sinusoidal Periodic Waves.

Unit-5 **Time Domain and Frequency Domain Analysis:** Response of networks to step, ramp, impulse, pulse and sinusoidal inputs. Time domain and frequency domain analysis of circuits. Shifting theorem, initial and final value theorems. Special signal waveforms with Laplace transform & applications to circuit operations.

Reference/Suggested Books

1. Van Valkenburg – Network Analysis, PHI
2. Hayt & Kemmerly: Engineeirng Circuit Analysis 6/e (TMH)
3. J. Edminster & M. Nahvi: Electric Circuits (SIE), 5/e, Scaum's Out Line.
4. Nagsarkar & Sukhija : Circuits & Networks, Oxford
5. John Bird-Electric Circuit Theory & Technology, ELSEVIER
6. D Roy Chodhary: Network & Systems, New Age
7. Ghosh & Chakrabarti: Network Analysis and Synthesis (TMH)
8. A. Chakarvorty: Circuit Theory. Publisher: Dhanpat Rai & Co. (p) Ltd.

3EE4 ELECTRICAL MACHINES-I

Unit-1 **Electromechanical Energy Conversion:** Basic principles of electromechanical energy conversion. Basic aspects and physical phenomena involved in energy conversion. Energy balance.

Unit-2 **DC generators**: Construction, Types of DC generators, emf equation, lap & wave windings, equalizing connections, armature reaction, commutation, methods of improving commutations, demagnetizing and cross magnetizing mmf, interpoles, characteristics, parallel operation. Rosenberg generator.

Unit-3 **DC Motors:** Principle, back emf, types, production of torque, armature reaction & interpoles, characteristics of shunt, series & compound motor, DC motor starting. Speed Control of DC

Motor: Armature voltage and field current control methods, Ward Leonard method. Braking, losses and efficiency, direct & indirect test, Swinburne's test, Hopkinsion test, field & retardation test, single-phase series motor.

Unit-4 **Transformers:** Construction, types, emf equation. No load and load conditions. Equivalent circuits, Vector diagrams, OC and SC tests, Sumpner's back-to-back test, efficiency. voltage regulation, effect of frequency, parallel operation, autotransformers, switching currents in transformers, separation of losses.

Unit-5 **Polyphase Transformers:** Single unit or bank of single-phase units, polyphase connections, Open delta and V connections, Phase conversion: 3 to 6 phase and 3 to 2 phase conversions, Effect of 3-phase winding connections on harmonics, 3-phase winding transformers, tertiary winding.

Reference/Suggested Books

1. A.E. Fitggerald, C.Kingsley Jr and Umans,"Electric Machinery" 6th Edition McGraw Hill, International Student Edition.
2. Kothari & Nagrath: Electric Machines 3/e,TMH
3. M.G. Say, "The Performance and Design of AC machines", Pit man & Sons.
4. Guru: ELECTRIC MACHINERY 3E, Oxford
5. P. S. Bimbhra-Electrical Machinery, Khanna Pub.
6. Stephen J Chapman: Electric Machinery Fundamentals, McGraw-Hill
7. Husain Ashfaq ," Electrical Machines", Dhanpat Rai & Sons
8. Bhag S. Guru and Huseyin R. Hizirogulu, "Electric Machinery and Transformers" Oxford Uiversity Press, 2001

3EE5 ELECTRICAL MEASUREMENTS

Unit-1 **Measuring Instruments:** Moving coil, moving iron, electrodynamic and induction instruments-construction, operation, torque equation and errors. Applications of instruments for measurement of current, voltage, single-phase power and single-phase energy. Errors in wattmeter and energy meter and their compensation and adjustment. Testing and calibration of single-phase energy meter by phantom loading.

Unit-2 **Polyphase Metering:** Blondel's Theorem for n-phase, p-wire system. Measurement of power and reactive kVA in 3-phase balanced and unbalanced systems: One-wattmeter, two-wattmeter and three-wattmeter methods. 3-phase induction type energy meter. Instrument Transformers: Construction and operation of current and potential transformers. Ratio and phase angle errors and their minimization. Effect of variation of power factor, secondary burden and frequency on errors. Testing of CTs and PTs. Applications of CTs and PTs for the measurement of current, voltage, power and energy.

Unit-3 **Potentiometers:** Construction, operation and standardization of DC potentiometers– slide wire and Crompton potentiometers. Use of potentiometer for measurement of resistance and voltmeter and ammeter calibrations. Volt ratio boxes. Construction, operation and standardization of AC potentiometer – in-phase and quadrature potentiometers. Applications of AC potentiometers.

Unit-4 **Measurement of Resistances:** Classification of resistance. Measurement of medium resistances – ammeter and voltmeter method, substitution method, Wheatstone bridge method. Measurement of low resistances – Potentiometer method and Kelvin's double bridge method. Measurement of high resistance: Price's Guard-wire method. Measurement of earth resistance.

Unit-5 **AC Bridges:** Generalized treatment of four-arm AC bridges. Sources and detectors. Maxwell's bridge, Hay's bridge and Anderson bridge for self-inductance measurement. Heaviside's bridge for mutual inductance measurement. De Sauty Bridge for capacitance measurement. Wien's bridge for capacitance and frequency measurements. Sources of error in bridge measurements and precautions. Screening of bridge components. Wagner earth device.

Reference/Suggested Books

1. H.S. Kalsi-Electronic Inst. & Measurement; Tata Mc-Graw Hill
2. Morris-Electrcal Measurements & Instrumentation , ELSEVIER
3. BELL: ELECTRONIC INSTRUMENTATION AND MEASUREMENT Oxford
4. W.D. Cooper-Electronic Inst. & Measurement Techniques; Prentice Hall, India.
5. A.K. Sawhney-Electrical & Electronic Measurement & Inst; Dhanpat Rai & Sons.
6. E.W. Golding & F.C. Widdis, "Electrical Measurement & Measuring Instrument", A.W. Wheeler& Co. Pvt. Ltd. India.
7. Forest K. Harries,"Electrical Measurement",Willey Eastern Pvt. Ltd. India.

3EE6.1 MATHEMATICS

Unit-1 **Laplace Transform:** Laplace transform with its simple properties, applications to the solution of ordinary and partial differential equations having constant coefficients with special reference to wave and diffusion equations, digital transforms.

Unit-2 **Fourier Transform**: Discrete Fourier transform, Fast Fourier transform, Complex form of Fourier transform and its inverse applications, Fourier transform for the solution of partial differential equations having constant coefficients with special reference to heat equation and wave equation.

Unit-3 **Fourier Series:** Expansion of simple functions in Fourier series, half range series, change of interval, harmonic analysis.

Calculus of Variation: Functional, strong and weak variations, simple variation problems, Euler's equation

Unit-4 **Complex Variables:** Analytic functions, Cauchy–Riemann equations, Elementary conformal mapping with simple applications, Line integral in complex domain, Cauchy's theorem, Cauchy's integral formula.

Unit-5 **Complex Variables:** Taylor's series, Laurent's series, poles, Residues. Evaluations of simple definite real integrals using the theorem of residues. Simple contour integration.

Reference/Suggested Books

1. M.Ray, J.C. Chaturvedi & H.C. Sharma – Differential Equations. Pub: Students friends & company
2. Chandrika Prasad – Mathematics for Engineers, Prasad Mudralaya
3. Bird-Higher Engineering mathematics , ELSEVIER
4. Jeffrey-Advanced Engineering Mathematics , ELSEVIER
5. Chandrika Prasad – Advanced Mathematics for Engineers, Prasad Mudralaya
6. Ervin Kreyzig - Advanced Engineering Maths, Wiley.

3EE7 POWER ELECTRONICS LAB-I

1 Study the following devices: (i) Analog & digital multimeter (ii) Function/ Signal generators (iii) Regulated d. c. power supplies (constant voltage and constant current operations)

2 Study of digital storage CRO and store a transient on it.

3 Study of analog CRO, CRO probes, measurement of time period, amplitude, frequency & phase angle using Lissajous figures.

4 Plot V-I characteristic of P-N junction diode & calculate cut-in voltage, reverse Saturation current and static & dynamic resistances.

5 Plot V-I characteristic of zener diode and study zener diode as voltage regulator. Observe the effect of load changes and determine load limits of the voltage regulator.

6 Plot frequency response curve for audio amplifier and to determine gain bandwidth product.

7 Plot drain current - drain voltage and drain current – gate bias characteristics of field effect transistor and measure of Idss & Vp

8 Plot gain- frequency characteristic of two stages RC coupled amplifier & calculate its bandwidth and compare it with theoretical value.

9 Plot gain- frequency characteristic of emitter follower & find out its input and output resistances.

10 Plot input and output characteristics of BJT in CB, CC and CE configurations. Find their h-parameters.

11 Study half wave rectifier and effects of filters on wave. Also calculate ripple factor.

12 Study bridge rectifier and measure the effect of filter network on D.C. voltage output & ripple factor.

3EE8 COMPUTER PROGRAMMING LAB-I

1 Write a program to find the greatest between four numbers.

2 Write a program to prepare mark sheet of students using structures.

3 Write a C program to read several different names and addresses, re-arrange the names in alphabetical order and print name in alphabetical order using structures.

4 Write a program to implement concatenation of two strings using pointers.

5 Write a program to create a singly link list of ten students names and implement add node, delete node and isemptylist operations.

6 Write a program to search a pattern in a given string.

7 Write a Program to read add, subtract and multiply integer matrices.

8 Write a program to calculate the power function (m^n) using the function overloading technique; implement it for power of integer and double.

9 Implement file creation and operate it in different modes: seek, tell, read, write and close operations.

10 Using multiple inheritance, prepare students' mark sheet. Three classes containing marks for every student in three subjects. The inherited class generate mark sheet.

11 Write a program to print the following output using FOR loop.

```
        1                       1
      2   2                   2   2
    3   3   3               3   3   3
  4   4   4   4           4   4   4   4
5   5   5   5   5       5   5   5   5   5
```

3EE9 ELECTRICAL CIRCUIT LAB

1 Draw the circuit symbols.

2 Verify theorems for A. C. & D. C. circuits.

PSPICE Programs For Circuit Analysis:

3 DC-analyze resistor networks to determine node voltages, components voltages, and component currents.

4 Analyze resistor networks that have several voltage and current sources and variable load resistors.

5 Transient –analyze RC & RL circuits to produce tables of component voltage & current levels for a given set of time instants & to produce graphs of voltages & currents versus time.

6 AC-analyze impedance networks to determine the magnitude & phase of node voltages, components voltages and component currents.

7 Determine the magnitude & phase and component voltages and currents in resonant circuits & produce voltage and current verses frequency graphs.

Programs For Circuit Analysis:

8 Calculate the resistance of a conductor, given its dimensions & resistivity or determine the change in conductor resistance when the temp changes.

9 D.C.-analyze resistor networks to determine all junction voltages, component voltages, and component currents.

10 Transient –analyze RC & RL circuits to produce tables of component voltage & current levels for a given set of time instants.
11 Convert Y-connected resistor networks to delta-connected circuits.

3EE10 ELECTRICAL MACHINES LAB-I

1 Speed control of D.C. shunt motor by (a) Field current control method & plot the curve for speed verses field current. (b) Armature voltage control method & plot the curve for speed verses armature voltage.
2 Speed control of a D.C. Motor by Ward Leonard method and to plot the curve for speed verses applied armature voltage.
3 To determine the efficiency of D.C. Shunt motor by loss summation (Swinburne's) method.
4 To determine the efficiency of two identical D.C. Machine by Hopkinson's regenerative test.
5 To perform O.C. and S.C. test on a 1-phase transformer and to determine the parameters of its equivalent circuit its voltage regulation and efficiency.
6 To perform back-to-back test on two identical 1-phase transformers and find their efficiency & parameters of the equivalent circuit.
7 To perform parallel operation of two 1-phase transformers and determine their load sharing.
8 To determine the efficiency and voltage regulation of a single-phase transformer by direct loading.
9 To perform OC & SC test on a 3-phase transformer & find its efficiency and parameters of its equivalent circuit.
10 To perform parallel operation of two 3-phase transformers and determine their load sharing.
11 To study the performance of 3-phase transformer for its various connections, i.e. star/star star/delta delta/star and delta/delta and find the magnitude of 3rd harmonic current.

Reference/Suggested Books

1. D.R. Kohli & S.K. Jain – A laboratory course in Electrical Machine.
2. S.G. Tarnekar & P.K. Kharbanda – Laboratory courses in Electrical Engineering

3EE11 ELECTRICAL MEASUREMENT LAB

1 Study working and applications of (i) C.R.O. (ii) Digital Storage C.R.O. & (ii) C.R.O. Probes
2 Study working and applications of Meggar, Tong-tester, P.F. Meter and Phase Shifter.
3 Measure power and power factor in 3-phase load by (i) Two-wattmeter method and (ii) One-wattmeter method.
4 Calibrate an ammeter using DC slide wire potentiometer.
5 Calibrate a voltmeter using Crompton potentiometer.
6 Measure low resistance by Crompton potentiometer.
7 Measure Low resistance by Kelvin's double bridge.
8 Measure earth resistance using fall of potential method.
9 Calibrate a single-phase energy meter by phantom loading at different power factors.
10 Measure self-inductance using Anderson's bridge.
11 Measure capacitance using De Sauty Bridge.
12 Measure frequency using Wein's bridge.

