FACULTY OF ENGINEERING

IASE Deemed University

Gandhi Vidya Mandir

Sardarshahr (Rajasthan) – 331401

INDIA

Teaching and Examination Scheme and Syllabus

for

BACHELOR OF TECHNOLOGY

(Four-Year Full Time Degree Programme)

ELECTRICAL ENGINEERING

2ND TO 4TH YEAR

(SEMESTER SCHEME)

Sessions 2016-17, 2017-18, 2018-19

RULES AND GUIDELINES FOR THE STUDENTS

1. **The Bachelor of Technology (Electrical Engineering) course is a four year (Eight Semester) full time integrated degree programme**.

2. **THE PROGRAMME**

The Bachelor of Technology (Electrical Engineering) is a four year (Eight semesters) full time degree programme .The course structure and programme administration are as follows.

3. COURSE STRUCTURE

The four year, eight semester teaching comprises of Theory (Lectures and Tutorials) and Practicals/Sessionals (Laboratory work, Engineering Graphics, Workshop Practice and Project etc.).Examination will be held at the end of the each semester. Details of these are given in the Teaching & Examination Scheme.

4. PROGRAMME ADMINISTRATION

4.1. Medium of Instruction

English shall be the medium of instruction and examination.

4.2. EVALUATION

(a) Each subject will be evaluated through a theory paper at the end of the semester carrying 80 marks along with continuous evaluation of sessional work, carrying 20 marks. The theory paper shall be of three hour duration. The sessional work will consist of continuous assessment of student's performance by teachers in tutorial classes, and class tests.

(b) Three class tests will be organized in each semester as per the scheme. The higher two out of the marks scored in the three tests will be considered for the sessional marks.

(c) Evaluation of laboratory practical work and Engineering Graphics (Drawing) will be through continuous assessment throughout the semester as well as examination at the end of the semester.

(d) At the end of the sixth semester the student will undergo practical training for a period of at least 45 working days in an industry / research organization related to his / her field of Study. At the end of the training, the student will submit its report to the Head of the Department within three weeks of the start of the seventh semester. The work of the practical training will be evaluated by a board of two teachers appointed by the Head of the Department. The later will counter sign the marks awarded by the board.

(e) Project: The project work will be carried out in the VII & VIII semester. The topic of the project will be approved by the Head of the Department and the entire project work will be carried out under the guidance of a teacher of the department approved as project supervisor by the Head of the Department. The nature of the project work will consist of varying proportions of designing, fabrication, testing and analysis of results. The project topic can also be taken from a live industrial problem. The report of the

completed project shall be signed by the guide and submitted to the Head of the Department on or before the last working day of the eighth semester. The evaluation of the project will be done by a board consisting of two examiners.

5. Promotion

5.1 The maximum span period of a programme is eight years from the date of registration in the programme.

5.2 The minimum grade for passing the examination for each semester shall be **"P"** of all the subjects (theory, sessional) of the semester.

5.3 A student will be permitted to attend the classes of the fourth/sixth/eighth semesters immediately after the examination of the third/fifth/seventh semester's examination, as the case may be, provided he/she has appeared in the first/third/fifth/seventh semester examination, respectively.

5.4 To be eligible for promotion to the 5^{th} semester of the programme a student must have successfully cleared 50% of the total subjects including practicals and sessionals of the third and fourth semesters taken together. In case of 50% of total number of papers is fractional number, the candidate must have cleared number of papers next higher number of the fraction so obtained.

5.5 To be eligible for promotion to the 7^{th} semester of the programme a student must have successfully cleared 50% of the total subjects including practicals and sessionals of the fifth and sixth semesters taken together. In case of 50% of total number of papers is fractional number, the candidate must have cleared number of papers next higher number of the fraction so obtained.

5.6 A student promoted to the third/fifth/seventh semesters, without having cleared all the papers, will have to appear and pass the backlog papers of the first/third/seventh semesters along with the regular examination of the first/third/fifth semesters and backlog papers of the second/fourth/sixth semesters along with the regular examination of the second/fourth/sixth semesters.

5.7 (a) Award of Grade:

- **Academic Year**: Two consecutive (one odd + one even) semesters constitute one academic year.
- **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed courses (core, elective courses).
- **Course**: Usually referred to, as 'papers' is a component of a programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course has been designed to comprise lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/seminars/term papers/assignments/presentations/self-study etc. or a combination of some of these.
- **Credit Based Semester System (CBSS)**: Under the CBSS, the requirement for awarding a degree is prescribed in terms of number of credits to be completed by the students.
- **Credit Point**: It is the product of grade point and number of credits for a course.

- **Credit**: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.
- **Cumulative Grade Point Average (CGPA)**: It is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
- **Grade Point**: It is a numerical weight allotted to each letter grade on a 10-point scale.
- **Letter Grade:** It is an index of the performance of students in a said course/semester/programme. Grades are denoted by letters O, A+, A, B+, B, C, P and F.

Letter Grade	% Scale	Grade Point
O (Outstanding)	85% and Above	10
A+(Excellent)	75% to 84.99%	9
A(Very Good)	65% to 74.99%	8
B+(Good)	55% to 64.99%	7
B(Above Average)	50% to 54.99%	6
C(Average)	45% to 49.99%	5
P (Pass)	40% to 44.99%	4
F(Fail)	Less than 40%	0
Ab (Absent)	0 %	0

- **Programme**: An educational programme leading to award of a Degree.
- **Semester Grade Point Average (SGPA)**: It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.
- **Semester**: Each semester will consist of 13-18 weeks of academic work equivalent to 90 teaching days. The odd semester may be scheduled from July to December and even semester from January to June.
- **Transcript or Grade Card or Certificate:** Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, credit points, grade secured) along with SGPA of that semester and CGPA earned till that semester.

5.8 If a student (who has successfully completed the programme) wishes to reappear in one or more theory papers of the first, second, third, fourth, fifth, sixth, seventh or eighth semesters for the purpose of improving his/her marks, he/she will be permitted to do so on payment of requisite examination fee along with the regular examinations of that semester; however, the total number of

such attempts shall not exceed four theory papers during the span period of the programme. For this his/her previous performance in the paper/papers concerned shall be treated as cancelled. The application for such reappearing/re-examination must be submitted before the next examination of the corresponding semester. However, such candidates shall not be considered for award of gold medal.

5.9 A student to be eligible for award of degree has to clear all papers offered during four-year programme within the span period of eight years.

6. LATERAL ENTRY

Students who have passed 3 year diploma examination from the Board of Technical Education, Rajasthan, or its equivalent with a minimum of 60% marks can be admitted to the Third Semester of the B. E. programme. However, they will be required to pass a course on Special Mathematics (BE300) for Diploma pass students. Students will have to pass this course before they are admitted to the seventh semester. However, the marks obtained in this course will not be counted for deciding the division of the student.

7. Attendance: All students are required to have 75% attendance in each subject and there must be 75% attendance of the student before he/she could be permitted to appear in the examination.

8. RULES FOR CHANGE OF BRANCH FOR THE STUDENTS OF III SEM. B.TECH/ B.E.:

I The faculty, on the basis of applications received from desirous students up to the date and time notified by the Director, will prepare a merit list of the students. The list will be prepared on the basis of overall merit of the I(Semester) result only and the applications for change of branch will be processed as per the merit list.

ELIGIBILITY CRITERIA:

(a) The students must have passed the I Semester B.Tech. Examination in all components in one attempt with at least **"B+"** grade. The student with back papers or whose result has not been declared will not be considered for change of branch.

(b) In case any student has applied for re-valuation/ re-totalling of his/her marks of I Semester B.Tech and the result has not been received till the time of change of branch, such a student will not be entitled for change of branch on the basis of his/her subsequently revised result.

PROCEDURE:

1) Applications in a specified format (developed by the faculty) for change of branch will be invited by the Director/Principal of the faculty on the basis of the result of I (Semester) B. Tech. in duplicate, upto the date notified by IASE University. One copy of each such application be sent to IASE University by that date.

2) The students would submit a photo copy of I (Semester) Examination mark sheet of that year along with the application. The student may give as many preferences as possible against the vacant seats

in respective college.

3) A seat matrix shall be prepared by the faculty, as per the details of the vacant seats (admitted through direct admission) in the previous year.

4) Due to change of branch, the strength of student in any branch should not fall short of 75% of the enrolled students in that branch in that year. And under no circumstances, due to change of branch, the number of seats in a particular branch in a college shall exceed the sanctioned strength approved by the AICTE, for that batch.

5) All students who have applied for the change of branch in-time will be called for counselling by the admission council of the faculty and considered for change of branch as per merit, preference and availability of seat. However, at the time of the counselling, if any student wishes to withdraw his/her application he/she can do so by a written request. In case any student does not present himself/herself for counselling, his/her branch will be changed as per the preference mentioned in the application form, merit and availability of seat. Once a student has been permitted to change of a branch it will not be withdrawn.