B. TECH. IV- SEMESTER

4EE1 POWER ELECTRONICS-II

Unit-1 **Feedback Amplifiers:** Classification, Feedback concept, transfer gain with feedback. General characteristics of negative feedback amplifiers. Analysis of voltage series, voltage

shunt, current series and current shunt feedback amplifiers. Stability criterion.

Unit-2 **Oscillators:** Classification of oscillators and Criterion for oscillation. RC-phase shift, Hartley, Colpitts, tuned collector, Wein Bridge and crystal oscillators. Astable, monostable and bistable multivibrators. Schmitt trigger.

Unit-3 **OP-AMP and Its Applications:** Operational amplifier: inverting and non-inverting modes. Characteristics of ideal op-amp. Offset voltage and currents. Basic op-amp applications. Differential Amplifier and common mode rejection ratio. Differential DC amplifier and stable ac coupled amplifier. Integrator and differentiator. Analog computation, comparators, sample and hold circuits, logarithmic & antilog Amplifiers and Analog multipliers.

Unit-4 **Integrated Circuits:** Precision AC/DC converters-precision limiting, Precision half wave and full wave rectifiers. Active average and peak detectors, A to D and D to A converters. IC 555 timer and its application. Regulated power supplies, Series and shunt voltage regulators, Brief idea of Monolithic regulator.

Unit-5 **Power Amplifiers:** Class –A large signal amplifiers, second harmonic distortion, higher order harmonic generation, Transformer coupled audio power amplifier, collector efficiency. Pushpull amplifier: Class A, Class B and Class AB operations. Comparison of performance with single ended amplifiers.

Reference/Suggested Books

1. David A. Bell – Electronic Devices and Circuits, 5Ed, Oxford
2. Robert L. Boylested & Louis Nashelshky: Electronic Devices and Circuit theory (PHI)
3. Millman & Halkias-Electronic Devices& Circuits 2/e, TMH.
4. A.S. Sedra and K.C. Smith "Microelectronics Circuits" Oxford University Press (India)
5. R.A. Gayakwad "Op amps and Linear Integrated Circuits" Prentice Hall of India.
6. Allen Mottershed – Electronic Devices and Circuits, PHI.
7. Salivahanan: Electronic Devices and Circuits 2/e, TMH.

4EE2 DIGITAL ELECTRONICS

Unit-1 **Number Systems and Codes:** Radix and Radix conversions, sign, magnitude & complement notation. Weighted and non-weighted codes, BCD codes, self-complementing codes, cyclic codes, error detecting and correcting codes, ASCII & EBCDIC codes. Alphanumeric codes. Fixed point and floating point arithmetic. BCD arithmetic.

Unit-2 **Boolean Algebra and Digital Logic Gates:** Features of Boolean algebra, postulates of Boolean algebra, theorems of Boolean algebra. Fundamental logic gates, derived logic gates, logic diagrams and Boolean expressions. Converting logic diagrams to universal logic. Positive, negative and mixed logic. **Minimization Techniques:** Minterm, Maxterm, Karnaugh's maps, simplification of logic functions with K-map, conversions of truth tables in SOP & POS forms, incompletely specified functions, variable mapping, Quinn-Mcklusky method.

Unit-3 **Switching Circuits And Logic Families:** Diode, BJT, FET as switch. Different types of logic families: RTL, TTL, open collector TTL, three state output logic, TTL subfamilies, MOS, CMOS, ECL IIL.

Unit-4 **Combination Systems:** Combinational logic circuit design, Half and full adder & subtractors. Binary serial and parallel adders, BCD adder. Binary multiplier, comparator, decoders, encoders, multiplexer, de-multiplexer, Code converters.

Unit-5 **Sequential Systems:** Latches, Flip-Flop: R-S, D, J-K, T, Master slave. Flip-flop conversions. Counters: asynchronous & synchronous counter. Counter design, counter applications. Registers: buffer & shift register.

Reference/Suggested Books

1. T.M. Floyd, R.P. Jain-Digital fundamentals, Pearson Education.
2. Morris and Mano - Digital logic and Computer Design, Prentice – Hall of India
3. R.P. JAIN:Modern Digital Electronics 4/e, TMH.

4. Kharate G K : Digital Electronics, Oxford
5. Pedroni -Digital Electronics & Design , ELSEVIER.
6. Balbir Kumar and Shail B.Jain, "Electronic Devices and Circuits" PHI, 2007.
7. Anil K. Maini, "Digital Electronics: Principles and Integrated circuits" Wiley 2008.
8. Anand Kumar, "Switching Theory and Logic Design" Prentice Hall of India, 2008.

4EE3 ELECTRICAL MACHINES-II

Unit-1 **Introduction:** General equation of inducted emf, AC armature windings: concentric and distributed winding, chording, skewing, effect on induced emf. Armature and field mmf, effect of power factor and current on armature mmf, harmonics. Rotating fields.

Unit-2 **Induction Motors:** Construction of squirrel cage & slip ring induction motor, basic principles, flux and mmf waves, induction motor as a transformer. Equivalent circuits, torque equation, torque-slip curves, no load & block rotor tests, circle diagram, performance calculation. Effect of rotor resistance. Cogging, Crawling. Double cage squirrel cage induction motor, induction generator, induction regulator.

Unit-3 **Starting & Speed Control of Induction Motors:** Various methods of starting & speed control of squirrel cage & slip ring motor, cascade connection, braking.
Single-Phase Induction Motor: Revolving field theory, starting methods, equivalent circuits.

Unit-4 **Synchronous Generator:** Construction, types, excitation systems, principles. Equation of induced emf, flux and emf waves, theory of cylindrical rotor and salient pole machines, two-reactance theory, phasor diagrams, power developed, voltage regulation, OC & SC tests, zero power factor characteristics, potier triangle and ASA method of finding voltage regulation, synchronization, parallel operation, hunting and its prevention.

Unit-5 **Synchronous Motors:** types, construction, principle, phasor diagrams, speed torque characteristics, power factor control, V-curves, starting methods, performance calculations, applications, synchronous condenser, synchronous induction motor.

Reference/Suggested Books

1. A.E. Fitggerald, C.Kingsley Jr and Umans,"Electric Machinery" 6th Edition McGraw Hill, International Student Edition.
2. Kothari & Nagrath: Electric Machines 3/e,TMH
3. M.G. Say, "The Performance and Design of AC machines", Pit man & Sons.
4. Guru: ELECTRIC MACHINERY 3E, Oxford
5. P.S. Bimbhra-Electrical Machinery, Khanna Pub.
6. Stephen J Chapman: Electric Machinery Fundamentals, McGraw-Hill
7. Husain Ashfaq ," Electrical Machines", Dhanpat Rai & Sons
8. Irving L.Kosow, "Electric Machine and Tranformers", Prentice Hall of India.

4EE4 COMPUTER PROGRAMMINNG-II

Unit-1 **UNIX-** Introduction to following basic commands (excluding shell programming): who, touch, cat, cp, rm, mv, ls, unmask, pwd, mkdir, rmdir, bc, expr, factor, logname, id, uname, try, date, banner, dspace, du, ulimit, passwd, cal, wc, sort, cut, grep, dd, head, pg, lp, tail, compress, man, tee.

Unit-2 **VI Editor:** Text entry and command modes, cursor movement commands, string replacement commands and set commands.

Unit-3 **JAVA:** Variation from C++ to JAVA. Introduction to JAVA bytecode, virtual machine, application, application & applets of Java, integer, floating point, characters, Boolean, literals, and array declarations.

Unit-4 **Operators and Control Statements:** Arithmetic operators, bitwise operators, relational operators, Boolean logic operators, the assignment operators, ?: operators, operator precedence. Switch and loop statements.

Unit-5 **Package and Interfaces:** Packages, access protection, importing & defining packages. Defining and implementing interfaces. I/O APPLETS: I/O basics, reading console I/O, input

and print stream classes, applet fundamental and string handling, mouse and keyboard interfaces, awt tools and controls.

Reference/Suggested Books

1. Yashwant Kanithkar: Unix & Shell Programming (BPB)
2. Sumitabha Das: Unix: Concepts & Applications 4/e (TMH)
3. Balagurusamy: Programming with Java 4/e (TMH)
4. Grady Booch – Object Oriented Analysis & Design with Applications (Pearson Education, Patrick.
5. Naughton, Herbert Schildt – Java 2: The complete Reference (McGraw-Hill, 3rd Ed.)
6. James Rambaugh - Object Oriented Modelling and Design (PHI, IGNOU Ed.) & Pearson

4EE5 CIRCUIT ANALYSIS-II

Unit-1 **Impedance and Admittance Functions:** The concept of complex frequency, transform impedance and admittance, series and parallel combinations.

Network Functions: Terminals and terminal pairs, driving point impedance transfer functions, poles and zeros. Restrictions on pole and zero location in s-plane. Time domain behavior from pole and zero plot. Procedure for finding network functions for general two terminal pair networks.

Unit-2 **Network Synthesis:** Hurwitz polynomial, positive real functions, reactive networks. Separation property for reactive networks. The four-reactance function forms, specification for reactance function. Foster form of reactance networks. Cauer form of reactance networks. Synthesis of R-L and R-C networks in Foster and Cauer forms.

Unit-3 **Two Port General Networks:** Two port parameters (impedance, admittance, hybrid, ABCD parameters) and their inter relations. Equivalence of two ports. Transformer equivalent, inter connection of two port networks. The ladder network, image impedance, image transfer function, application to L-C network, attenuation and phase shift in symmetrical T and pi networks.

Unit-4 **Two Port Reactive Network (Filters):** Constant K filters. The m-derived filter. Image impedance of m-derived half (or L) sections, composite filters. Band pass and band elimination filters. The problem of termination, lattice filters, Barlett's bisection theorem. Introduction to active filters.

Unit-5 **Coupled Circuits:** Conductively coupled circuits. Mutual impedance, magnetic coupling, mutual inductance, co-efficient of magnetic coupling, circuit directions and sign of mutual inductance, mutual inductance between portions of the same circuit, mutual inductance between parallel branches, transferred impedance. Transformer equivalent inductively and conductively coupled circuits; Resonance in Single tuned and Double tuned circuits, effect of coefficient of coupling.

Reference/Suggested Books

1. M.E. Van Valkenburg, "An Introduction to Modern Network Synthesis",Wiley Eastern
2. Nagsarkar & Sukhija : Circuits & Networks, Oxford
3. Choudhary D.Roy, "Network & Systems", Wiley Eastern Ltd.
4. Ghosh & Chakrabarti: Network Analysis and Synthesis (TMH)
5. Samarajit Ghosh, "Network Theory: Analysis and Synthesis" Prentice Hall of India, 2008
6. A.Chakrabarti, "Circuit Theory" Dhanpat Rai & Co.
7. Umesh Sinha, Transmission Lines and Networks, Satya prakashan.
8. Murthy and Kamath, Basic Circuit Analysis, Jaico Publishing House.

4EE6.1 ADVANCED MATHEMATICS

Unit-1 **Numerical Analysis:** Finite differences - Forward backward and central difference. Newton's forward and backward differences interpolation formulae. Sterling's formulae, Lagrange's interpolation formula. Solution of non-linear equations in one variable by Newton Raphson and Simultaneous algebraic equation by Gauss and Regula Falsi method. Solution of

simultaneous equations by Gauss elimination and Gauss Seidel methods. Fitting of curves (straight line and parabola of second degree) by method of least squares.

Unit-2 **Numerical Analysis:** Numerical differentiation, numerical integration trapezoidal rule, Simpson's one-third and one eighth rule. Numerical Integration of ordinary differential equations of first order, Picard's method, Euler's & modified Euler's methods. Miline's method and Runga Kutta fourth order method. Simple linear difference equations with constant coefficients.

Unit-3 **Special Functions:** Bessel's function of first and second kind, simple recurrence relations, orthogonal property of Bessel functions, Transformation, Generating functions, Legendre's function of first kind, simple recurrence relations, orthogonal property, Generating functions.

Unit-4 **Statistics & Probability:** Elementary theory of probability, Baye's theorem with simple applications, Expected value. Theoretical probability distributions – Binomial, Poisson and Normal distributions.

Unit-5 **Statistics & Probability:** Lines of regression, co-relation and rank correlation. **Transforms**: Z-transforms, its inverse, simple properties and application to difference equations.

Reference/Suggested Books

1. Jeffrey-Advanced Engineering Mathematics , ELSEVIER
2. Ervin Kreyzig - Advanced Engineering Maths, John Wiley
3. Bird-Higher Engineering Mathematics , ELSEVIER
4. Chandrika Prasad – Advanced Mathematics for Engineers, Prasad Mudralaya
5. Kaplan, W. "Advanced Mathematics for Engineers", Addison-Wesley Publishing Co.
6. Brigham, E.O. "The Fast Fourier Transform and its Applications", Prentice-Hall
7. J.N. Kapur, Mathematical Statistics, S. Chand & company Ltd.,2000
8. R.K. Jain & S.R.K. Iyenger, Advance Engineering Mathematics, Narosa Pub., 2002.
9. E. Kreysig, Advanced Engineering Mathematics, John Wiley & Sons, 2005.

4EE7 POWER ELECTRONICS LAB-II

1. Plot gain-frequency characteristics of BJT amplifier with and without negative feedback in the emitter circuit and determine bandwidths, gain bandwidth products and gains at 1KHz with and without negative feedback.
2. Study of series and shunt voltage regulators and measure line and load regulation and ripple factor.
3. Plot and study the characteristics of small signal amplifier using FET.
4. Push Pull amplifier: To study variation of output power & distortion with load.
5. Study Wein bridge oscillator and observe the effect of variation in R & C on oscillator frequency
6. Study transistor phase shift oscillator and observe the effect of variation in R & C on oscillator frequency and compare with theoretical value.
7. Study the following oscillators and observe the effect of variation of C on oscillator frequency: (i) Hartley (ii) Colpitts
8. (i) Study op-amp in inverting and non-inverting modes. (ii) Use op-amp as scalar, summer and voltage follower.
9. Use of op-amp as differentiator and integrator.
10. Study Op-amp characteristics and get data for input bias current, measure the output-offset voltage and reduce it to zero and calculate slow rate.
11. Obtain a frequency response of filters.
12. Analyze filter circuits to produce voltage frequency & phase-frequency response graphs using PSPICE.

4EE8 DIGITAL ELECTORNICS LAB

1. Study of following combinational circuits: Multiplexer, Demultimplexer and Encoder. Verify

truth tables of various logic functions.

2 Study of various combinational circuits based on: AND/NAND Logic blocks and OR/NOR Logic blocks.

3 To study various waveforms at different points of a transistor bistable multivibrator and its frequency variation with different parameters.

4 To design a frequency divider using IC-555 timer.

5 To study various types of registers and counters.

6 To study Schmitt trigger circuit.

7 To study transistor astable multivibrator.

8 Experimental study of characteristics of CMOS integrated circuits.

9 Interfacing of CMOS to TTL and TTL to CMOS.

10 BCD to binary conversion on digital IC trainer.

11 Testing of digital IC by automatic digital IC trainer.

12 To study OP-AMP as Current to Voltage & Voltage to Current converters & comparator.

4EE09 ELECTERICAL MACHINES LAB-II

1 Separation of transformer core losses and to determine the hystersis and eddy current losses at rated voltage and frequency.

2 To plot the O.C.C. & S.C.C. of an alternator and to determine its regulation by synchronous impedance method.

3 To synchronize an alternator across the infinite bus (RSEB) & summarize the effects of variation of excitation on load sharing.

4 To plot the V-curve for a synchronous motor for different values of loads.

5 To perform sumpner's back-to-back test on 3 phase transformers, find its efficiency & parameters for its equivalent circuits.

6 To perform the heat run test on a delta/delta connected 3-phase transformer and determine the parameters for its equivalent circuit.

7 To perform no load and blocked rotor test on a 3 phase induction motor and to determine the parameters of its equivalent circuits. Draw the circle diagram and compute the following (i) Max. Torques (ii) Current (iii) slip (iv) p.f. (v) Efficiency.

8 To perform the load test on a 3-phase induction motor and determine its performance characteristics (a) Speed vs load curve (b) p.f. vs load curve (c) Efficiency vs load curve (d) Speed vs torque curve

9 Determination of losses and efficiency of an alternator.

10 To find Xd and Xq of a salient pole synchronous machine by slip test.

Reference/Suggested Books

1. D.R. Kohli & S.K. Jain – A Laboratory Course in Electrical Machines, Publisher: NEM CHAND & BROTHERS.
2. S.G. Tarnekar & P.K. Kharbanda – Laboratory Course in Electrical Engineering , S. Chand

4EE10 COMPUTER PROGRAMMING LAB - II

UNIX

1 Use of advanced vi commands.

2 Sorting of files containing records using sort command.

3 Searching patterns in files.

4 Use of bc, expr, factor commands.

5 Use of head, tail, compress commands.

6 Memory management commands, dfspace, du, ulimit etc.

JAVA

7 Programs based on matrix: addition, multiplication, transpose, check if matrix is symmetric / upper triangular / lower triangular / unit matrix.

8 Representation of complex numbers and their operation: add, multiply; divide, subtraction, magnitude (mod) etc.

9 Complex matrix representation and operation: add, subtract, multiply.

10 Defining packages for sorting algorithms.

11 File handling operations: input from file, output to file, file copy, file concatenation.

12 Mouse and keyboard event handling programs.

13 Programs based on string operations.

14 Drawing in applet and use of buttons check boxes, text fields and labels in applets.

4EE11 HUMANITIES & SOCIAL SCIENCES

Unit-1 **India:** Brief history of Indian Constitution, farming features, fundamental rights, duties, directive principles of state. History of Indian National Movement, socio economic growth after independence.

Unit-2 **Society:** Social groups- concept and types, socialization- concept and theory, social control: concept, social problem in contemporary India, status and role.

Unit-3 **The Fundamentals of Economics:** meaning, definition and importance of economics, Logic of choice, central economic problems, positive and normative approaches, economic systems-socialism and capitalism.

Unit-4 **Microeconomics:** Law of demand supply, utility approach, indifference curves, elasticity of demand and supply and applications, consumer surplus, Law of returns to factors and returns to scale.

Unit-5 **Macroeconomics:** concepts relating to National product–National income and its measurement, Simple Keynesian theory, simple multiplier, money and banking. Meaning, concept of international trade, determination of exchange rate, Balance of payments.

B. TECH. V- SEMESTER

5EE1 POWER ELECTRONICS-III

Unit-1 **Power Semiconductor Devices:** Characteristics of Power Transistor, Thyristor, GTO, Power MOSFET and IGBT. Two-Transistor Model of Thyristor.

Unit-2 **SCR:** Construction and characteristics, specification and ratings, pulse transformer, optical isolators, methods of turn on: R, RC, UJT relaxation oscillator, Rating extension by series and parallel connections, string efficiency. Protection of SCR-Protection against over voltage, over current, dv/dt, di/dt, Gate protection.

Unit-3 **Converters-I:** Single Phase half & full wave converters with RL load, Single phase dual converters, Three phase half wave converters, Three phase full converters with RL load, Three phase dual converters.

Unit-4 **Converters-II:** Single and three-phase semi converters with RL load. Power Factor Improvement-Extinction angle control, symmetrical angle control, pulse width modulation control and sinusoidal pulse width modulation control. Inversion operation. Effect of load and source impedances.

Unit-5 **DC-DC Converters: Choppers:** Step Up/Down Copper, Chopper Configurations, analysis of type A Chopper Commutation of Choppers. Switched Mode Regulators-buck, boost, buck-boost and cuk regulator.

Reference/Suggested Books

1. M H Rashid: Power Electronics, Circuits Devices and Applications, PHI
2. Ned Mohan: Power Electronics, John Wiley
3. M D Singh and K B Khanchandani: Power Electronics 2/e, TMH, 2008.
4. Krein P. T: Eleements of Power Electronics, Oxford.
5. P C Sen: Power Electronics, Tata McGraw-Hill, India.
6. C W Lander: Power Electronics, McGraw Hill
7. W Shepherd: Power Electronics and Motor Control, Cambridge Uni. Press.
8. P S Bimbhra: Power Electronics, Khanna Publishers.

5EE2 MICROPROCESSORS & COMPUTER ARCHITECTURE

Unit-1 **Introduction**: CPU, address bus, data bus and control bus. Input/Output devices, buffers, encoders, latches and memories. Brief introduction to comparison of different features in 8085 and 8086 microprocessors.

Unit-2 **8085 Microprocessor Architecture**: Internal Data Operations and Registers, Pins and Signals, Peripheral Devices and Memory Organization, Interrupts.

Unit-3 **8085 Microprocessor Instructions**: Classification, Format and Timing. Instruction Set. Programming and Debugging, 8 Bit And 16 Bit Instructions.

Unit-4 **8085 Microprocessor Interfacing**: 8259, 8257, 8255, 8253, 8155 chips and their applications. A/D conversion, memory, keyboard and display interface (8279).

Unit-5 **Basic Computer Architecture:** Central Processing Unit, memory and input/output interfacing. Memory Classification: Volatile and non-volatile memory, Primary and secondary memory, Static and Dynamic memory, Logical, Virtual and Physical memory. Types of memory: Magnetic core memory, binary cell, Rom architecture and different types of ROM, RAM architecture, PROM, PAL, PLA, Flash and Cache memory, SDRAM, RDRAM and DDRAM. Memory latency, memory bandwidth, memory seek time.

Reference/Suggested Books

1. Gaonkar, Ramesh S, "Microprocessor Architecture, programming and applications with the 8085" Pen ram International Publishing 5th Ed.
2. Douglas Hall: Microprocessors and Interfacing, Revised Second Edition (SIE) TMH
3. Mathur A P -Introduction to Microprocessors , TMH
4. Ray, A.K. & Burchandi, K.M., "Advanced Microprocessors and Peripherals: Architecture, Programaming and Interfacing" Tata Mc. Graw Hill.
5. Krishna Kant, "Microprocessors and Microcontrollers" PHI Learning.
6. Brey, Barry B. "INTEL Microprocessors" Prentice Hall (India)
7. M. Rafiquzzaman, "Microprocessors- Theory and applications" PHI
8. B. Ram, "Advanced Microprocessor & Interfacing" Tata McGraw Hill
9. Liu and Gibson G.A., "Microcomputer Systems: The 8086/8088 Family" PHI

5EE3 CONTROL SYSTEMS

Unit-1 **Introduction:** Elements of control systems, concept of open loop and closed loop systems., Examples and application of open loop and closed loop systems, brief idea of multivariable control systems.

Unit-2 **Mathematical Modeling of Physical Systems:** Representation of physical system (Electro Mechanical) by differential equations, Determination of transfer function by block diagram reduction techniques and signal flow method, Laplace transformation function, inverse Laplace transformation.

Unit-3 **Time Response Analysis of First Order and Second Order System:** Characteristic equations, response to step, ramp and parabolic inputs, transient response analysis, steady state errors and error constants, Transient & steady state analysis of LTI systems.

Unit-4 **Stability of the System:** Absolute stability and relative stability, Routh's stability criterion, root locus method of analysis, polar plots, Nyquist stability criterion. M and N Loci, Nichols

chart.

Unit-5 **Elementary Ideas of Compensation, Networks:** Lag, lead and log lead networks, brief idea of proportional, derivative and integral controllers.

Reference/Suggested Books

1. I J Nagrath and M Gopal: Control Systems Engineering, 3rd Ed, New Age Publication.
2. Robert H Bishop : Modern Control Systems, Boyd and Fraser pub
3. B C Kuo: Modern Control Engineering, NEW AGE
4. K.Ogata,"Modern Control Engineering" Prentice Hall of India.
5. Norman S.Nise, "Control System Engineering", John Wiley & Sons.
6. Richard C Dorf, Robert H Bishop : Modern Control Systems, Prentice-Hall

5EE4 GENERATION OF ELECTRICAL POWER

Unit-1 **Conventional Energy Generation Methods**: **(i) Thermal Power plants:** Basic schemes and working principle. **(ii) Gas Power Plants:** open cycle and closed cycle gas turbine plants, combined gas & steam plants – basic schemes. **(iii) Hydro Power Plants:** Classification of hydroelectric plants. Basic schemes of hydroelectric and pumped storage plants. **(iv) Nuclear Power Plants:** Nuclear fission and Nuclear fusion. Fissile and fertile materials. Basic plant schemes with boiling water reactor, heavy water reactor and fast breeder reactor. Efficiencies of various power plants.

Unit-2 **New Energy Sources**: Impact of thermal, gas, hydro and nuclear power stations on environment. Green House Effect (Global Warming). Renewable and non-renewable energy sources. Conservation of natural resources and sustainable energy systems. Indian energy scene. Introduction to electric energy generation by wind, solar and tidal.

Unit-3 **(i) Loads and Load curves:** Types of load, chronological load curve, load duration curve, energy load curve and mass curve. Maximum demand, demand factor, load factor, diversity factor, capacity factor and utilization. **(ii) Power factor improvement**: Causes and effects of low power factor and advantages of power factor improvement. Power factor improvement using shunt capacitors and synchronous condensers.

Unit-4 **Power Plant Economics: (i)** Capital cost of plants, annual fixed and operating costs of plants, generation cost and depreciation. Effect of load factor on unit energy cost. Role of load diversity in power system economics. **(ii)** Calculation of most economic power factor when (a) kW demand is constant and (b) kVA demand is constant. **(iii) Energy cost reduction:** off peak energy utilization, co-generation, and energy conservation.

Unit-5 **(i) Tariffs:** Objectives of tariffs. General tariff form. Flat demand rate, straight meter rate, block meter rate. Two part tariff, power factor dependent tariffs, three-part tariff. Spot (time differentiated) pricing. **(ii) Selection of Power Plants:** Comparative study of thermal, hydro, nuclear and gas power plants. Base load and peak load plants. Size and types of generating units, types of reserve and size of plant. Selection and location of power plants.