TEACHING & EXAMINATION SCHEME

FOR B.TECH- FOUR YEAR (8 SEMESTER) FULL TIME DEGREE

B.TECH ELECTRICAL ENGINEERING SECOND YEAR

SEMESTER: III

Subject Code	Title	Hrs. / Week			Credit	IA		Exam		Total
		L	T	P		Th	P	Th	P	
EE 301&301-P	Electronic Devices & Circuits	3	1	2	5	20	45	80	30	175
EE 302&302-P	Circuit Analysis-I	3	1	2	5	20	30	80	20	150
EE 303&303-P	Digital Electronics	3	1	2	5	20	45	80	30	175
EE 304&304-P	Object Oriented Programming	3	-	2	4	20	45	80	30	175
EE 305	Electrical Machines-I	3	1	-	4	20	-	80	-	100
EE 306	Advanced Engg. Mathematics-1	3	-	-	3	20	-	80	-	100
EE 307-P	Humanities & Social Sciences	-	-	2	1	-	45	-	30	75
EE 308	Discipline & Extra Curricular Activity									50
	Total	**18**	**4**	**10**	**27**					**1000**

SEMESTER: IV

Subject Code	Title	Hrs. / Week			Credit	IA		Exam		Total
		L	T	P		Th	P	Th	P	
EE 401&401-P	Analog Electronics	3	1	2	5	20	45	80	30	175
EE 402	Circuit Analysis-II	3	1	-	4	20	-	80	-	100
EE 403&403-P	Electrical Measurements	3	1	2	5	20	45	80	30	175
EE 404&404-P	Generation of Electrical Power	3	-	-	3	20	45	80	30	175
EE 405&405-P	Electrical Machines-II	3	1	2	5	20	45	80	30	175
EE 406	Advanced Engineering Mathematics-II	3	-	-	3	20	--	80	-	100
EE 407-P	Electrical Machine Design			2	2		30		20	50
EE 408	Discipline & Extra Curricular Activity									50
	Total	**18**	**4**	**10**	**27**					**1000**

IA- Internal Assessment **T- Tutorial**

L- Lecture **P- Practical**

Th- Theory

TEACHING & EXAMINATION SCHEME

FOR B.TECH- FOUR YEAR (8 SEMESTER) FULL TIME DEGREE

B.TECH ELECTRICAL ENGINEERING THIRD YEAR

SEMESTER: V

Subject Code	Title	Hrs. / Week			Credit	IA		Exam		Total
		L	T	P		Th	P	Th	P	
EE 501&501-P	Power Electronics	3	1	2	5	20	45	80	30	175
EE 502&502-P	Microprocessors & Computer Architecture	3	-	2	4	20	45	80	30	175
EE 503	Control Systems	3	1	-	4	20	-	80	-	100
EE 504&504-P	Data Base Management System	3	-	2	4	20	45	80	30	175
EE 505	Transmission & Distribution of Electrical Power	3	1	-	4	20	-	80	-	100
EE 506 I	Optimisation Techniques	3	1	-	4	20	-	80	-	100
EE 506 II	Principle of Communication Systems									
EE 506 III	Introduction to VLSI									
EE 507-P	System Programming Lab			2	1	-	45	-	30	75
EE 508-P	Professional Ethics and IPR			2	1	-	30	-	20	50
EE 509	Discipline & Extra Curricular Activity									50
	Total	**18**	**4**	**10**	**27**					**1000**

SEMESTER: VI

Subject Code	Title	Hrs. / Week			Credit	IA		Exam		Total
		L	T	P		Th	Pr	Th	Pr	
EE 601&601-P	Modern Control Theory	3	1	2	5	20	45	80	30	175
EE 602&602-P	High Voltage Engineering	3	-	2	4	20	45	80	30	175
EE 603&603-P	Switchgear & Protection	3	1	2	5	20	45	80	30	175
EE 604&604-P	Advanced Power Electronics	3	1	2	5	20	45	80	30	175
EE 605&605-P	Smart Grid Technology	3	-	2	4	20	30	80	20	150
EE 606 I	Advanced Microprocessors	3	1	-	4	20	-	80	-	100
EE 606 II	Power System Instrumentation									
EE 606 III	Digital Communication and Information Theory									
EE 607	Discipline & Extra Curricular Activity									50
	Total	**18**	**4**	**10**	**27**					**1000**

IA- Internal Assessment **T- Tutorial**

L- Lecture **P- Practical**

Th- Theory

TEACHING & EXAMINATION SCHEME

FOR B.TECH- FOUR YEAR (8 SEMESTER) FULL TIME DEGREE

B.TECH ELECTRICAL ENGINEERING FOURTH YEAR

SEMESTER: VII

Subject Code	Title	Hrs. & Week			Credit	IA		Exam		Total
		L	T	P		Th	P	Th	P	
EE 701&701-P	Power System Planning	3	1	2	5	20	45	80	30	175
EE 702&702-P	Power System Analysis	3	1	2	5	20	45	80	30	175
EE 703	Artificial Intelligence Techniques	3	-	-	3	20	-	80	-	100
EE 704	Non-Conventional Energy Sources	3	-	-	3	20	-	80	-	100
EE 705	Power System Engineering	3	1	-	4	20	-	80	-	100
EE 706 I	Electromagnetic Field Theory	3	1	-	4	20	-	80	-	100
EE 706 II	Computer Aided Design of Electrical Machines									
EE 706 III	Economic Operation of Power Systems									
EE 707-P	Industrial Economics & Management			2	1	-	30	-	20	50
EE 708	Practical Training & Industrial visit			2	1	-	45	-	30	75
EE 709	Project-1			2	1	-	45	-	30	75
EE 710	Discipline & Extra Curricular Activity									50
	Total	**18**	**4**	**10**	**27**					**1000**

SEMESTER: VIII

Subject Code	Title	Hrs. / Week			Credit	IA		Exam		Total
		L	T	P		Th	P	Th	P	
EE 801	EHV AC/DC Transmission	3	1	-	4	20	-	80	-	100
EE 802&802-P	Electric Drives and Their Control	3	1	2	5	20	60	80	40	200
EE 803	Protection of Power System	3	1	-	4	20	-	80	-	100
EE 804 I	Utilization of Electrical Power	3	-	-	3	20	-	80	-	100
EE 804 II	FACTS Devices & Their Applications									
EE 804 III	Power System Transients									
EE 805-P	Computer Based Power System Lab			2	1	-	60	-	40	100
EE 806-P	Entrepreneurship Development			2	1	-	45	-	30	50
EE 807	Project-2			2	1	-	120	-	80	200
EE 808	Seminar			2	1	-	60	-	40	100
EE 809	Discipline & Extra Curricular Activity									50
	Total	**12**	**3**	**10**	**20**					**1000**

IA- Internal Assessment **T- Tutorial**

L- Lecture **P- Practical**

Th- Theory

EE 301 ELECTRONIC DEVICES & CIRCUITS

UNIT	CONTENTS	CONTACT HOURS
I	**Semiconductor Physics:** Mobility and conductivity, charge densities in a semiconductor, Fermi Dirac distribution, Fermi-Dirac statistics and Boltzmann approximation to the Fermi-Dirac statistics, carrier concentrations and Fermi levels in Semiconductor. Generation and recombination of charges, diffusion and continuity equation, transport equations, Mass action Law, Hall effect.	**8**
II	**Junction Diodes:** Formation of homogenous and hetro junction diodes and their energy band diagrams, calculation of contact potential and depletion width, V-I characteristics, Small signal models of diode, Diode as a circuit element, diode parameters and load line concept, C-V characteristics and dopant profile. Applications of diodes in rectifier, clipping, clamping circuits and voltage multipliers. Transient behavior of PN diode. Breakdown diodes, Schottky diodes, and Zener diode as voltage regulator. Construction, characteristics and operating principle of UJT.	**8**
III	**Transistors:** Characteristics, Current Components, Current Gains: alpha and beta. Variation of transistor parameter with temperature and current level, Operating point, Hybrid model, DC model of transistor, h-parameter equivalent circuits. CE, CB and CC configuration DC and AC analysis of single stage CE, CC (Emitter follower) and CB amplifiers AC & DC load line, Ebers-Moll model. Biasing & stabilization techniques. Thermal runaway, Thermal stability.	**8**
IV	**JFET & MOSFET:** Construction and operation of JFET & MOSFET, noise performances of FET, parasitic of MOSFET, small signal models of JFET & MOSFET Biasing of JFET's & MOSFET's. Low frequency single stage CS and CD (source follower) JFET amplifiers. FET as voltage variable resistor and active load.	**8**
V	**Small Signal Amplifiers at Low Frequency:** Analysis of BJT and FET multistage amplifier, DC and RC coupled amplifiers. Frequency response of single and multistage amplifier, mid-band gain, gains at low and high frequency. Analysis of DC and differential amplifiers, Miller's Theorem, use of Miller and bootstrap configuration. Cascade and cascade configuration of multistage amplifiers (CE-CE, CE-CB, CS-CS and CS-CD), Darlington pair.	**8**

Text Books:	Reference Books:
• Millman Halkias, Integrated Electronics, TMH • R. L. Boylestad, Louis Nashelsky, Electronic devices & circuits theory, Pearson Education	• David Bell, Electronic Devices & Circuits, Oxford Publications • Schultz, Grob's, Basic Electronics, TMH 2007 • Millman, Electronics Devices and Circuits, ed. 3, TMH 2006 • Cathey, Electronics Devices and Circuits, ed. 3, TMH 2005 • J. Millman and A. Grabel, Microelectronics, TMH, International 1999 • B. G. Streetman, Solid State Electronic Devices, Prentice Hall of India, New Delhi 2002 • A. S. Sedra and K. C. Smith, Microelectronic Circuits, Saunder's College, Publishing 2014 • Salivahnan, Electronics Devices and Circuits, ed. 3, TMH.