Reference/Suggested Books

1. B.R. Gupta - Generation of Electrical Energy Wheelar Pub
2. Soni, Gupta and Bhatnagar - Generation of Electrical Power. Dhanpat Rai Pub
3. S. L. Uppal - Electrical Power. Khanna Pub
4. M. V Deshpande: Elements of Electrical Power Station Design, Wheeler Publishing Co.

5EE5 TRANSMISSION & DISTRIBUTION OF ELECTRICAL POWER

Unit-1 **(i) Supply systems: -** Basic network of power system. Transmission and distribution voltage, effect of system voltage on size of conductor and losses. Comparison of DC 2- wire, DC 3- wire, 1- phase AC and 3- phase AC (3- wire and 4- wire) systems. **(ii) Distribution Systems**: - Primary and secondary distribution systems, feeder, distributor and service mains. Radial and ring- main distribution systems. Kelvin's law for conductor size.

Unit-2 **Mechanical features of overhead lines:-** Conductor material and types of conductor. Conductor arrangements and spacing. Calculation of sag and tension, supports at different

levels, effect of wind and ice loading, stringing chart and sag template. Conductor vibrations and vibration dampers.

Unit-3 **Parameters of Transmission Lines:** Resistance inductance and capacitance of overhead lines, effect of earth, line transposition. Geometric mean radius and distance. Inductance and capacitance of line with symmetrical and unsymmetrical spacing Inductance and capacitance of double circuit lines. Skin and proximity effects.
Equivalent circuits and performance of short and medium transmission lines**.**

Unit-4 **(i)**Generalized ABCD line constants, equivalent circuit and performance of long transmission line. Ferranti effect. Interference with communication circuits. Power flow through a transmission line **(ii) Corona:** Electric stress between parallel conductors. Disruptive critical voltage and visual critical voltage, Factors affecting corona. Corona power loss. Effects of corona.

Unit-5 **(i) Insulators:** Pin, shackle, suspension, post and strain insulators. Voltage distribution across an insulator string, grading and methods of improving string efficiency**. (ii) Underground Cables:** Conductor, insulator, sheathing and armoring materials. Types of cables. Insulator resistance and capacitance calculation. Electrostatic stresses and reduction of maximum stresses. Causes of breakdown. Thermal rating of cable. Introduction to oil filled and gas filled cables.

Reference/Suggested Books

1. A S Pabla: Electric Power Distribution. (TMH)
2. B R Gupta: Power System Analysis & Design, S. CHAND PUBLISHERS
3. Soni, Gupta and Bhatnagar: A Course in Electrical Power, Dhanpat Rai
4. C.L. Wadhwa: Electrical Power Systems, New Age
5. Nagrath Kothari: Modern Power System Analysis. (TMH)
6. J. J. Grainger& W. D. Stevenson: Power System Analysis (TMH).
7. Kamaraju: Electrical Power Distribution Systems (TMH)

5EE 6.1 ADVANCED DISTRIBUTION SYSTEM

Unit-1 **(i) Distribution Systems:** Distribution of power, future distribution systems, power loads. **(ii) Load Forecasting:** Introduction, load survey, load forecasting-regression analysis, correlation theory, analysis of time series, load growth factors, sources of error.

Unit-2 **Operation:** Operation criterion and standards: Voltage control – voltage regulation, kVA – km conductor loading, correction of system voltage. Harmonics – introduction, effects of harmonics on networks, limits of harmonics, filters. Load variations- causes of voltage fluctuations, measures to reduce flickering. Ferro resonance. System losses - introduction, losses in components, measurement of losses, reduction of losses. Energy management.

Unit-3 **Distribution Power Capacitors:** Reactive power flow, monitoring and compensation in distribution system, maintaining system voltage. Series and shunt capacitors, comparison. Shunt capacitors in distribution system - LT and HT shunt capacitors, capacitor rating for power factor improvement, constructional features. System harmonics.

Unit-4 **Grounding:** Grounding system, earth and safety, earth electrode- earth resistance calculation, effect of rod size and soil resistivity, earth conductor sizes. Introduction to earth electrode design. Brief description of system earthing – system neutral earthing, earthing of substations, lines and consumer premises. Earth fault protection of feeders.

Unit-5 **Distribution Automation:** Introduction to distribution automation. Concept of communication-power line carrier, radio communication, fibre optics, satellite communication and sensors. Introduction to supervisory control and data acquisition (SCADA). Brief descriptor of an automation system.

Reference/Suggested Books

1. A S Pabla: Electric Power Distribution. (TMH)
2. B R Gupta: Power System Analysis & Design, S. CHAND PUBLISHERS
3. Nagrath Kothari: Modern Power System Analysis. (TMH)

4. J. J. Grainger& W. D. Stevenson: Power System Analysis (TMH).
5. Kamaraju: Electrical Power Distribution Systems (TMH)

5EE6.2 PRINCIPLE OF COMMUNICATION SYSTEMS

Unit-1 **Noise Effects in Communication Systems:** Resistor noise, Networks with reactive elements, Noise temperature, Noise bandwidth, effective input noise temperature, Noise figure. Noise figure & equivalent noise temperature in cascaded circuits.

Unit-2 **Amplitude Modulation:** Frequency translation, Recovery of base band signal, Spectrum & power relations in AM systems. Methods of generation & demodulation of AM-DSB, AM-DSB/SC and AM-SSB signals. Modulation & detector circuits for AM systems. AM transmitters & receivers.

Unit-3 **Frequency Modulation:** Phase & freq. modulation & their relationship, Spectrum & bandwidth of a sinusoidally modulated FM signal, phasor diagram, Narrow band & wide band FM. Generation & demodulation of FM signals. FM transmitters & receivers, Comparison of AM, FM & PM. Pre emphasis & de-emphasis. Threshold in FM, PLL demodulator.

Unit-4 **Noise in AM and FM:** Calculation of signal-to-noise ratio in SSB-SC, DSB-SC, DSB with carrier, Noise calculation of square law demodulator & envelope detector. Calculation of S/N ratio in FM demodulators, Super-heterodyne receivers.

Unit-5 **Pulse Modulation Systems:** Sampling theorem, Generation and demodulation methods of PAM, PWM, PPM.

Reference/Suggested Books

1. Taub and Schilling: Principles of Communication Systems 3/e, TMH
2. B P Lathi : Modern Analog & Digital Communication System, Oxford University Press
3. Simon Hykin: Communication Systems, John Wiley and Sons
4. R P Singh and S D Sapre: Communication System Analog & Digital 2/e. (TMH)
5. G. Kennedy and B. Davis , "Electronic Communication Systems" Tata McGraw Hill
6. Roy Blake, " Wireless Communication Technology" Thomson Asia Pvt. Ltd. Singapore

5EE6.3 INTRODUCTION TO VLSI

Unit-1 **Introduction to MOS Technology:** Basic MOS transistors, Enhancement Mode transistor action, Depletion Mode transistor action, NMOS and CMOS fabrication.

Unit-2 **Basic Electrical Properties of MOS Circuits:** I_{ds} versus V_{ds} relationship, Aspects of threshold voltage, Transistor Transconductance g_m. The nMOS inverter, Pull up to Pull-down ratio for a NMOS Inverter and CMOS Inverter (B_n/B_p), MOS transistor circuit Model, Noise Margin.

Unit-3 **CMOS Logic Circuits:** The inverter, Combinational Logic, NAND Gate NOR gate, Compound Gates, 2 input CMOS Multiplexer, Memory latches and registers, Transmission Gate, Gate delays, CMOS-Gate Transistor sizing, Power dissipation.

Unit-4 **Basic Physical Design of Simple Gates and Layout Issues:** Layout issues for inverter, Layout for NAND and NOR Gates, Complex Logic gates Layout, Layout optimization for performance.

Unit-5 Introduction to VHDL, Verilog & other design tools. VHDL Code for simple Logic gates, flip-flops, shift-registers, Counters, Multiplexers, adders and subtractors.

Reference/Suggested Books

1. S M Sze: VLSI Technology (TMH)
2. SM KANG:CMOS Digital Integrated Circuits, TMH
3. Stephen A Compbell: The Science & Engineering of Microelectronic Fabrication, Oxford.
4. James D Plummer, Micheal Deal & Petter B Griffin: Silicon VLSI Tech. Fundamental, Practice & Modeling, Prentice Hall.

5EE7 POWER ELECTRONICS LAB-III

1 Study the comparison of following power electronics devices regarding ratings, performance characteristics and applications: Power Diode, Power Transistor, Thyristor, Diac, Triac, GTO, MOSFET, MCT and SIT.

2 Determine V-I characteristics of SCR and measure forward breakdown voltage, latching and holding currents.

3 Find V-I characteristics of TRIAC and DIAC.

4 Find output characteristics of MOSFET and IGBT.

5 Find transfer characteristics of MOSFET and IGBT.

6 Find UJT static emitter characteristics and study the variation in peak point and valley point.

7 Study and test firing circuits for SCR-R, RC and UJT firing circuits.

8 Study and test 3-phase diode bridge rectifier with R and RL loads. Study the effect of filters.

9 Study and obtain waveforms of single-phase half wave controlled rectifier with and without filters. Study the variation of output voltage with respect to firing angle.

10 Study and obtain waveforms of single-phase half controlled bridge rectifier with R and RL loads. Study and show the effect of freewheeling diode.

11 Study and obtain waveforms of single-phase full controlled bridge converter with R and RL loads. Study and show rectification and inversion operations with and without freewheeling diode.

12 Control the speed of a dc motor using single-phase half controlled bridge rectifier and full controlled bridge rectifier. Plot armature voltage versus speed characteristics.

Reference/Suggested Books

1. O P Arora: Power Electronics Laboratory-Experiments and Organization, Narosa Pub.
2. P B Zbar: Industrial Electronics- A Text-Lab Manual, Tata McGraw Hill

5EE8 MICROPROCESSOR LAB

1 Study the hardware, functions, memory structure and operation of 8085-Microprocessor kit.

2 Program to perform integer division: (1) 8-bit by 8-bit (2) 16 bit by 8 bit.

3 Transfer of a block of data in memory to another place in memory

4 Transfer of black to another location in reverse order.

5 Searching a number in an array.

6 Sorting of array in: (1) Ascending order (2) Descending order.

7 Finding party of a 32-bit number.

8 Program to perform following conversion (1) BCD to ASCII (2) BCD to hexadecimal.

9 Program to multiply two 8–bit numbers

10 Program to generate and sum 15 Fibonacci numbers.

11 Program for rolling display of message “India”, “HELLO”.

12 To insert a number at correct place in a sorted array.

13 Reversing bits of an 8-bit number.

14 Fabrication of 8-bit LED interfaces for 8085 kit through 8155 and 8255.

15 Data transfer on output port 8155 & 8255 & implementation of disco light, running light, and sequential lights on the above mentioned hardware.

16 Parallel data transfer between two DYNA-85 kit using 8253 ports.

17 Generation of different waveform on 8253/8254 programmable timer.

5EE9 MATLAB PROGRAMMING LAB

1 Basics of MATLAB matrices and vectors, matrix and array operations, Saving and loading data, plotting simple graphs, scripts and functions, Script files, Function files, Global Variables, Loops, Branches, Control flow, Advanced data objects, Multi-dimensional matrices, Structures,

Applications in linear algebra curve fitting and interpolation. Numerical integration, Ordinary differential equation. (All contents is to be covered with tutorial sheets)

2 **Simulink:** Idea about simulink, problems based on simulink. (All contents is to be covered with tutorial sheets)

Reference/Suggested Books

1. Almos Gilat, "MATLAB: An Introduction with Applications" Wiley India Ltd., 2004.

5EE10 POWER SYSTEM DESIGN

1 Generating station design**:** Design considerations and basic schemes of hydro, thermal, nuclear and gas power plants. Electrical equipment for power stations,

2 Auxiliary power supply scheme for thermal power plant.

3 Distribution system Design: Design of feeders & distributors. Calculation of voltage drops in distributors. Calculation of conductor size using Kelvin's law.

4 Methods of short term, medium term and long term load forecasting.

5 Sending end and receiving end power circle diagrams.

6 Instrument Transformers: Design considerations of CTs & PTs for measurement and protection.

7 Substations: Types of substations, various bus–bar arrangements**.** Electrical equipment for substations.

5EE11 ENTREPRENEURSHIP DEVELOPMENT

1 Definition of entrepreneur, qualities of a successful entrepreneur, Charms of being an entrepreneur, achievement- motivation, leadership and entrepreneurial competencies.

2 Decision-making, procedures and formalities for starting own business, financial support system.

3 Identification and selection of business opportunities and market survey, business plan. Implementation and customer satisfaction.

4 Business crises, problem-solving attitude, communication skill. Government policies for entrepreneurs.

5 Knowledge based enterprises, Scope of entrepreneur in present context, area of future entrepreneurship.

6 Marketing & Sales Promotion, Techno-Economic Feasibility Assessment by Preparation of Preliminary & Detailed project report.

B. TECH. VI- SEMESTER

6EE1 MODERN CONTROL THEORY

Unit-1 **Introduction:** Concept of Linear vector space Linear Independence, Bases & Representation, domain and range. Concept of Linearity, relaxedness, time invariance, causality.

Unit-2 **State Space Approach of Control System Analysis:** Modern Vs conventional control theory, concept of state, state variable state vector, state space, state space equations, Writing state-space equations of mechanical, Electrical systems, Analogous systems.

Unit-3 State Space Representation using physical and phase variables, comparison form of system representation. Block diagram representation of state model. Signal flow graph representation. State space representation using canonical variables. Diagonal matrix. Jordan canonical form, Derivation of transfer functions from state-model.

Unit-4 **Solution of State Equations:** Diagonalization, Eigenvalues and eigen vectors. Matrix exponential, State transition matrix, Properties of state transition matrix. Computation of State transition matrix concepts of controllability & observability. Pole placement by state feedback, Ackerman's formula

Unit-5 **Digital Control Systems:** Introduction, sampled data control systems, signal reconstruction, difference equations. The z-transform, Z-Transfer Function. Block diagram analysis of sampled data systems, z and s domain relationship, digital PID controller

Reference/Suggested Books

1. I J Nagrath and M Gopal: Control Systems Engineering, 3rd Ed, New Age Publication.
2. Richard C Dorf, Robert H Bishop : Modern Control Systems, Prentice-Hall
3. M. GOPAL:Digital Control and State Variable Methods , TMH
4. B.C.Kuo, "Digital Control System",Saunders College Publishing.
5. C.H. Houpis and G.B.Lamont, "Digital Control Systems:MGH
6. Donald E. Kiv, "Optimal Control Theory: An Introduction" Prentice Hall
7. D.Roy Choudhary, "Modern Control Engineering", Prentice Hall of India
8. C T Chen, System Theory & Design, Oxford University Press

6EE2 HIGH VOLTAGE ENGINEERING

Unit-1 **(i) Breakdown in Gases:** Introduction to mechanism of breakdown in gases, Townsend's breakdown mechanism. Breakdown in electromagnetic gases, Application of gases in power system.

(ii) Breakdown in Liquids: Introduction to mechanism of breakdown in liquids, suspended solid particle mechanism and cavity breakdown. Application of oil in power apparatus.

(iii) Breakdown in solids: Introduction to mechanism of breakdown in solids, electromechanical breakdown, treeing & tracking breakdown and thermal breakdown.

Unit-2 **(i) High DC Voltage Generation:** Generation of high dc voltage, basic voltage multiplier circuit.

(ii) High AC Voltage Generation: Cascaded Transformers.

(iii) Impulse Voltage generation: Impulse voltage, basic impulse circuit, Mark's multistage impulse generator.

(iv) Measurement of High Voltage: Potential dividers - resistive, capacitive and mixed potential dividers. Sphere gap- Construction and operation. Klydonorgraph.

Unit-3 **Nondestructive Insulation Tests: (i)** Measurement of resistively, dielectric constant and loss factor. High Voltage Schering Bridge- measurement of capacitance and dielectric loss.

(ii) Partial Discharges: Introduction to partial discharge, partial discharge equivalent circuit. Basic wide-band and narrow band PD detection circuits.

Unit-4 **(i) Over voltages:** Causes of over voltages, introduction to lightning phenomena, over voltages due to lighting.

(ii) Travelling Waves: Travelling waves on transmission lines-open end line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at a T-junction and line terminated through a capacitance. Attenuation of traveling waves.

Unit-5 **(i) Over Voltage Protection:** Basic construction and operation of ground wires- protection angle and protective zone, ground rods, counterpoise, surge absorber, rod gap and arcing horn, lighting arresters - expulsion type, non -linear gap type and metal oxide gapless type.

(ii) Insulation Coordination: Volt - time curves, basic impulse insulation levels, coordination of insulation levels.

Reference/Suggested Books

1. Naidu:High Voltage Engineering 4/e, TMH
2. Kauffel-High Voltage engineering, ELSEVIER
3. Wadhwa: High Voltage Engg., Wiley Eastern Ltd
4. Kuffe E. & Abdulla M., High Voltage Engineering, Pergman Press
5. Alston L.L., H. V. Technology, Oxford, University Press
6. Thapar B., Power System Transients and High Voltage Principles , Capital Pub.
7. Subir Ray,' An Introduction to High Voltage Engineering' Prentice Hall of India

6EE3 PROTECTION OF POWER SYSTEM

Unit-1 **(i)** Causes and consequences of dangerous currents: Faults, overloads and switching over currents. Introduction to protection, trip circuit of a circuit breaker. Functional characteristics of a relay, zone of protection, primary and backup protection.

(ii) CTs & PTs: Current transformer construction, measurement and protective CTs. Type of potential transformers. Steady state ratio and phase angle errors in CTs and PTs. Transient errors in CT and CVT (Capacitive Voltage Transformer).

Unit-2 **Overcurrent Protection:** HRC fuse and thermal relay. Overcurrent (OC) relays – instantaneous, definite time, inverse time and inverse definite minimum time overcurrent relays, time and current gradings. Induction disc type relay. Directional overcurrent relay, 30°, 60° and 90° connections. Earth fault relay. Brief description of overcurrent protective schemes for a feeder, parallel feeders and ring mains.

Unit-3 **Generator Protection:** Stator protection – differential and percentage differential protection, protection against stator inter-turn faults, stator overheating protection. Rotor protection-protection against excitation and prime mover failure, field earth fault and unbalanced stator currents (negative sequence current protection).

Unit-4 **(i) Transformer Protection:** Percentage differential protection, magnetizing inrush current, percentage differential relay with harmonic restraint. Buchholz relay. Differential protection of generator transfer unit.

(ii) Busbar Protection: Differential protection of busbars. High impedance relay scheme, frame leakage protection.

Unit-5 **(i) Transmission Line Protection:** Introduction to distance protection. Construction, operating principle and characteristics of an electromagnetic impedance relay. Effect of arc resistance. Induction cup type reactance and mho relays. Comparison between impedance, reactance and mho relays. Three stepped distance protection of transmission line.

(ii) Induction Motor Protection: Introduction to various faults and abnormal operating conditions, unbalance supply voltage and single phasing. Introduction to protection of induction motors- HRC fuse and overcurrent, percentage differential, earth fault and negative sequence voltage relays.

Reference/Suggested Books

1. BADRI RAM:Power System Protection and Switchgear , TMH
2. Ravindra Nath M. Chander, Power System Protection and Switch Gear, John Wiley Eastern
3. Sunil S. Rao. Power System Protection and Switch Gear, Khanna Publishers 1989
4. Oza:Power System Protection and Switchgear , TMH
5. T.S. Madhava Rao, Power System Protections (Static Relays), Tata McGrwaw-hill, 1989.
6. A.R. van C Warrington, Protective Relays, Chapman and Hall London, 1968.
7. S.K. Basu and S. Chaudhary, Power System Protection, Raju Primlan Oxford, 1983.

6EE4 ADVANCED POWER ELECTRONICS

Unit-1 **AC Voltage Controllers:** Principle of On-Off Control, Principle of Phase control, Single Phase Bi-directional Controllers with Resistive Loads, Single Phase Controllers with Inductive Loads, Three Phase full wave AC controllers, AC Voltage Controller with PWM Control.

Unit-2 **Inverters:** Principle of Operation, Single-phase bridge inverters, Three phase bridge Inverters: 180 and 120 degree of conduction. Voltage control of Single Phase and Three Phase Inverters, Current Source Inverters, Harmonics and its reduction techniques.

Unit-3 **Cycloconverters:** Basic principle of operation, single phase to single phase, three-phase to three-phase and three-phase to single phase cycloconverters. Output equation, Control circuit.

Unit-4 **DC Power Supplies:** Switched Mode DC Power Supplies, flyback converter, forward converter, half and full bridge converter, resonant DC power supplies, bi-directional power supplies.

Unit-5 **AC Power Supplies:** Switched mode power supplies, Resonant AC power supplies, bi-directional AC power supplies. Multistage conversions, Control Circuits: Voltage Mode Control, Current Mode Control

Reference/Suggested Books

1. M.H. Rashid,"Power Electronics: Circuits, Devices & Applications", Prentice Hall of India Ltd. 3rd Edition,2004.
2. Bose -Power Electronics & Motor Drives ELSEVIER
3. V.R. Moorthy, "Power Electronics: Devices, Circuits and Industrial Applications" Oxford Press, 2007.
4. V Subrahmanyam: Power Electronics, New Age Inc. Publishers, New Delhi.
5. Chakrabarti & Rai, "Fundamentals of Power Electronics & Drives"Dhanpat Rai & Sons.
6. Ned Mohan, T.M.Undeland and W.P.Robbins, "Power Electronics:Converters, Applications and Design", Wiley India Ltd,2008.
7. R Krishnan, electric motor drives: modeling, analysis and control, Pearson Edu
8. Randal Shaffer, "Fundamentals of Power Electronics with MATLAB" Firewall Media, 2007.

6EE5 DATA STRUCTURES IN C

Unit-1 **Performance Measurement:** Space complexity and Time complexity, big oh, omega and theta notations and their significance. Linear Lists - Array and linked representation, singly & doubly linked lists. Concept of circular linked lists.

Unit-2 **Array & Matrices:** Row and Column Major mapping & representation, irregular 2D array, Matrix operations, Special matrices: diagonal, tri-diagonal, triangular and symmetric. Sparse matrices representation and its transpose.

Unit-3 **Stacks:** Representation in array & linked lists, basic operation, Applications of stacks in parenthesis matching, towers of Hanoi etc. Queues - Representation in array & linked lists, applications, circular queues.

Unit-4 **Trees:** Binary Tree, representation in array & linked lists, basic operation on binary trees, binary tree traversal (preorder, post order, in order). Search Trees - Binary search tree, indexed-binary search tree, basic operation, AVL tree, B-tree & Heap Tree.

Unit-5 **Graphs:** Representation of unweighted graphs, BFS, DFS, and Minimum cost spanning trees, Single source shortest path. Sorting - Bubble sort, insertion sort, merge sort, selection sort, quick sort, heap sort.

Reference/Suggested Books

1. Havowitz & Sawn: Data structures in Pascal (BPB Publication)
2. Havowitz & Sawhni: Data structures in C & C++ (BPB Publication)
3. Tannenbaum: Data structures in C (PHI)
4. PAI:Data Structures and Algorithms , TMH
5. TREMBLAY: Introduction to Data Structures with Applications , TMH

6EE6.1 ADVANCED MICROPROCESSORS

Unit-1 **8086 Microprocessor:** Hardware specifications, architecture, address spaces, clock generator, bus controller and arbiter, Minimum and maximum mode, System Bus Timing.

Unit-2 **Software & Instruction Set:** Assembly language programming: addressing mode and instructions of 8086, linking and execution of programs, MACRO programming, assembler directives and operators.

Unit-3 **I/O Interfaces:** Programmable peripheral interfacing **(**8255, 8155), Programmable Timer interfacing (8253, 8254), Programmable interrupt controller (8259) Serial Communication interfaces.

Unit-4 **Data & Memory Interfacing:** A/D, D/A converter interfacing, Memory interfacing and Decoding, DMA controller.

Unit-5 **Multiprocessor Configurations:** 8086 based Multiprocessor systems. 8087 Numeric data processor.

Reference/Suggested Books

1. John Freer - System design with Advance Microprocessors, A.H. Wheeler
2. Ray & Bhurchandi: Advanced Microprocessors and Peripherals 2/e (TMH)

3. Gibson - 16-Bit Microprocessor.
4. Brey – 16-Bit Microprocessor
5. Ray, A.K. & Burchandi, K.m., "Advanced Microprocessors and Peripherals: Architeacture, Programming and Interfacing" Tata Mc.Graw Hill.
6. Renu Sing & B.P.Singh, "Advanced Microprocessors and Microcontrollers" New Age Krishna Kant,"Microprocessors and Microcontrollers" PHI Learning.
7. Brey, Barry B. "The INTEL Microprocessors" Pearson Education.
8. Ayala, "The 8051 Micro Controller", Centage Learning.
9. Mazidi M.A., Maizidi J.G. Mckinlay R.D., "The 8051 Microcontroller and Embedded Systems" Pearson Education.

6EE6.2 POWER SYSTEM INSTRUMENTATION

Unit-1 **Theory of Errors:** Accuracy and precision, systematic and random errors, limits of error, probable error and standard deviation. Gaussian error curves, combination of errors.

Unit-2 **Transducers:** Construction & Operating Characteristics of active and digital transducers, Measurement of temperature, pressure, displacement, acceleration, noise level, Instrumentation for strain, displacement, velocity, acceleration, force, torque and temperature.

Unit-3 **Signal Conditioning:** Instrumentation amplifiers, isolation amplifiers, analog multipliers, analog dividers, function generators, timers, sample and hold, optical and magnetic isolators, frequency to voltage converters, temperature to current converters. Shielding and grounding.

Unit-4 **Power System Instrumentation-I:** Measurement of voltage, current, phase angle, frequency, active power and reactive power in power plants. Energy meters and multipart tariff meters.

Unit-5 **Power System Instrumentation-II:** Capacitive voltage transformers and their transient behavior, Current Transformers for measurement and protection, composite errors and transient response.