EE 301-P ELECTRONIC DEVICES LAB

1	Study the following devices: (a) Analog & digital multimeters (b) Function/ Signal generators (c) Regulated d. c. power supplies (constant voltage and constant current operations) (d) Study of analog CRO, measurement of time period, amplitude, frequency & phase angle using Lissajous figures.
2	Plot V-I characteristic of P-N junction diode & calculate cut-in voltage, reverse saturation current and static & dynamic resistances.
3	Plot V-I characteristic of zener diode and study of zener diode as voltage regulator. Observe the effect of load changes and determine load limits of the voltage regulator.
4	Plot frequency response curve for single stage amplifier and to determine gain bandwidth product.
5	Plot drain current - drain voltage and drain current – gate bias characteristics of field effect transistor and measure of Idss&Vp.
6	Application of Diode as clipper & clamper.
7	Plot gain- frequency characteristic of two stage RC coupled amplifier & calculate its bandwidth and compare it with theoretical value.
8	Plot gain- frequency characteristic of emitter follower & find out its input and output resistances.
9	Plot input and output characteristics of BJT in CB, CC and CE configurations. Find their h-parameters.
10	Study half wave rectifier and effect of filters on wave. Also calculate theoretical & practical ripple factor.
11	Study bridge rectifier and measure the effect of filter network on DC voltage output and ripple factor.

EE 302 CIRCUIT ANALYSIS-I

UNIT	CONTENTS	CONTACT HOURS
I	**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.	**8**
II	**Network Theorems:** Thevenis's, Norton's, Superposition, Reciprocity, Compensation, Millman's theorem, Tellegen's, Maximum power transfer and Miller`s theorems in DC & AC Circuits.	**8**
III	**Polyphase Circuits:** General Circuit Relations: Three Phase Star, Three Phase Delta, Star and Delta Combination, Four Wire Star Connection. Balanced and unbalanced Three Phase Voltages, currents and 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.	**8**
IV	**Non-Sinusoidal Waves:** Complex Periodic Waves and Their Analysis By Fourier Series. Different Kinds of Symmetry, Determination of Co-Efficient. 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.	**8**
V	**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.	**8**

Text Books:	Reference Books:
• Van Valkenburg, Network Analysis, PHI 2013 • Hayt & Kemmerly, Engineeirng Circuit Analysis, 6/e (TMH) 2012	• J. Edminster & M. Nahvi, Electric Circuits (SIE), 5/e, Scaum's Out Line. 2013 • Nagsarkar & Sukhija, Circuits & Networks, Oxford 2010 • John Bird, Electric Circuit Theory & Technology, ELSEVIER 2007 • D. Roy Chodhary, Network & Systems, New Age 2010 • Ghosh & Chakrabarti, Network Analysis and Synthesis, (TMH) 2009 • A. Chakarvorty, Circuit Theory, Publisher DhanpatRai& Co. (Pvt.) Ltd. 2013

EE 302-P ELECTRICAL CIRCUIT LAB

1	Draw the circuit symbols.
2	Verify theorems for A. C. & D. C. circuits.
3	PSPICE Programs for Circuit Analysis: a. DC: Analysis resistor networks to determine node voltages, components voltages, and component currents. b. DC: Analysis of resistor networks that have several voltage and current sources and variable load resistors. c. Transient: Analysis of 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. d. AC: Analysis of impedance networks to determine the magnitude & phase of node voltages, components voltages and component currents.
4	Determine the magnitude & phase and component voltages and currents in resonant circuits & produce voltage and current verses frequency graphs.
5	Programs for Circuit Analysis: a. Calculate the resistance of a conductor, given its dimensions & resistivity or determine the change in conductor resistance when the temp changes. b. D.C.: Analysis of resistor networks to determine all junction voltages, component voltages, and component currents. c. Transient: Analysis RC & RL circuits to produce tables of component voltage & current levels for a given set of time instants.
6	Convert Y-connected resistor networks to delta-connected circuits.

EE 303 DIGITAL ELECTRONICS

UNIT	CONTENTS	CONTACT HOURS
I	**Number Systems, Basic Logic Gates & Boolean Algebra:** Binary Arithmetic & Radix representation of different numbers. Sign & magnitude representation, Fixed point representation, complement notation, various codes & arithmetic in different codes & their inter conversion. Features of logic algebra, postulates of Boolean algebra.Theorems of Boolean algebra.Boolean function. Derived logic gates: Exclusive-OR, NAND, NOR gates, their block diagrams and truth tables. Logic diagrams from Boolean expressions and vica-versa. Converting logic diagrams to universal logic. Positive, negative and mixed logic.Logic gate conversion.	**8**
II	**Digital Logic Gate Characteristics:** TTL logic gate characteristics: Theory & operation of TTL NAND gate circuitry. Open collector TTL. Three state output logic. TTL subfamilies. MOS & CMOS logic families. Realization of logic gates in RTL, DTL, ECL, C-MOS & MOSFET. Interfacing logic families to one another.	**8**
III	**Minimization Techniques:** Minterm, Maxterm, Karnaugh Map, K map upto 4 variables. Simplification of logic functions with K-map Conversion of truth tables in POS and SOP form. Incomplete specified functions. Variable mapping. Quinn-McKlusky minimization techniques.	**8**
IV	**Combinational Systems:** Combinational logic circuit design, half and full adder, subtractor. Binary serial and parallel adders. BCD adder. Binary multiplier. Decoder: Binary to Graydecoder, BCD to decimal, BCD to 7-segment decoder. Multiplexer, demultiplexer, encoder. Octal to binary, BCD to excess-3 encoder .Diode switching matrix. Design of logic circuits by multiplexers, encoders, decoders and demultiplexers.	**8**
V	**Sequential Systems:** Latches, flip-flops, R-S, D, J-K, Master Slave flip flops. Conversions of flip-flops. **Counters:** Synchronous & asynchronous ripple and decade counters, Modulus counter, skipping state counter, counter design, state diagrams and state reduction techniques. Ring counter. Counter applications. Registers: buffer register, shift register.	**8**

Text Books:	Reference Books:
• Herbert Taub, Donald L. Schilling, Digital Integrated Electronics, TMH 2008 • M. Morris Mano, Digital Logic and Computer Design, Pearson Edu. 2014	• Millman Taub, Pulse Switching and Network, TMH 2009 • A. Anandkumar, Fundamentals of Digital circuits, PHI 2009 • Floyd, Digital Funadamentals, Pearson 2008 • S. Salivahanan, Sarivazhagan, Digital circuit design, Vikas publications 2009 • Leach, Digital Principles and Applications, ed. 7, TMH 2008 • Mandal, Digital Electronics: Principles and Applications, TMH 2009

EE 303-P DIGITAL ELECTRONICS LAB

1	To verify the truth tables of basic logic gates: AND, OR, NOR, NAND, NOR. Also to verify the truth table of Ex-OR, Ex-NOR (For 2, 3, & 4 inputs using gates with 2, 3, & 4 inputs).
2	To verify the truth table of OR, AND, NOR, Ex-OR, Ex-NOR realized using NAND & NOR gates.
3	To realize an SOP and POS expression
4	To realize Half adder/ Subtractor& Full Adder/ Subtractor using NAND & NOR gates and to verify their truth tables.
5	To realize a 4-bit ripple adder/ Subtractor using basic Half adder/ Subtractor& basic Full Adder/ Subtractor.
6	To verify the truth table of 4-to-1 multiplexer and 1-to-4 demultiplexer. Realize the multiplexer using basic gates only. Also to construct and 8-to-1 multiplexer and 1-to-8 demultiplexer using blocks of 4-to-1 multiplexer and 1-to-4 demultiplexer.
7	Design & Realize a combinational circuit that will accept a 2421 BCD code and drive a TIL -312 seven segment display.
8	Using basic logic gates, realize the R-S, J-K and D-flip flops with and without clock signal and verify their truth table
9	Construct a divide by 2,4& 8 asynchronous counter. Construct a 4-bit binary counter and ring counter for a particular output pattern using D flip flop.
10	Perform input/output operations on parallel in/Parallel out and Serial in/Serial out registers using clock. Also exercise loading only one of multiple values into the register using multiplexer.