Reference/Suggested Books

1. R H Cerni and L E Foster: Instrumentation for Engineering Measurements, John Wiley and Sons,
2. Curtis and D Hohnson: Process Control Instrumentation Technology, John Wiley and sons.
3. R Morrison: Instrumentation Fundamentals and Applications, John Wiley and Sons
4. A.K.Sawhney, "Advanced Measurements & Instrumentation", Dhanpat Rai & Sons
5. E.O. Decblin, "Measurement System – Application & design", Mc Graw Hill.
6. W.D. Cooper and A.P. Beltried, "Electronics Instrumentation and Measurement Techniques" Prentice Hall International
7. A.S. Moris / Principles of Measurement & Instrumentation / Prentice Hall, 1993.

6EE6.3 DIGITAL COMMUNICATION AND INFORMATION THEORY

Unit-1 **PCM & DELTA Modulation Systems:** PCM and delta modulation, quantization noise in PCM and delta modulation. Signal-to-noise ratio in PCM and delta modulation, T1 Carrier System, Comparison of PCM and DM. Adaptive delta Modulation. Bit, word and frame synchronization, Matched filter detection.

Unit-2 **Digital Modulation Techniques:** Various techniques of phase shift, amplitude shift and frequency shift keying. Minimum shift keying. Modulation & Demodulation.

Unit-3 **Error Probability in Digital Modulation:** Calculation of error probabilities for PSK, ASK, FSK & MSK techniques.

Unit-4 **Information Theory:** Amount of Information, Average Information, Entropy, Information rate, Increase in Average information per bit by coding, Shannon's Theorem and Shannon's bound, Capacity of a Gaussian Channel, BW-S/N trade off, Orthogonal signal transmission.

Unit-5 **Coding:** Coding of Information, Hamming code, Single Parity-Bit Code, Linear Block code, cyclic code & convolutional code.

Reference/Suggested Books

1. H. Taub & D.L. Schilling-"Principles of Communication Systems", Tata Mc-Graw Hill.

2. Simon Haykin-"Communication Systems", John Wiley & Sons.
3. Proakis –"Digital Communication", Mc-Graw Hill.
4. Sklar – "Digital Communication", Pearson Education.
5. P. Chakrabarti – "Principles of Digital Communications", Danpatrai & Sons.
6. K. Sam Shanmugam – "Digital and Analog Communication System", John Wiley Sons.
7. Lathi, B.P. / "Modern Digital &Analog Communication System" /Oxford Press.
8. A.B. Carlson / "Digital Communication Systems", Tata McGraw-Hill.

6EE7 CONTROL SYSTEM LAB

1 Introduction to MATLAB Computing Control Software.

2 Defining Systems in TF, ZPK form.

3 (a) Plot step response of a given TF and system in state-space. Take different values of damping ratio and w_n natural undamped frequency. (b) Plot ramp response.

4 For a given 2^{nd} order system plot step response and obtain time response specification.

5 To design 1st order R-C circuits and observe its response with the following inputs and trace the curve. (a) Step (b) Ramp (c) Impulse

6 To design 2nd order electrical network and study its transient response for step input and following cases. (a) Under damped system (b) Over damped System. (c) Critically damped system.

7 To Study the frequency response of following compensating Networks, plot the graph and final out corner frequencies. (a) Log Network (b) Lead Network (c) Log-lead Network.

8 To draw characteristics of ac servomotor

9 To perform experiment on Potentiometer error detector.

10 Check for the stability of a given closed loop system.

11 Plot bode plot for a 2^{nd} order system and find GM and PM.

6EE8 POWER SYSTEM LAB

1 Study the burden effect on the performance of CT and measure ratio error.

2 Find out the sequence components of currents in three 1-Phase transformers and 3-Phase transformer and compare their results.

3 (i) Study over current relay.
(ii) Draw the current-time characteristic of an over current relay for TMS=1 & 0.5 and PSM=1.25 & 1.0.

4 (i) Study percentage bias differential relay.
(ii) Plot the characteristics of a percentage bias differential relay for 20%, 30% and 40% biasing.

5 Study gas actuated Buchholz relay.

6 Study under frequency relay and check it's setting experimentally.

7 Design a HV transmission line.

8 Study a typical grid substation.

9 Study earthing of power station, substation and building

6EE9 DATA STRUCTURES LAB

1 Simple array and sorting algorithm implementations.

2 Addition, multiplication and transpose of sparse matrices represented in array form.

3 Polynomial addition, multiplication (8^{th} degree polynomials), using array & linked lists.

4 Implementation of stack and queue using array & linked lists.

5 Implementation of circular queue using array.

6 Infix to postfix/prefix conversion.

7 Binary search tree creation and traversing.

8 Generation of spanning trees for a given graph using BFS & DFS algorithms.

9 AVL tree implementation (creation, insertion, deletion).

10 Symbol table organization (Hash Table).

11 Simple array and sorting algorithm implementations.

12 Basic operation over linked list (add node, delete node).

6EE10 ADVANCED POWER ELECTRONICS LAB

1 Study and test AC voltage regulators using triac, antiparallel thyristors and triac & diac.

2 Study and test single phase PWM inverter.

3 Study and test buck, boost and buck- boost regulators.

4 Study and test MOSFET chopper.

5 Study and test Zero voltage switching.

6 Study and test SCR DC circuit breaker.

7 Control speed of a dc motor using a chopper and plot armature voltage versus speed characteristic.

8 Control speed of a single-phase induction motor using single phase AC voltage regulator.

9 (i) Study single-phase dual converter. (ii) Study speed control of dc motor using single-phase dual converter.

10 Study one, two and four quadrant choppers (DC-DC converters).

11 Study speed control of dc motor using one, two and four quadrant choppers.

12 Study single-phase cycloconverter.

B. TECH. VII- SEMESTER

7EE1 DATA BASE MANGEMENT SYSTEM

Unit-1 Introduction, need, purpose and goals of DBMS. DBMS Architecture, Concept of keys, Generalization and specialization, introduction to relational data model, ER modeling, concept of ER diagram.

Unit-2 **Database Design:** Conceptual Data Base design. Theory of normalization, Primitive and composite data types, concept of physical and logical databases, data abstraction and data independence, relational algebra and relational calculus.

Unit-3 SQL, DDL and DML. Constraints assertions, views database security. Application Development using SQL: Host Language interface, embedded SQL programming. GL's, Forms management and report writers. Stored procedures and triggers. Dynamic SQL, JDBC.

Unit-4 **Internal of RDBMS:** Physical data organization in sequential, indexed, random and hashed files. Inverted and multilist structures.

Unit-5 **(i) Transaction Management:** Transaction concept, transaction state, serializability, conflict serializabiltiy, view serializability. **(ii) Concurrency Control:** Lock based protocol. **(iii) Deadlock Handling:** Prevention detection, recovery. **(iv) Recovery System:** Log based recovery.

Reference/Suggested Books

1. Silverschatz Korth and Sudarshan – Database System Concepts, 5th ed., Tata Mc-Graw Hill.
2. Raghu Rama Krishnan – Database Management Systems, 2nd ed., Tata Mc-Graw Hill.
3. Elmasari – Fundamentals of Data Base Systems, Pearson Education.
4. Gordon C. Everest – Database Management Objectives, System Functions and

Administration, TMH.
5. Date C.J., "An Introduction To Database System",Addition Wesley
6. Alex Berson & Stephen J.Smith,"Data Warehousing,Data Mining & OLAP",TMH.
7. Mallach, "Data Warehousing System", Mc. Graw Hill
8. Majumdar & Bhattacharya, "Database Management System", Tata Mc Graw Hill

7EE2 POWER SYSTEM ANALYSIS

Unit-1 (i) Percent and per unit quantities. Single line diagram for a balanced 3-phase system. **(ii) Admittance Model:** Branch and node admittances Equivalent admittance network and calculation of $Y_{bus.}$ Modification of an existing $Y_{bus.}$

Unit-2 **(i) Impendence Model:** Bus admittance and impedance matrices. Thevenin's theorem and Z_b Direct determination of $Z_{bus.}$ Modification of an existing bus. **(ii) Symmetrical fault Analysi** Transient on a Transmission line, short circuit of a synchronous machine on no load, short circu of a loaded synchronous machine. Equivalent circuits of synchronous machine under sub transier transient and steady state conditions. Selection of circuit breakers, Algorithm for short circu studies. Analysis of three-phase faults.

Unit-3 **(i) Symmetrical Components:** Fortescure theorem, symmetrical component transformation. Phase shift in star-delta transformers. Sequence Impedances of transmission lines, Synchronous Machine and Transformers, zero sequence network of transformers and transmission lines. Construction of sequence networks of power system. **(ii) Fault Analysis:** Analysis of single line to ground faults using symmetrical components, connection of sequence networks under the fault condition.

Unit-4 **Unsymmetrical Fault Analysis:** (i) Analysis of line-to-line and double line to ground faults using symmetrical components, connection of sequence networks under fault conditions.
(ii) Analysis of unsymmetrical shunt faults using bus impedance matrix method.

Unit-5 **Load Flow Analysis:** Load flow problem, development of load flow equations, bus classification. Gauss Seidel, Newton Raphosn, decoupled and fast decoupled methods for load flow analysis. Comparison of load flow methods.

Reference/Suggested Books

1. J. J. Grainger, William, D. Stevenson Jr. – Power System Analysis. McGraw-Hill
2. Nagrath and Kothari – Power System Engineering 2/e Tata Mc Graw Hill
3. Haadi SAADAT- Power System Analysis (With Disk) ,TMH
4. T.K Nagsarkar & M.S. Sukhija, "Power System Analysis" Oxford University Press,2007.
5. W.D. Stevenson, Jr. "Elements of Power System Analysis", Mc Graw Hill.
6. J.D. Glover, M.S. Sharma & T.J.Overbye, "Power System Analysis and Design" Thomson, 2008.
7. Kothari & Nagrath, "Modern Power System Analysis" Tata Mc. Graw Hill.

7EE3 ARTIFICIAL INTELLIGENCE TECHNIQUES

Unit-1 **Artificial Intelligence:** Introduction to AI and knowledge based Expert systems: Introduction, Importance and Definition of AI, ES, ES building tools and shells.

Unit-2 **Knowledge Representation:** Concept of knowledge, Representation of knowledge using logics rules, frames. Procedural versus. Declarative knowledge, forward versus backward chaining. Control Strategies: -Concept of heuristic search, search techniques depth first search, Breath first search, Generate & test hill climbing, best first search.

Unit-3 **Artificial Neural Network:** Biological Neurons and synapses, characteristics Artificial Neural Networks, types of activation functions. **Perceptions:** Perception representation, limitations of perceptrons. Single layer and multiplayer perceptrons. Perceptron learning algorithms.

Unit-4 **Basic Concepts in Learning ANN:** Supervised learning, Back propagation algorithm, unsupervised learning, Kohonen's top field network & Algorithm.

Unit-5 **Fuzzy Logic:** Fuzzy logic concepts, Fuzzy relation and membership functions, Defuzzufication, Fuzzy controllers Genetic algorithm: concepts, coding, reproduction, crossover, mutation,

scaling and fitness.

Reference/Suggested Books

1. Elaine Rich and Kevin Knight, Artificial Intelligence 3/e, TMH
2. PADHY: ARTIFICIAL INTELLIGENCE & INTELLIGENT SYSTEMS, Oxford
3. James A Anderson, An introduction to Neural Networks.
4. Dan. W Patterson, Artificial Intelligence and Expert Systems.
5. Kumar Satish, "Neural Networks" Tata Mc Graw Hill
6. S. Rajsekaran & G.A. Vijayalakshmi Pai, "Neural Networks,Fuzzy Logic and Genetic Algorithm:Synthesis and Applications" Prentice Hall of India.
7. Siman Haykin,"Neural Netowrks"Prentice Hall of India

7EE4 UTILIZATION OF ELECTRICAL POWER

Unit-1 **(i)Electric Heating:** Different methods of electric heating. Principle of high frequency induction and di-electric heating. Construction, operation, performance and applications of arc furnace and induction furnace. **(ii) Electric Welding:** Welding process, welding transformer, Classification of Electric Welding: arc welding, resistance welding, welding of various metals.

Unit-2 **Illuminations:** Definitions, laws of illuminations, polar curves, luminous efficiency, photometer, incandescent lamps: filament materials, halogen lamp. electric discharge lamps: sodium vapour lamp mercury vapour lamp and fluorescent lamp. **Light Calculations:** commercial, industrial, street and flood lighting.

Unit-3 **Electrolytic Process:** Principles and applications of electrolysis, electro-deposition, manufactures of chemicals, anodizing, electro polishing electro-cleaning, electroextraction, electrorefinig, electro-stripping (parting) power supplies for electrolytic process.

Unit-4 **Electric Traction & Means of Supplying Power:** Systems of Electric Traction: DC & AC Systems, Power Supply for Electric Traction System: Comparison and application of different systems. Sub-station equipment and layout, conductor rail & pantograph.

Unit-5 **Traction Methods:** Types of services, speed time and speed distance curves, estimation of power and energy requirements, Mechanics of train movement. Co-efficient of adhesion, Adhesive weight, effective weight. **Traction Motor Controls:** DC and AC traction motors, Series parallel starting. Methods of electric braking of traction motors.

Reference/Suggested Books

1. H. Partab,"Art and Science of Electrical Energy" Dhanpat Rai & Sons
2. H. Partab, "Modern Electric Traction" Dhanpat Rai & Sons.
3. C.L. Wadhwa – Utilization of Electric Traction Electric Power.
4. G.K.Dubey,"Fundamentals of Electric Drives" Narosa Publishing House
5. Vedam and Subrahmanyam – Concept & Application of Electric Drives (TMH)

7EE5 POWER SYSTEM ENGINEERING

Unit-1 **Economic Operation of Power Systems:** Introduction, system constraints, optimal operation of power systems. Input output, heat rate and incremental rate curves of thermal generating units. Economic distribution of load between generating units within a plant. Economic distribution of load between power stations, transmission loss equation. Introduction to unit commitment and dynamic programming.

Unit-2 **Power System Stability -I:** Power angle equations and power angle curves under steady state and transient conditions. Rotor dynamics and swing equation (solution of swing equation not included), synchronizing power coefficient. Introduction to steady state and dynamic stabilities, steady state stability limit.

Unit-3 **Power System Stability-II:** Introduction to transient stability. Equal area criterion and its application to transient stability studies under basic disturbances, critical clearing angle and critical clearing time. Factors affecting stability and methods to improve stability.

Unit-4 **(i) Excitation Systems:** Introduction of excitation systems of synchronous machines, types of excitation systems, Elements of various excitation systems and their control (functional block

diagrams and their brief description)-DC excitation systems, AC excitation systems, brushless excitation system. **(ii) Interconnected Power Systems:** Introduction to isolated and interconnected powers systems. Reserve capacity of power stations, spinning and maintenance resaves. Advantages and problems of interconnected power systems. Power systems inter connection in India.

Unit-5 (i) Tap Changing transformer, phase angle control and phase shifting transformer. Series compensation of transmission lines, location and protection of series capacitors, advantages and problems. (ii) Introduction to power system security. (iii) Introduction to voltage stability.

Reference/Suggested Books

1. J. Nagrath and D.P. Kothari: Power System Engineering 2/e (TMH)
2. J. J. Grainger and W. D. Stevenson: Power System Analysis (TMH)
3. B. R. Gupta, "Power System Analysis and Design" Third Edition, S. Chand & Co.
4. C. L. Wadhwa, "Electrical Power Systems" New age international Ltd. Third Edition
5. W. D. Stevenson, "Element of Power System Analysis", McGraw Hill.
6. B.R. Gupta,"Generation of Electrical Energy", S. Chand Publication.

7EE6.1 ELECTROMAGNETIC FIELD THEORY

Unit-1 **Introduction:** Vector Relation in rectangular, cylindrical, spherical and general curvilinear coordinate system. Concept and physical interpretation of gradient, Divergence and curl, Green's Stoke's and Helmholz theorems.

Unit-2 **Electrostatics:** Electric field vectors-electric field intensity, flux density & polarization. Electric field due to various charge configurations. The potential functions and displacement vector. Gauss's law. Poisson's and Laplace's equation and their solution. Uniqueness theorem. Continuity equation. Capacitance and electrostatics energy. Field determination by method of images. Boundary conditions. Field mappings and concept of field cells.

Unit-3 **Magnetostatics:** Magnetic field vector: Magnetic field intensity, flux density & magnetization, Bio-Savart's law, Ampere's law, Magnetic scalar and vector potential, self & mutual inductance, Energy stored in magnetic field, Boundary conditions, Analogy between electric and magnetic field, Field mapping and concept of field cells.

Unit-4 **Time Varying Fields:** Faraday's law, Displacement currents and equation of continuity. Maxwell's equations, Uniform plane wave in free space, dielectrics and conductors, skin effect sinusoidal time variations, reflections, refraction & polarization of UPW, standing wave ratio. Pointing vector and power considerations.

Unit-5 **Transmission Lines:** The high-frequency circuit. LCR ladder model. The transmission line equation. Solution for loss-less lines. Wave velocity and wave impedance. Reflection and Transmission coefficients at junctions. VSWR.

Reference/Suggested Books

1. HAYT-Engineering Electromagnetics 7/e, (With CD), TMH
2. SADIKU:PRINCIPLES OF ELECTROMAGNETICS 4E (Intl. Version) Oxford
3. David K Cheng – Field and Wave Electromagnetic. 2nd Ed., Wesley Publishing Company.
4. Griffith – Introduction to Electrodynamics. 2nd Ed., Prentice Hall of India.
5. J D Kraus, Electromagnetic. 5th edition, (TMH).
6. V.V. Sarwate – Electromagnetic Field and Waves, Willey Eastern Ltd.
7. Bhag Guru, Electromagnetic Field Theory Fundamentals, Cambridge Uni. Press.
8. Kraus, F. "Electromagnetic" Tata Mc. Graw Hill 5th Edition

7EE6.2 COMPUTER AIDED DESIGN OF ELECTRICAL MACHINES

Unit-1 **Basic Principles of Electrical Machine Design:** Specifications, Factors affecting the design, Limitations, main dimension, loadings, output equation, factor affecting the size and rating, Electrical Engineering Materials: conducting, magnetic and insulating materials. **Magnetic Circuit Calculation:** Ohm's law for magnetic circuit, mmf required for air gap and iron parts, tapered teeth, real and apparent flux density, magnetizing current.

Unit-2 **Heating and Cooling of Electrical Machines:** heat dissipation and heat flow equations, Newton's law of cooling, equations for temperature rise, **Rating of Machines**: Continuous, short and intermittent ratings, mean temperature rise, hydrogen cooling of turbo alternators, quantity of cooling medium.

Unit-3 **Computer Aided Design of Transformers:** Power and Distribution Transformers, core and yoke cross sections, square and stepped core, output equations, main dimensions, types &, design of windings, optimization concepts.

Unit-4 **Computer Aided Design of Synchronous Machines:** Turbo and Hydro alternators, choice of specific magnetic & electric loading, short circuit ratio and its effects, air gap length, output equation, main dimensions, flow charts for design of synchronous machine, design of stator core & winding.

Unit-5 **Computer Aided Design of Induction Machines:** Output equation, main dimensions, design criteria, flow charts for design of induction motor, air gap length, design of stator core and winding, rotor design.

Reference/Suggested Books

1. A. K. Sawhney, "A Course in Electrical Machine Design" Dhanpat Rai & Sons.
2. Generalized theory of electrical Machines by B. Edikins.
3. Electrical Machinery by Fitzegerald; Kingsley.
4. M.G. Say, "The Performance and Design of AC Machines" Pitman & Sons.
5. R.K. Agrawal – Electrical Machine Design

7EE6.3 ECONOMIC OPERATION OF POWER SYSTEMS

Unit-1 **Economics of Power Generation:** Introduction, cost of electrical energy, expression for cost of electrical energy, depreciation, power plant cost analysis, economics in plant selection, selection of types of generation and types of equipments, factors effecting economic generations and distributions, generating cost, economics of different types of generating plants.

Unit-2 **Economical Operations of thermal power plants:** Methods of loading turbo generators, input, output and heat rate characteristics, incremental cost, two generations units, large no of units, sequence of adding units, effects of transmission losses, economic scheduling considering transmission losses, coordination equations, penalty factors

Unit-3 **Hydro Thermal coordination:** Advantages of combined operation, base load peak load operation requirement, combined working of run-off river and steam plant, reservoirs hydro-plants and thermal plants (long term operational aspects), short term hydro thermal coordination, coordination equations, scheduling methods and applications.

Unit-4 **Parallel Operations of Generators:** Conditions, synchronizing current and power, two alternators in parallel (effect of change in excitation, load sharing, sharing of load currents), Infinite bus bars, active and reactive power control, synchronizing power, torque, operating limits of alternators, operating characteristics of cylindrical alternator rotor.

Unit-5 **Economics for Electrical Engineers:** Concepts of physical and financial efficiencies of electrical goods and services, supply and demand, break even and minimum cost analysis, linear and nonlinear break even, min cist analysis

Reference/Suggested Books

1. Nagrath and Kothari: Modern Power System Analysis (TMH)
2. D.P. Kothari & I.J. Nagrath, "Modern Power System Analysis" Tata Mc Graw Hill,
3. J. Wood & B.F. Wollenburg, " Power Generation, Operation and Control " John Wiley
4. O.I. Elgerd, "Electric Energy System Theory" Tata McGraw Hill.
5. P. Kundur, "Power System Stability and Control Mc Graw Hill.

6. Arthur R. Bergen and Vijay Vittal, Power System Analysis, Second Edition. PHI, 1999
7. C.L. Wadhwa, 'Electrical Power Systems', Newage International (P) Ltd., 2000
8. C. Gross, Power Systems Analysis, 2nd Edition. John Wiley & Sons, 1986.

7EE7 DBMS LAB

1 Designing database and constraints using DDL statements.

2 Experiments for practicing SQL query execution on designed database.

3 Database connectivity using JDBC/ODBC.

4 Features of embedded SQL.

5 Designing front end in HLL and accessing data from backend database.

6 Designing simple projects using front end-back end programming.

7 Project for generating Electricity Bills

8 Project for managing student's attendance/marks details.

7EE8 POWER SYSTEM MODELLING & SIMULATION LAB

1 Simulate Swing Equation in Simulink (MATLAB)

2 Modelling of Synchronous Machine.

3 Modelling of Induction Machine.

4 Simulate simple circuits using Circuit Maker.

5 (a) Modelling of Synchronous Machine with PSS (b) Simulation of Synchronous Machine with FACTS device.

6 (a) Modelling of Synchronous Machine with FACTS device (b) Simulation of Synchronous Machine with FACTS devices.

7 FACTS Controller designs with FACT devices for SMIB system.

7EE9 INDUSTRIAL ECONOMICS & MANAGEMENT

1 **Money Banking and Trade:** Functions of money, supply & demand for money, money price level & inflation, black money, meaning, magnitude & consequences. Functions of Commercial banks, banking system in India, shortcomings and improvements.. Function of RBI, monetary policy-making, objectives and features. Sources of public revenue, principles of taxation, direct and indirect taxes, Theory of international trade, balance of trade and payment, Foreign exchange control, devaluation New economic policy: Liberalization, extending privatization, globalization.

2 **Management Principles:** Management functions, responsibilities of management to society, development of management thought. Nature of planning, decision making, management by objectives, Line and staff authority relationships, decentralization and delegation of authority, span of management.

3 **Production Management:** Production planning and control, inventory control, quality control and Total quality management. Tools of project management - CPM, PERT, project information systems. Marketing functions, management of sales and advertising marketing research.

4 **Human Resource Management:** Function, application of industrial psychology for selection, training and recruitment. Communication process, media channels and barriers to effective communication, theories of motivation, leadership.

5 **Finance and Account Management: Engineering Economics:** Investment decision, present worth, annual worth and rate of return methods. Payback time. Need for good cost accounting system, cost control techniques of financial control, financial statements, financial ratios, break-even analysis, budgeting and budgetary control.

B. TECH. VIII- SEMESTER

8EE1 EHV AC/DC TRANSMISSION

Unit-1 **EHV AC Transmission:** Need of EHV transmission lines, power handling capacity and surge impedance loading. Problems of EHV transmission, bundled conductors: geometric mean radius of bundle, properties of bundle conductors. Electrostatic fields of EHV lines and their effects, corona effects: Corona loss, audio and radio noise.

Unit-2 **Load Frequency Control:** Introduction to control of active and reactive power flow, turbine speed governing system. Speed governing characteristic of generating unit and load sharing between parallel operating generators. **Method of Load Frequency Control:** Flat frequency, flat tie line and tie line load bias control. Automatic generation control (description of block diagram only).

Unit-3 **Voltage Control:** No load receiving end voltage and reactive power generation. Methods of voltage control. Synchronous phase modifier, shunt capacitors and reactors, saturable reactors, Thynstorised static VAR compensators- TCR, FC-TCR and TSC- TCR.

Unit-4 **FACTS:** Introduction to FACTS controllers, types of FACTS controllers, Brief description of STATCOM, Thyristor controlled series capacitors and unified power flow controller.

Unit-5 **HVDC Transmission:** Types of D.C. links, advantages and disadvantages of HVDC transmission. Basic scheme and equipment of converter station. Ground return. Basic principles of DC link control and basic converter control characteristics. Application of HVDC transmission.

Reference/Suggested Books

1. K.R. Padiyar – HVDC Power Transmission Systems. NEW AGE PUB
2. HVDC Power Transmission System, K.R, Padiyar, Wiley Eastern Ltd., 1990
3. E.W. Kimbark, Direct Current Transmission Vol: 1 Wiley Interscience, 1971.
4. J. Arrillaga, H.V.D.C Transmission, Peter Peregrines, 1983.
5. J. Arrillaga HVDC et. al, Computer Modelling of Electrical Power System. John Wiley 1993.
6. R.D. Begamudre, E.H.V. A.C. Transmission, Wiley Eastern Ltd., 2nd edition.
7. S. Rao, EHV-AC and H.V.D.C. Transmission Engineering Practice, Khanna publishers, 1990.
8. R. D. Begamudre, "Extra High Voltage AC Transmission Engineering" Wiley Eastern.