EE 304 OBJECT ORIENTED PROGRAMMING

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction:** Review of structures in C, accessing members of structures using structure variables, pointer to structures, passing structures to functions. Structures as user defined data types.	8
II	**Introduction to Programming Paradigms:** (Process oriented and Object oriented). Concept of object, class, objects as variables of class data type, difference in structures and class in terms of access to members, private and public Basics of C++: Structure of C++ programs, introduction to defining member functions within and outside a class, keyword *using*, declaring class, creating objects, constructors & destructor functions, Initializing member values with and without use of constructors, simple programs to access & manipulate data members, *cin* and *cout* functions. Dangers of returning reference to a private data member, constant objects and members function, composition of classes, friend functions and classes, using *this* pointer, creating and destroying objects dynamically using *new* and *delete* operators. Static class members, container classes and iterators, proxy classes. Members of a class, data & function members. Characteristics of OOP- Data hiding, Encapsulation, data security..	8
III	**Operator Overloading:** Fundamentals, Restrictions, operator functions as class members v/s as friend functions. Overloading stream function, binary operators and unary operators. Converting between types.	8
IV	**Inheritance:** Base classes and derived classes, protected members, relationship between base class and derived classes, constructors and destructors in derived classes, public, private and protected inheritance Relationship among objects in an inheritance hierarchy, abstract classes, virtual functions and dynamic binding, virtual destructors.	8
V	Multiple inheritance, virtual base classes, pointers to classes and class members, multiple class members. Templates, exception handling.	8

Text Books:	Reference Books:
• Dietel, How to Program C++, Pearson 2013 • K. R. Venugopal, Mastering C++, TMH 1999	• Robert Lafore, Object Oriented Programming in C++, Pearson 2001 • Rambaugh, Object Oriented Design & Modelling, Pearson 2004

EE 304-P C++ PROGRAMMING LAB

1	To write a simple program for understanding of C++ program structure without any CLASS declaration. Program may be based on simple input output, understanding of keyword using.
2	Write a C++ program to demonstrate concept of declaration of class with public & private member, constructors, object creation using constructors, access restrictions, defining member functions within and outside a class. Scope resolution operators, accessing an object's data members and functions through different type of object handle name of object, reference to object, pointer to object, assigning class objects to each other.
3	Program involving multiple classes (without inheritance) to accomplish a task. Demonstrate composition of class.
4	Demonstration Friend function friend classes and this pointer.
5	Demonstration dynamic memory management using new & delete & static class members.
6	Demonstration of restrictions an operator overloading, operator functions as member function and/ or friend function, overloading stream insertion and stream extraction, operators, overloading operators etc.
7	Demonstrator use of protected members, public & private protected classes, multi-level inheritance etc.
8	Demonstrating multiple inheritance, virtual functions, virtual base classes, abstract classes

EE 305 ELECTRICAL MACHINES-I

UNIT	CONTENTS	CONTACT HOURS
I	**(I)Magnetic circuits:** Magnetic circuits, magneto motive force magnetic field strength, permeability, reluctance, analogy between electric and magnetic-circuits, B-H curve, hysteresis, series and parallel magnetic circuits, practical magnetic circuits, permanent magnet and their applications. **(ii)Electromechanical energy conversion:** Basic principles, conservation of energy, physical phenomenon involved in conversion, energy balance, energy stored in magnetic field.	**8**
II	**DC Generators:** Introduction, construction, types, emf equation, lap and wave windings, armature reaction, commutation, methods of improving commutation, equalizer rings. Demagnetizing and cross magnetizing ampere turns, various characteristics of shunt, series and compound generators, voltage build up, losses and efficiency, condition for maximum efficiency.	**8**
III	**DC Motors:** Introduction, principals, back-emf, torque of motor, types, characteristics of shunt, series and compound motors, speed control (field and armature control methods), basic idea of solid state devices in controlling of DC motors. Starting of DC motors, three point and four point starters, losses and efficiency, testing (brake test and swimburnes test), electric braking of DC motors, Applications.	**8**
IV	**Transformer:** Construction, Principal, Types, emf equation, no load and short circuit test, equivalent circuits, back-to-back (Sumpner's test), phasor diagram, Voltage regulation, Efficiency, Condition for maximum efficiency, all day efficiency, parallel operation, auto-transformer, basic idea of welding transformer, current and potential transformer, separation of losses.	**8**
V	**Polyphase Transformer:** Construction, Various connections and groups, choice of connections, open delta connection, Scott connection, three phase to two phase conversion and vice-versa, Applications, Parallel operation and its conditions. Three to six phase conversion. Excitation phenomenon in transformers, magnetizing harmonic currents and their effects, switching currents in transformers, inrush of magnetizing current. Three winding transformer.	**8**

Text Books:	Reference Books:
• A. E. Fitzgerald, C. Kingsley Jr and Umans, Electric Machinery, 6th Edition McGraw Hill, International Student Edition. 2002 • Kothari & Nagrath, Electric Machines, 3/e, TMH 2004	• M. G. Say, The Performance and Design of AC machines, Pit man & Sons. 2003 • Guru, Electric Machinery, 3e, Oxford 2000 • R. K. Srivastava, Electrical Machines, Cengage Learning. 2013 • P. S. Bimbhra, Electrical Machinery, Khanna Pub. 1995 • Stephen J Chapman, Electric Machinery Fundamentals, McGraw-Hill 2001 • Husain Ashfaq, Electrical Machines, DhanpatRai& Sons 2013

EE 306 ADVANCED ENGINEERING MATHEMATICS-I

UNIT	CONTENTS	CONTACT HOURS
I	**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.	8
II	**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.	8
III	**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	8
IV	**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.	8
V	**Complex Variables:** Taylor's series, Laurent's series, poles, Residues. Evaluations of simple definite real integrals using the theorem of residues. Simple contour integration.	8

Text Books:	Reference Books:
• M. Ray, J. C. Chaturvedi & H.C. Sharma, Differential Equations, Students friends & company 2011 • Chandrika Prasad, Mathematics for Engineers, Prasad Mudralaya 2012	• Bird, Higher Engineering Mathematics, ELSEVIER. 2004 • Jeffrey, Advanced Engineering Mathematics, ELSEVIER. 2001 • Chandrika Prasad, Advanced Mathematics for Engineers, Prasad Mudralaya 2006 • Ervin Kreyzig, Advanced Engineering Maths, Wiley. 2005

EE 307-P HUMANITIES & SOCIAL SCIENCE

UNIT	CONTENTS	CONTACT HOURS
I	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.	8
II	Society: Social groups- concept and types, socialization- concept and theory, social control: concept, social problem in contemporary India, status and role.	8
III	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.	8
IV	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.	8
V	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.	8

EE 401 ANALOG ELECTRONICS

UNIT	CONTENTS	CONTACT HOURS
I	**Feedback Amplifiers:** Classification, Feedback concept, Feedback Topologies, Transfer gain with feedback, General characteristics of negative feedback amplifiers. Analysis of voltage-series, voltage-shunt, current-series and current-shunt feedback amplifier. Stabilitycriterion. Compensation techniques, miller compensation.	8
II	**Oscillators & Multivibrators:** Classification. Criterion for oscillation.Tuned collector, Hartley, Colpitts, RC Phase shift, Wien Bridge and crystal oscillators. Astable, monostable and bistable multivibrators. Schmitt trigger. Blocking oscillators	8
III	**High Frequency Amplifiers:** Hybrid Pi model, conductances and capacitances of hybrid Pi model, high frequency analysis of CE amplifier. Gain bandwidth product, unity gain frequency f_T.Emitter follower at high frequencies.	8
IV	**Tuned Amplifier**: Band pass amplifier, Parallel resonant circuits, Band Width of Parallel resonant circuit. Analysis of Single Tuned Amplifier, Primary & Secondary Tuned Amplifier with BJT & FET Double Tuned Transformer Coupled Amplifier. Stagger Tuned Amplifier. Pulse Response of such Amplifier. Class C tuned amplifiers, Shunt Peaked Circuits for Increased Bandwidth.	8
V	**Power Amplifiers:** Classification, Power transistors & power MOSFET (DMOS, VMOS). Output power, power dissipation and efficiency analysis of Class A, class B, class AB, class C, class D and class E amplifiers as output stages. Push pull amplifiers with and without transformers. Complementary symmetry & quasi complimentary symmetry amplifiers	8

Text Books:	Reference Books:
• Millman, Integrated Electronics, ed. 2, TMH. 2010 • A. S. Sedra, Kenneth C. Smith, Microelectronic Circuits, Oxford university press. 2009	• M. H. Rashid, Microelectronic Circuits Analysis and design, Cengage Learning. 2009 • David A. BELL, Electronic Devices and Circuits, Oxford university press. 2009 • Salivahnan, Electronics Devices and Circuits, ed. 3, TMH. 2011

EE 401-P ANALOG ELECTRONIC LAB

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 measurement of line and load regulation and ripple factor.
3	Plot and study the characteristics of small signal amplifier using FET.
4	Study of push pull amplifier. Measure 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: (a) Hartley (b) Colpitts.
8	Design Fabrication and Testing of k-derived filters (LP/HP).
9	Study of a Digital Storage CRO and store a transient on it.
10	To plot the characteristics of UJT and UJT as relaxation.
11	To plot the characteristics of MOSFET and CMOS.

EE 402 CIRCUIT ANALYSIS-II

UNIT	CONTENTS	CONTACT HOURS
I	**Impedance and Admittance Functions:** The concept of complex frequency, transform impedance and admittance, series and parallel combinations	8
II	**Network Functions:** Terminals and terminal pairs, driving point impedance transfer functions, poles and zeros. Restrictions on pole and zero location in splane. Time domain behavior from pole and zero plot. Procedure for finding network functions for general two terminal pair networks	8
III	**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.	8
IV	**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.	8
V	**Two Port Reactive Network (Filters):** Constant K filters. The m-derived filter. Image impedance of m-derived half (or L) sections, composite filters. Bands pass and band elimination filters. The problem of termination, lattice filters, Barlett's bisection theorem. Introduction to active filters.	8

Text Books:	Reference Books:
• M. E. Van Valkenburg, An Introduction to Modern Network Synthesis, Wiley Eastern 2014 • Nagsarkar & Sukhija, Circuits & Networks, Oxford 2011	• M. E. Van Valkenburg, An Introduction to Modern Network Synthesis, Wiley Eastern 2008 • Nagsarkar & Sukhija, Circuits & Networks, Oxford 2011 • M. E. Van Valkenburg, An Introduction to Modern Network Synthesis, Wiley Eastern 2008 • Nagsarkar & Sukhija, Circuits & Networks, Oxford 2011 • M. E. Van Valkenburg, An Introduction to Modern Network Synthesis, Wiley Eastern 2008

EE 403 ELECTRICAL MEASUREMENTS

UNIT	CONTENTS	CONTACT HOURS
I	**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 singlephase energy. Errors in wattmeter and energy meter and their compensation and adjustment. Testing and calibration of single-phase energy meter by phantom loading.	8
II	**Polyphase Metering:** Blondel's Theorem for n-phase, p-wire system. Measurement of power and reactive kVA in 3-phase balanced and unbalanced systems: Onewattmeter, 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.	8
III	**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.	8
IV	**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.	8
V	**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.	8

Text Books:	Reference Books:
• H. S. Kalsi, Electronic Inst. & Measurement, TMH 2004 • Morris, Electrical Measurements & Instrumentation, ELSEVIER 1997	• Bell, Electronic Instrumentation And Measurement, Oxford 1994 • W. D. Cooper, Electronic Inst. & Measurement Techniques, Prentice Hall, India. 2004 • A. K. Sawhney, Electrical & Electronic Measurement & Inst, DhanpatRai& Sons 2002 • E. W. Golding & F. C. Widdis, Electrical Measurement & Measuring Instrument, A.W. Wheeler 2004 • Forest K. Harries, Electrical Measurement, Willey Eastern Pvt. Ltd. India. 2008

EE 403-P 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

EE 404 GENERATION OF ELECTRICAL POWER

UNIT	CONTENTS	CONTACT HOURS
I	**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	**8**
II	**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.	**8**
III	**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. **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.	**8**
IV	**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.	**8**
V	**(i) Tariffs:** Objectives of tariffs. General tariff form. Flat demand rate, straight meter rate, block meter rate. Two part tariff, power factor dependent tariffs, threepart 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.	**8**

Text Books:	Reference Books:
• B. R. Gupta. Generation of Electrical Energy (4/e), S. Chand Publication. 2013 • S. L. Uppal. Electrical Power (13/e), Khanna Publishers 2009	• V. K. Mehta, Principles of Power system (3/e), S. Chand Publication 2005 • Soni, Gupta and Bhatnagar, Generation of Electrical Power, Dhanpat Rai & Sons 1996 • L. Elgerd Olle, Electric Energy Systems Theory, PHI 2013 • C. A. Gross, Power System Analysis, TMH 1979

EE 404-P POWER SYSTEM DESIGN LAB

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. Electricalequipment for substations.

EE 405 ELECTRICAL MACHINES-II

UNIT	CONTENTS	CONTACT HOURS
I	**AC Machines Fundamentals:** Introduction, emf equation, mmf of three phase AC winding, production of rotating magnetic field, types of AC windings Concentric, distributed and chorded windings, pitch factor, distribution factor, effect of these factors on induced emf, effect of harmonics.	**8**
II	**Polyphase Induction Motor**: Introduction. Construction, cage and wound rotors, principal, starting and running torque, condition for maximum torque, equivalent circuits, no load and block rotor test. Torque-slip characteristics, losses and efficiency, circle diagram, starting of cage and wound motors, speed control, cogging and crawling, double cage rotor, induction generator, application.	**8**
III	(i) **Single Phase Induction Motor:** Introduction, construction, principal, double revolving field theory, equivalent circuit, performance calculations, starting methods, and their types, torque slip characteristics of various types. ii) **Special Machines:** Single phase synchronous motor, series motor, universal motor, Stepper motors variable reluctance, permanent magnet and hybrid stepper motors.	**8**
IV	**Synchronous Generators (Alternators):** Introduction, Construction, advantages of rotating field, types of rotors, emf equation, excitation systems, equivalent circuit and their phasor diagrams, voltage regulation, synchronous impedance method, mmf method. Zero power factor method, two reaction theory of salient pole rotor, phasor diagram, power developed and power angle characteristics of salient pole machine, determination of X_d and X_q, synchronization, synchronizing power and torque, parallel operation application.	**8**
V	**Synchronous Motors:** Introduction, construction, principal of operation, starting of synchronous motor, equivalent circuit and phasor diagrams, power and torque, performance calculation, speed torque characteristics, power factor control-effect of change of excitation. V curve and inverted V curve, synchronous condenser and reactors, synchronous phase modifiers, hunting-causes and remedies, applications, synchronous induction motor application.	**8**

Text Books:	Reference Books:
• A. E. Fitzgerald, C. KingsleyJr and Umans, Electric Machinery, 6th Edition McGraw Hill, International Student Edition. 2002 • Kothari & Nagrath, Electric Machines 3/e,TMH 2004	• M. G. Say, The Performance and Design of AC machines, Pit man & Sons. 2002 • Guru, Electric Machinery 3e, Oxford 2000 • R. K. Srivastava, Electrical Machines, Cengage Learning. 2010 • P. S. Bimbhra, Electrical Machinery, Khanna Pub. 1995 • Stephen J Chapman, Electric Machinery Fundamentals, McGraw-Hill 2001 • Husain Ashfaq, Electrical Machines, DhanpatRai & Sons 2012 • Irving L. Kosow, Electric Machine and Tranformers, Prentice Hall of India. 1992

EE 405-P ELECTRICAL MACHINE LAB

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	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.
3	To perform back-to-back test on two identical 1-phase transformers and find their efficiency & parameters of the equivalent circuit.
4	To determine the efficiency and voltage regulation of a single-phase transformer by direct loading.
5	To plot the O.C.C. & S.C.C. of an alternator and to determine its Z_s, X_d andregulation by synchronous impedance method.
6	To plot the V-curve for a synchronous motor for different values of loads.
7	To perform the heat run test on a delta/delta connected 3-phase transformer and determine the parameters for its equivalent circuit.
8	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. Torque (ii) Current (iii) slips (iv) p.f. (v) Efficiency.
9	To Plot V-Curve and inverted V-Curve of synchronous motor.
10	To synchronize an alternator across the infinite bus (RSEB) and control load sharing.

EE 406 ADVANCED ENGINEERING MATHEMATICS-II

UNIT	CONTENTS	CONTACT HOURS
I	**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.	8
II	**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.	8
III	**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.	8
IV	**Statistics & Probability:** Elementary theory of probability, Baye's theorem with simple applications, Expected value. Theoretical probability distributions – Binomial, Poisson and Normal distributions.	8
V	**Statistics & Probability:** Lines of regression, co-relation and rank correlation. **Transforms**: Z-transforms, its inverse, simple properties and application to difference equations.	8

Text Books:	Reference Books:
• Jeffrey, Advanced Engineering Mathematics, ELSEVIER 2006 • Ervin Kreyzig, Advanced Engineering Maths, John Wiley 2010	• Bird, Higher Engineering Mathematics , ELSEVIER 2004 • Chandrika Prasad, Advanced Mathematics for Engineers, Prasad Mudralaya 2002 • Kaplan, W., Advanced Mathematics for Engineers, Addison-Wesley Publishing Co. 2008 • Brigham, E.O., The Fast Fourier Transform and its Applications, Prentice-Hall 1988 • J. N. Kapur, Mathematical Statistics, S. Chand & company Ltd 2000 • R. K. Jain & S. R. K. Iyenger, Advance Engineering Mathematics, Narosa Pub. 2002 • E. Kreysig, Advanced Engineering Mathematics, John Wiley & Sons 2005