8EE2 ELECTRIC DRIVES AND THEIR CONTROL

Unit-1 **Dynamics of Electric Drives:** Fundamental torque equations, speed-torque conventions and multiquardant operation, equivalent values of drive parameters, nature and classification of load torques, steady state stability, load equalization, close loop configurations of drives.

Unit-2 **DC Drives:** Speed torque curves, torque and power limitation in armature voltage and field control, Starting, **Braking-**Regenerative Braking, dynamic braking and plugging. **Speed Control-**Controlled Rectifier fed DC drives, Chopper Controlled DC drives.

Unit-3 **Induction Motor Drives-I:** Starting, **Braking-**Regenerative braking, plugging and dynamic braking. **Speed Control-**Stator voltage control, variable frequency control from voltage source, Voltage Source Inverter (VSI) Control.

Unit-4 **Induction Motor Drives-II:** Variable frequency control from current source, Current Source Inverter (CSI) Control, Cycloconverter Control, Static rotor resistance control, Slip Power Recovery- Stator Scherbius drive, Static Kramer drive.

Unit-5 **Synchronous Motor Drive**: Control of Synchronous Motor-Separately Controlled and VSI fed Self-Controlled Synchronous Motor Drives. Dynamic and Regenerative Braking of Synchronous Motor with VSI. Control of Synchronous Motor Using Current Source Inverter (CSI)

Reference/Suggested Books

1. G K Dubey: Fundamentals of Electrical Drives, Narosa Publishing House, New Delhi.
2. V Subrahmanyam: Thyristor Control of Electric Drives, Tata McGraw Hill, New Delhi.
3. V Subrahmanyam: Electric Drives- Concepts and Applications, Tata McGraw Hill.
4. S K Pillai: A First Course on Electrical Drives, Wiley Eastern limited, India.

5. G K Dubey: Power Semiconductor Controlled Drives, Prentice Hall, Englewood Cliffs.
6. B K Bose: Power Electronics and A. C. Drives, Prentice Hall.
7. G.K. Dubey, "Fundamentals of Electric Drives", Narosa publishing House.
8. M.Chilkin, "Electric Drives",Mir Publishers, Moscow.
9. N.K. De and Prashant K.Sen, "Electric Drives", Prentice Hall of India Ltd.

8EE3 SWITCHGEAR & PROTECTION

Unit-1 **(i) Static Relays:** Introduction to static relays, merits and demerits. **Comparators:** amplitude and phase comparators, duality between amplitude and phase comparators. Introduction to (a) amplitude comparators-circulating current type, phase splitting type and sampling type, (b) phase comparators-vector product type and coincidence type.

(ii) Static over Current Relays: Introduction to instantaneous, definite time, inverse time and directional overcurrent relays.

Unit-2 **(i) Static Differential Relays:** Brief description of static differential relay schemes-single phase and three phase schemes. Introduction to static differential protection of generator and transformer.

(ii) Static Distance Relays: Introduction to static impedance, reactance and mho relays.

Unit-3 **(i) Carrier Current Protection:** Basic apparatus and scheme of power line carrier system. Principle of operation of directional comparison and phase comparison carrier protection and carrier assisted distance protection.

(ii) Distance Protection: Effect of power swings on the performance of distance protection. Out of step tripping and blocking relays, mho relay with blinders. Introduction to quadrilateral and elliptical relays.

Unit-4 **Circuit Breakers I:** Electric arc and its characteristics, arc interruption-high resistance interruption and current zero interruption. Arc interruption theories–recovery rate theory and energy balance theory. Restriking voltage and recovery voltage, develop expressions for restriking voltage and RRRV. Resistance switching, current chopping and interruption of capacitive current. Oil circuit breakers-bulk oil and minimum oil circuit breakers. Air circuit breakers.

Unit-5 **(i) Circuit Breakers II:** Air blast, SF_6 and vacuum circuit breakers. Selection of circuit breakers, rating of circuit breakers.

(ii) Digital Protection: Introduction to digital protection. Brief description of block diagram of digital relay. Introduction to digital overcurrent, transformer differential and transmission line distance protection.

Reference/Suggested Books

1. S. S. Rao, "Switchgear and Protection", Khanna Publishers.
2. B. Ravindranath and M. Chander, Power system Protection and Switchgear, Wiley.
3. B. Ram and D. N. Vishwakarma, "Power System Protection and Switchgear", TMH.
4. Y. G. Paithankar and S R Bhide, "Fundamentals of Power System Protection", PHI.
5. T.S.M Rao,"Power System Protection: Static Relays with Microprocessor Applications" Tata Macgraw Hill".
6. A.R. Van C. Warringtaon, "Protective Relays- Their Theory and Practice, Vol. I & II" Jhon Willey & Sons.

8EE4.1 NON-CONVENTIONAL ENERGY SOURCES

Unit-1 (i) Introduction: World energy situation, conventional and non-conventional energy sources, Indian energy scene.

(ii) Tidal Energy: Introduction to tidal power. Components of tidal power plants, double basin arrangement. Power generation. Advantages and limitations of tidal power generation. Prospects of tidal energy in India.

Unit-2 **Solar Energy:** Solar radiation, solar radiation geometry, solar radiation on tilted surface. Solar energy collector. Flat- plate collector, concentrating collector – parabolidal and heliostat. Solar

pond. Basic solar power plant. Solar cell, solar cell array, basic photo-voltaic power generating system.

Unit-3 **(i) Wind Energy:** Basic principle of wind energy conversion, efficiency of conversion, site selection. Electric power generation-basic components, horizontal axis and vertical axis wind turbines, towers, generators, control and monitoring components. Basic electric generation schemes- constant speed constant frequency, variable speed constant frequency and variable speed variable frequency schemes. Applications of wind energy.

(ii) Geothermal Energy: Geothermal fields, estimates of geothermal power. Basic geothermal steam power plant, binary fluid geothermal power plant and geothermal preheat hybrid power plant. Advantages and disadvantages of geothermal energy. Applications of geothermal energy. Geothermal energy in India.

Unit-4 **Nuclear Fusion Energy:** Introduction, nuclear fission and nuclear fusion. Requirements for nuclear fusion. Plasma confinement - magnetic confinement and inertial confinement. Basic Tokamak reactor, laser fusion reactor. Advantages of nuclear fusion. Fusion hybrid and cold fusion.

Unit-5 **Biomass Energy:** Introduction, biomass categories, bio-fuels. Introduction to biomass conversion technologies. Biogas generation, basic biogas plants-fixed dome type, floating gasholder type, Deen Bandhu biogas plant, Pragati design biogas plant. Utilization of bio gas. Energy plantation. Pyrolysis scheme. Alternative liquid fuels –ethanol and methanol. Ethanol production.

Reference/Suggested Books

1. Dr. A.N. Mathur – Non-Conventional Resources of Energy.
2. Boyle: Renewable Energy, 2E Oxford
3. S.P. Sukhatme – Solar Energy (TMH)
4. Duffie & Beckman – Solar Engineering of Thermal Processes.
5. BH KHAN: Non-Conventional Energy Resources, (TMH)
6. GARG & PRAKASH : Solar Energy : Fundamentals and Applications, TMH
7. Bio Energy by David Boyles, Elis Horwood Ltd.,
8. Renewable energy sources and conversion technology by N.K. Bansal, M. Kleemann, M. Heliss, Tata Mc-Graw-Hill, 1990.

8EE4.2 FACTS DEVICES & THEIR APPLICATIONS

Unit-1 Problems of AC transmission systems, power flow in parallel paths and meshed system, factors limiting loading capability, stability consideration. Power flow control of an ac transmission line. Basic types of facts controllers. Advantages of FACTS technology.

Unit-2 **(i) Voltage-Sourced Converters:** Basic concept of voltage-sourced converters, single and three phase bridge converters. Introduction to power factor control. Transformer connections for 12-pulse, 24 pulse and 48 pulse operations.

(ii) Static Shunt Compensators: Mid point and end point voltage regulation of transmission line, and stability improvement. Basic operating principle of Static Synchronous Compensators (STATCOM). Comparison between STATCOM and SVC.

Unit-3 **Static Series Compensators:** Concept of series capacitive compensation, voltage and transient stabilities, power oscillation and subsynehronous oscillation damping. Introduction to thyristor-switched series capacitor (TSSC), thyristor controlled series capacitor (TCSC), and static synchronous series compensator, - operation, characteristics and applications.

Unit-4 **(i) Static Voltage and Phase Angle Regulators:** Voltage and phase angle regulation. Power flow control and improvement of stability by phase angle regulator. Introduction to thyristor controlled voltage and phase angle regulators (TCVR and TCPAR)

(ii) Introduction to thyristor controlled braking resistor and thyristor controlled voltage limiter.

Unit-5 **(i) UPFC:** Unified Power Flow Controller (UPFC), basic operating principles, conventional transmission control capabilities. Comparison of UPFC to series compensators and phase angle regulator. Applications of UPFC.

(ii) IPFC: Interline Power Flow Controller (IPFC), basic operating principles and characteristics. Applications of IPFC.

Reference/Suggested Books

1. K.R. Padiyar – Flexible AC Transmission Systems
2. N.G. Hingorani, L. Gyugyi: Understanding FACTS: IEEE Press Book.
3. Yong Hua Song, Allan T Johns : Flexible AC Transmission Systems FACTS
4. Xiao Ping Zhang, Christian Rehtanz, Bikash Pal: Flexible AC Transmission Systems.
5. R Mohan & R M Mathur, Thyristor-based FACTS Controllers for Electrical Transmission Systems,, John Wiley

8EE4.3 POWER SYSTEM TRANSIENTS

Unit-1 Wave terminology, Development of wave quotations, Terminal problems, Lattice diagrams, Origin and Nature of power system transients and surges, Surge parameters of plants, Equivalent Circuit representations. Lumped and distributed circuit transients.

Unit-2 Line energisation and de-energisation transients-Earth and earthwire effects. Current chopping in circuit breakers. Short line fault condition and its relation to circuit breaker duty. Trapped charge effects. Effect of source and source representation in short line fault studies.

Unit-3 Control of transients, Lightening phenomenon, influence of tower footing resistance and earth resistance, Traveling waves in distributed parameters multiconductor lines, parameters as a function of frequency.

Unit-4 Mechanism of Lightning Discharge Types of Lightning strokes, Harmful effects of lighting, protections against lightning, overhead Ground wires.

Unit-5 Lightening Arresters, Types of lightening arresters, Surge Absorber simulation of surge diverters in trarient analysis. Fourier integral and z transform methods in power system trarient.

Reference/Suggested Books

1. Power System Transients: C S Indulkar and D P Kothari., NEW AGE
2. Lou Van der Sluis: Transients in Power Systems, John Wiley
3. NR Watson, J Arrillaga: Power Systems Electromagnetic Transients, John Wiley

8EE5 COMPUTER BASED POWER SYSTEM LAB

1. Fault analysis (for 3 to 6 bus) and verify the results using MATLAB or any available software for the cases: (i) LG Fault (ii) LLG Fault (iii) LL Fault and (iv) 3-Phase Fault
2. Load flow analysis for a given system (for 3 to 6 bus) using (i) Gauss Seidal (ii) Newton Raphson (iii) Fast Decoupled Method and verify results using MATLAB or any available software
3. Study of voltage security analysis
4. Study of overload security analysis and obtain results for the given problem using MATLAB or any software.
5. Study of economic load dispatch problem with different methods.
6. Study of transient stability analysis using MATLAB/ETAP Software.

8EE6 ELECTRICAL DRIVES AND CONTROL LAB

1. Study and test the firing circuit of three phase half controlled bridge converter.
2. Study and obtain waveforms of 3 phase half controlled bridge converter with R and RL loads.
3. Study and test the firing circuit of 3-phase full controlled bridge converter.
4. Study and obtain waveforms of 3-phase full controlled bridge converter with R and RL loads.
5. Study and test 3-phase AC voltage regulator.
6. Control speed of dc motor using 3-phase half controlled bridge converter. Plot armature voltage versus speed characteristic.
7. Control speed of dc motor using 3-phase full controlled bridge converter. Plot armature voltage

versus speed characteristic.

8 Control speed of a 3-phase induction motor in variable stator voltage mode using 3-phase AC voltage regulator.

9 Control speed of universal motor using AC voltage regulator.

10 Study 3-phase dual converter.

11 Study speed control of dc motor using 3-phase dual converter.

12 Study three-phase cycloconverter and speed control of synchronous motor using cycloconverter.

13 Control of 3-Phase Induction Motor in variable frequency V/f constant mode using 3-phase inverter.

8EE7 HIGH VOLTAGE ENGINEERING LAB

1 Study filtration and Treatment of transformer oil.

2 Determine dielectric strength of transformer oil.

3 Determine capacitance and dielectric loss of an insulating material using Schering bridge.

4 Study solid dielectrics used in power apparatus.

5 Study applications of insulating materials.

6 Study direct testing and indirect testing of circuit breakers.

7 Study high voltage testing of electrical equipment: line insulator, cable, bushing, power capacitor, and power transformer.

8 Design an EHV transmission line.