EE 407-P ELECTRICAL MACHINE DESIGN

UNIT	CONTENTS	CONTACT HOURS
I	Design of transformers: output of transformer, output equation- volt per turn, core area and weight of iron &copper, optimum design–(i) minimum cost and (ii) minimum losses. Design of core and windings. Design a 3-phase transformer.	8
II	Design of rotating machines: General concepts. specific loading, output equations –dc machines and ac machines, factor affecting size of rotating machines, choice of specific magnetic and electric loadings.	8
III	Design of 3-phase induction motors: output equation, choice of air gap flux density and ampere conductors' parameter, main dimensions. Design of a 3-phase squirrel cage induction motor.	8
IV	Design of single phase induction motors: output equation, main dimensions, relative size of single phase and 3-phase induction motors. Design of a single phase capacitor start induction motor.	8
V	Design of synchronous machines**:** output equation, choice of specific magnetic and electric loadings, main dimensions, short circuit ratio. Design a 3-phase, 2-pole turbo alternator.	8

EE 501 POWER ELECTRONICS

UNIT	CONTENTS	CONTACT HOURS
I	**Power Semiconductor Devices:**Construction, Principle of operation, Characteristics and applications of Power Transistor& Thyristor. Characteristics of GTO, DIAC, MCT, TRIAC, Power MOSFET and IGBT; Two- Transistor Model of Thyristor, Thyristor Commutation methods.	**8**
II	**SCR:** Construction and characteristics, specification and ratings, pulse transformer, optical isolators, methods of turn on, triggering circuits for SCR: 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.	**8**
III	**Converters-I:** Single Phase half & full wave converters with RL & RLE load, Single phase dual converters, Three phase half wave converters. Three phase full converters with RL load, Three phase dual converters.	**8**
IV	**Converters-II:** Single and thrEE phase semi converters with RL & RLE 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.	**8**
V	**DC-DC Converters:** Step Up/Down Copper, Control strategies, Chopper Configurations, Analysis of type A Chopper Voltage, current and load commutated chopper. Multiphase Chopper	**8**

Text Books:	Reference Books:
• M. D. Singh and K. B. Khanchandani: Power Electronics 2/e, MGH. 2008 • M. H. Rashid: Power Electronics, Circuits Devices and Applications, Pearson. 2011	• V. R. Moorthi: Power Electronics-Devices, Circuits and Industrial Applications, Oxford. 2005 • Theodore Wildi: Electrical Machines, Drives and Power Systems, Pearson. 2007 • Ned Mohan: Power Electronics, John Wiley. 2013 • Krein P. T.: Elements of Power Electronics, Oxford. 1998 • P. S. Bimbhra: Power Electronics, Khanna Publishers. 2012

EE 501-P POWER ELECTRONIC LAB

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.

EE 502 MICROPROCESSOR AND COMPUTER ARCHITECTURE

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction to 8085 Microprocessor Architecture:** CPU, address bus, data bus and control bus. Input/Output devices, buffers,encoders, latches and memories. Internal Data Operations and Registers, Pins and Signals, Peripheral Devices and Memory Organization, Interrupts.	**8**
II	**8085 Microprocessor Instructions:** Classification, Format and Timing. Instruction Set: 8 Bit and 16 Bit Instructions, Programming and Debugging, Subroutines.	**8**
III	**8085 Microprocessor Interfacing:** 8259, 8257, 8255, 8253, 8155 chips and their applications. A/D conversion, memory, keyboard and display interface (8279).	**8**
IV	**8086 Microprocessor: Architecture:** Architecture of INTEL 8086 (Bus Interface Unit, Execution unit), register organization, memory addressing, memory segmentation, Operating Modes **Instruction Set of 8086**: Addressing Modes: Instruction format: Discussion oninstruction Set: Groups: data transfer, arithmetic, logic string, branch control transfer, processor control. **Interrupts:** Hardware and software interrupts, responses and types.	**8**
V	**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.	**8**

Text Books:	Reference Books:
• Gaonkar, Ramesh S.: Microprocessor Architecture, programming and Applications with the 8085, Pen Ram International Publishing 5th Ed. 2002 • K. Udaykumar and B. S. Umashankar: The 8085 Microprocessor: Architecture, Programming and Interfacing, Pearson Publisher. 2008	• Douglas V. Hall: Microprocessors and Interfacing, Revised Second Edition (SIE), MGH. 2007 • Ray. A. K. & Burchandi, K. M.: Advanced Microprocessors and Peripherals, Architecture, Programming and Interfacing, MGH. 2006 • Lyla B. Das: The X 86 Microprocessors: Architecture, Programming and Interfacing (8086 to Pentium), Pearson Publisher. 2010 • Krishna Kant: Microprocessors and Microcontrollers, PHI Learning. 2007 • M. Rafiquzzaman: Microprocessors-Theory and applications, PHI. 1993 • B. Ram: Advanced Microprocessor & Interfacing. MGH. 2000

EE 502-P 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.

EE 503 CONTROL SYSTEMS

UNIT	CONTENTS	CONTACT HOURS
I	**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. **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.	**8**
II	**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	**8**
III	**Control System Components:** Constructional and working concept of ac servomotor, synchronous and stepper motor **Stability and Algebraic Criteria:** concept of stability and necessary conditions, Routh-Hurwitz criteria and limitations.Root Locus Technique: The root locus concepts, construction of root loci.	**8**
IV	**Frequency Response Analysis:** Frequency response, correlation between time and frequency responses,polar and inverse polar plots, Bode plots **Stability in Frequency Domain:** Nyquist stability criterion, assessment of relative stability: gain margin and phase margin, M and N Loci, Nichols chart.	**8**
V	The design problem and preliminary considerations lead, lag and lead-lag networks, design of closed loop systems using compensation techniques in time domain and frequency domain. Brief idea of proportional, derivative and integral controllers.	**8**

Text Books:	Reference Books:
• Smarjit Ghosh, Control Systems: Theory and Applications, 2/e, Pearson Publisher. 2004 • Dhannesh N. Manik: Control System, Cengage Learning. 2012	• I. J. Nagrath and M. Gopal: Control Systems Engineering, 3rd Ed, New Age Publication. 2008 • K. R. Varmah: Control Systems, MGH 2010 • Anandnatrajan et. al.: Control Systems Engineering, 4th ed., Scitech Pub. 2013 • K. Ogata: Modern Control Engineering, Prentice Hall of India. 2010 • Norman S. Nise: Control System Engineering, John Wiley & Sons. 2011 • Richard C. Dorf, Robert H. Bishop: Modern Control Systems, Prentice-Hall 2000 • Robert H. Bishop: Modern Control Systems, Boyd and Fraser pub 2000

EE 504 DATA BASE MANAGEMENT SYSTEM

UNIT	CONTENTS	CONTACT HOURS
I	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	8
II	**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.	8
III	**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.	8
IV	**Internal of RDBMS**: Physical data organization in sequential, indexed, random and hashed files. Inverted and multi-list structures	8
V	**(i) Transaction Management:** Transaction concept, transaction state, serializability, conflict serializability, views serializability. **(ii) Concurrency Control:** Lock based protocol. **(iii) Deadlock Handling:** Prevention detection, recovery. **(iv) Recovery System:** Log based recovery.	8

Text Books:	Reference Books:
• Silverschatz Korth and Sudarshan: Database System Concepts, 6th ed., MGH. 2011 • Raghu Rama Krishnan: Database Management Systems, 2nd ed., MGH. 2003	• S. K Singh: Database System Concepts, Designs and Applications, Pearson Education 2011 • Elmasari: Fundamentals of Data Base Systems, Pearson Education. 2003 • G. K. Gupta: Database Management Systems, MGH. 2011 • Date C. J.: An Introduction To Database System, Addition Wesley. 2003 • Alex Berson & Stephen J. Smith: Data Warehousing, Data Mining & OLAP, MGH. 2011 • Mallach: Data Warehousing System, MGH. 2003 • Majumdar & Bhattacharya: Database Management System, MGH. 2011

EE 504-P 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.

EE 505 TRANSMISSION & DISTRIBUTION OF ELECTRICAL POWER

UNIT	CONTENTS	CONTACT HOURS
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. **Distribution Systems:** Primary and secondary distribution systems, feeder, distributor and service mains. Radial and ring- main distribution systems. Kelvin's law for conductor size.	8
II	**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.	8
III	**Parameters of Transmission Lines:** Resistance inductance and capacitance of overheadlines, 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.	8
IV	**Generalized ABCD Line Constants:** equivalent circuit and performance of long transmission line. Ferranti effect. Interference with communication circuits. Power flow through atransmission line **Corona:** Electric stress between parallel conductors. Disruptive critical voltage and visual critical voltage, Factors affecting corona. Corona power loss. Effects of corona.	8
V	**Insulators:** Pin, shackle, suspension, post and strain insulators. Voltage distribution acrossan insulator string, grading and methods of improving string efficiency. **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.	8

Text Books:	Reference Books:
• S. Sivanagaraju and S. Satyanarayana: Electric Power Transmission and Distribution, Pearson Publisher. 2008 • A. S. Pabla: Electric Power Distribution, MGH. 2012	• B. R. Gupta: Power System Analysis & Design, S. Chand Publishers. 2008 • Soni, Gupta and Bhatnagar: A Course in Electrical Power, Dhanpat Rai. 1987 • C. L. Wadhwa: Electrical Power Systems, New Age. 2009 • Nagrath Kothari: Modern Power System Analysis, MGH. 2011 • J. J. Grainger & W. D. Stevenson: Power System Analysis, MGH. 2003 • Kamaraju: Electrical Power Distribution Systems, MGH. 2009

EE 506 I OPTIMIZATION TECHNIQUES

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction:** Engineering application of Optimization, Formulation of design problems as mathematical programming problems, classification of optimization problems.	8
II	**Optimization Techniques:** Classical optimization, multivariable with no constraints, unconstrained minimization techniques, Penalty function techniques, Lagrange multipliers and feasibility techniques	8
III	**Linear Programming:** Graphical method, Simplex method, Duality in linear programming (LP), Sensitivity analysis Applications in civil engineering.	8
IV	**Non Linear Programming Techniques/Method:** Unconstrained optimization, one dimensional minimization, golden section, elimination, quadratic and cubic, Fibonacci, interpolation Direct search, Descent, Constrained optimization, Direct and indirect, Optimization with calculus, Khun_Tucker conditions.	8
V	**Constrained Optimization Techniques:** Direct, complex, cutting plane, exterior penalty function methods for structural engineering problems.	8

Text Books:	Reference Books:
• Rao S. S.: Engineering Optimization- Theory and Practice, New Age International. 2009 • Hadley. G.: Linear programming, Narosa Publishing House, New Delhi. 2003	• Deb. K.: Optimization for Engineering Design_ Algorithms and Examples, PHI. 2012 • Bhavikatti S. S.: Structural Optimization Using Sequential Linear Programming, Vikas Publishing House, New Delhi. 2003 • Spunt: Optimum Structural Design, Prentice Hall. 1971 • Uri Krisch: Optimum Structural Design, MGH. 1981

EE 506 II PRINCIPLE OF COMMUNICATION SYSTEMS

L-03/T-01/P-02	Internal Marks: T-30/P-
Exam Hours: 03	External Marks: T-70/P-

UNIT	CONTENTS	CONTACT HOURS
I	**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.	8
II	**Amplitude Modulation:** Frequency translation, Recovery of base band signal, Spectrum & power relations in AM systems. Methods of generation & demodulation of AM-DSB, AMDSB/SC and AM-SSB signals. Modulation & detector circuits for AM systems. AM transmitters & receivers.	8
III	**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 & deemphasis. Threshold in FM, PLL demodulator.	8
IV	**Noise in AM and FM:** Calculation of signal-to-noise ratio in SSB-SC, DSBSC, DSB with carrier, Noise calculation of square law demodulator & envelope detector. Calculation of S/N ratio in FM demodulators, Super-heterodyne receivers.	8
V	**Pulse Modulation Systems:** Sampling theorem, Generation and demodulation methods of PAM, PWM, PPM.	8

Text Books:	Reference Books:
• John G. Proakis, and Masoud Salehi: Fundamentals of Communication Systems, Pearson Publisher. 2007 • P. Ramakrishna Rao: Communication Systems, MGH. 2013	• V. Chandra Sekar: Communication Systems, Oxford. 2006 • Taub and Schilling: Principles of Communication Systems 3/e, MGH. 2008 • B. P. Lathi: Modern Analog & Digital Communication System, 4th ed., Oxford. 2009 • Simon Hykin: Communication Systems, John Wiley and Sons. 2008 • R. P. Singh and S. D. Sapre: Communication System Analog & Digital 2/e, MGH. 2008 • G. Kennedy and B. Davis: Electronic Communication Systems, MGH. 1993 • Roy Blake: Wireless Communication Technology, Thomson Asia Pvt. Ltd. Singapore.

EE 506 III INTRODUCTION TO VLSI

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction to MOS Technology:** Basic MOS transistors, Enhancement Mode transistoraction, Depletion Mode transistor action, NMOS and CMOS fabrication.	**8**
II	**Basic Electrical Properties of MOS Circuits:** __ versus __relationship, Aspects of threshold voltage, Transistor Trans conductance gm. The NMOS inverter, Pull up to Pull-down ratio for a NMOS Inverter and CMOS Inverter__ __, MOS transistor circuit Model, Noise Margin.	**8**
III	**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	**8**
IV	**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.	**8**
V	Introduction to VHDL, Verilog & other design tools. VHDL Code for simple Logic gates, flip-flops, shift-registers, Counters, Multiplexers, adders and subtractors.	**8**

Text Books:	Reference Books:
• S. M. Sze: VLSI Technology, MGH. 2003 • 2 Debaprasad Das: VLSI Design, Oxford. 2011	• Angsuman Sarkaret. al.: VLSI Design and EDA Tools, Scitech Pub. 2011 • S. M. Kang: CMOS Digital Integrated Circuits, MGH. 2003 • Stephen A. Campbell: The Science & Engineering of Microelectronic Fabrication, Oxford. 2001 • James D. Plummer, Micheal Deal & Petter B. Griffin: Silicon VLSI Tech. Fundamental Practice & Modeling, Prentice Hall.2000

EE 507-P SYSTEM PROGRAMMING LAB

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)
Simulink: Idea about simulink, problems based on simulink. (All contents is to be covered with tutorial sheets)Write a program to generate Machine Op- code table using two pass Assembler.

EE 508-P PROFESSIONAL ETHICS AND IPR

UNIT	CONTENTS	CONTACT HOURS
I	**Objectives:** to help the students • To appreciate the importance and values and ethics in implementing the technology and ensure sustainable development, happiness and prosperity. • To understand the co-existence with nature and to be aware of potential natural and manmade disasters.	8
II	**Human Values:** Effect of Technological Growth and Sustainable Development. Profession and Human Values: Values crisis in contemporary society. Nature of values. Psychological Values, Societal Values and Aesthetic Values. Moral and Ethical values.	8
III	**Professional Ethics:** • Professional and Professionalism-Professional Accountability, Role of a professional, Ethic and image of profession. • Engineering Profession and Ethics-Technology and society, Ethical obligations of Engineering professionals, Roles of Engineers in industry, society, nation and the world. • Professional Responsibilities-Collegiality, Loyalty, Confidentially, Conflict of Interest, Whistle Blowing.	8
IV	**Introduction to IPR:** Nature and Enforcement. Trade Secrets. Trade Marks. Registration and Infringement Penalties.	8
V	**Patents:** Obtaining Patents, Tights and Obligations of Patentees. Transfer of Patent Rights. **Copyright:** Nature and Infringement of Copyright. International Copyrights. Publication and Registration. **Trade Secrets:** Industrial Secrets, Trade Secrets, Employer-Employee Relationship.	8

Text Books:

- R Subramanian: Professional Ethics, oxford publishers.
- Engineering Ethics: Concepts and cases by Charles E. Harris, Jr., Michael S. Pritchard, MichaelJ. Rabins. Cengage Learning, Delhi
- Stephen H. Unger: Controlling Technology- Ethics and Responsible Engineers, John Willey and Sons.
- Deborah Johnson: Ethical Issues in Engineering, Prentice Hall.
- A. N. Tripathi: Human Values in the engineering Profession, Moniograph, Published by IIM Calcutta.
- D. K. Sinha: Towards Basics of Natural Disaster Reduction, Researchco Book Center, Delhi.
- Amita Sinvhal: Understanding Earthquake Disasters,MGH, New Delhi.
- Selected Resources available on www.nidmindia.nic.in

EE 601 MODERN CONTROL THEORY

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction:** Concept of Linear vector space Linear Independence, Bases & Representation, domain and range. Concept of Linearity, relaxedness, time invariance, causality. **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 statespace equations of mechanical, Electrical systems, Analogous systems.	**8**
II	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.	**8**
III	**Solution of State Equations:**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.	**8**
IV	**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.	**8**
V	Modeling of sample-hold circuit, steady state accuracy, stability in z-plane and Jury stability criterion, bilinear transformation Routh-Hurwitz criterion on s-planes,digital PID controllers, Introductionto adaptive control.	**8**

Text Books:	Reference Books:
• J. Nagrath and M. Gopal: Control Systems Engineering, 3rd Ed, New Age Publication. 2008 • 2 S. K. Bhattacharya: Control Systems Engineering, 3e, Pearson Publishers. 2009	• Dhannesh N. Manik: Control System, Cengage Learning. 2010 • Richard C. Dorf, Robert H. Bishop: Modern Control Systems, Prentice-Hall. 2008 • M. Gopal: Digital Control and State Variable Methods, MGH. 2012 • B. C. Kuo: Digital Control System, Oxford. 1980 • C. H. Houpis and G. B. Lamont, Digital Control Systems, MGH. 1992 • Donald E. Kiv: Optimal Control Theory- An Introduction, Prentice Hall. 2009 • D. Roy, Choudhary: Modern Control Engineering, Prentice Hall of India. 2005 • C. T. Chen: System Theory &Design, Oxford University Press. 1999

EE 601-P 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 2nd 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 2nd order system and find GM and PM.

EE 602 HIGH VOLTAGE ENGINEERING

UNIT	CONTENTS	CONTACT HOURS
I	**(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	**8**
II	**(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.	**8**
III	**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.	**8**
IV	**(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.	**8**
V	**(i) Over Voltage Protection:** Basic construction and operation of ground wiresprotection 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	**8**

Text Books:	Reference Books:
• Naidu: High Voltage Engineering 4/e, MGH. 2013 • John Kuffel, E. Kuffel and W. S. Zaengl: High Voltage engineering, Elsevier. 2000	• C. L.Wadhwa: High Voltage Engineering, Wiley Eastern Ltd. 2007 • Subir Ray: An Introduction to High Voltage Engineering, Prentice Hall of India. 2013

EE 602-P HIGH VOLTAGE 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.

EE 603 SWITCHGEAR & PROTECTION

UNIT	CONTENTS	CONTACT HOURS
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. **Static Over Current Relays:** Introduction to instantaneous, definite time, inverse time and directional overcurrent relays.	**8**
II	**Static Differential Relays:** Brief description of static differential relay schemessingle phase and three phase schemes. Introduction to static differential protection of generator and transformer. **Static Distance Relays:** Introduction to static impedance, reactance and mho relays.	**8**
III	**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. **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.	**8**
IV	**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. Miniature Circuit breaker (MCB).	**8**
V	**Circuit Breakers-II**: Air blast, SF6 and vacuum circuit breakers. Selection of circuit breakers, rating of circuit breakers. **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.	**8**

Text Books:	Reference Books:
• Bhavesh Bhalja, R. P. Maheshari and Nilesh G. Chothani: Protection and Switchgear, Oxford. 2011 • Bhuvanesh A. Oza and Nair: Power System Protection and Switchgear, MGH. 2010	• B. Ravindranath and M. Chander: Power system Protection and Switchgear, Wiley. 1977 • B. Ram and D. N. Vishwakarma: Power System Protection and Switchgear, MGH. 2001 • Y. G. Paithankar and S. R. Bhide: Fundamentals of Power System Protection, PHI. 2010 • T.S.M. Rao: Power System Protection- Static Relays with Microprocessor Applications, MGH. 1989 • A. R. Van C. Warringtaon: Protective Relays-Their Theory and Practice, Vol. I & II, Jhon Willey & Sons. 1978 • S. S. Rao: Switchgear and Protection, Khanna Publishers. 2008

EE 603-P 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

EE 604 ADVANCED POWER ELECTRONICS

UNIT	CONTENTS	CONTACT HOURS
I	**AC Voltage Controllers**: Principle of On-Off Control, Principle of Phase control, SinglePhase Bi-directional Controllers with Resistive Loads, Single Phase Controllers with Inductive Loads, Three Phase full wave AC controllers, AC Voltage Controller with PWM Control.	**8**
II	**Cyclo-converters:** Basic principle of operation, single phase to single phase, thrEE phase to thrEE phase and thrEE phase to single phase cyclo-converters. Output equation, Control circuit.	**8**
III	**Inverters:** Principle of Operation, Single-phase bridge inverters. Three phase bridge Inverters: 180 and 120 degree of conduction. VSI and CSI. Voltage control of Single Phase and Three Phase Inverters, Harmonic analysis, harmonic reduction techniques, Pulse width modulation techniques.	**8**
IV	**Resonant Pulse Inverter:** Series resonant inverter with unidirectional switches, parallel resonant inverter, class E resonant inverter, L-type and M-type ZCS resonant converter, ZVS resonant converter.	**8**
V	**Power Supplies:** Switched Mode DC Power Supplies, fly-back converter, forward converter, half and full bridge converter, resonant DC power supplies, bi-directional power supplies. Resonant AC power supplies, bidirectional AC power supplies. Multistage conversions, Control Circuits: Voltage Mode Control, Current Mode Control	**8**

Text Books:	Reference Books:
• M. H. Rashid: Power Electronics: Circuits, Devices & Applications, Pearson Publishers. 2004 • Bimal Bose: Power Electronics & Motor Drives, Elsevier-2006. 2010	• V. R. Moorthy: Power Electronics: Devices, Circuits and Industrial Applications, Oxford. 2005 • P. C. Sen: Power Electronics, MGH. 1987 • Ned Mohan, T. M. Undeland and W. P. Robbins: Power Electronics-Converters, Applications and Design, Wiley India Ltd, 2008. 2007 • R. Krishnan: electric motor drives- modeling, analysis and control, Pearson Edu. 2001

EE 604-P ADVANCED POWER ELECTRONIC 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.

EE 605 SMART GRID TECHNOLOGY

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction to Smart Grid:** Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and Benefits Difference between conventional & Smart Grid, Concept of Resilient &Self-Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.	**8**
II	**Smart Grid Technologies:** Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, **Protection and Control, Distribution Systems**: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).	**8**
III	**Smart Meters and Advanced Metering Infrastructure:** Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMIprotocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement, Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.	**8**
IV	**Power Quality Management in Smart Grid:** Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Qualitymonitoring, Power Quality Audit.	**8**
V	**High Performance Computing for Smart Grid Applications:** Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadbandover Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing tomake Smart Grids smarter, Cyber Security for Smart Grid	**8**

Text Books:	Reference Books:
• Vehbi C. Güngör, Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke: Smart Grid Technologies- Communication Technologies and Standards IEEE Transactions on Industrial Informatics, Vol. 7, No. 4, November 2011. • Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang: Smart Grid – The New and Improved Power Grid- A Survey, IEEE Transaction on Smart Grids, 2011	• Stuart Borlase: Smart Grid-Infrastructure, Technology and Solutions, CRC Press 2012

EE 605-P SMART GRID LAB

1	Study different components of smart grid
2	To visit thermal/nuclear power plant
3	To design and simulate hybrid wind-solar power generation system using simulating software
4	Study Different terminology used in power quality assessment
5	Study and measure certain parameters of power quality in laboratory with and without power quality improvement devices.

EE 606 I ADVANCED MICROPROCESSORS

UNIT	CONTENTS	CONTACT HOURS
I	**8086 Microprocessor:** Hardware specifications, architecture, address spaces, clock generator, bus controller and arbiter, Minimum and maximum mode, System Bus Timing.	8
II	**Software & Instruction Set:** Assembly language programming: addressing mode and instructions of 8086, linking and execution of programs, MACRO programming, assembler directives and operators.	8
III	**I/O Interfaces:** Programmable peripheral interfacing (8255, 8155), Programmable Timer interfacing (8253, 8254), Programmable interrupt controller (8259), Serial CommunicationInterfaces.	8
IV	**Data & Memory Interfacing:** A/D, D/A converter interfacing, Memory interfacing and Decoding, DMA controller.	8
V	**Multiprocessor Configurations:** 8086 based Multiprocessor systems. 8087 Numeric data processor. Introduction to 8-bit and 16-bit microcontrollers.	8

Text Books:	Reference Books:
• A. Nagoor Kani: Microprocessors and Microcontrollers, 2nd ed., MGH. 2012 • N. Senthil Kumar and Saravanan: Microprocessors and Interfacing, Oxford. 2012	• John Freer: System design with Advance Microprocessors, A.H. Wheeler 1987 • Ray & Bhurchandi: Advanced Microprocessors and Peripherals 2/e (MGH) 2006 • Lyla B. Das: The X 86 Microprocessors- Architecture, Programming and Interfacing (8086 to Pentium), Pearson Publisher. 2010 • Gibson: 16-Bit Microprocessor. • Brey: 16-Bit Microprocessor 2009 • Ray, A. K. & Burchandi, K. M.: Advanced Microprocessors and Peripherals-Architecture, Programming and Interfacing, MGH. 2006 • Brey, Barry B.: The INTEL Microprocessors, Pearson Education. 2011 • Ayala: The 8051 Micro Controller, Cengage Learning. 2004

EE 606 II POWER SYSTEM INSTRUMENTATION

UNIT	CONTENTS	CONTACT HOURS
I	**Theory of Errors:** Accuracy and precision, systematic and random errors, limits of error, probable error and standard deviation. Gaussian error curves, combination of errors.	8
II	**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.	8
III	**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.	8
IV	**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. Basic idea of LT & HT panel's.	8
V	**Power System Instrumentation-II:** Capacitive voltage transformers and their transient behavior, Current Transformers for measurement and protection, composite errors and transient response.	8

Text Books:	Reference Books:
• R. H. Cerni and L. E. Foster: Instrumentation for Engineering Measurements, John Wiley and Sons. 1962 • Curtis and D. Hohnson: Process Control Instrumentation Technology, John Wiley and sons. 2013	• R. Morrison: Instrumentation Fundamentals and Applications, John Wiley and Sons. 1984 • A. K. Sawhney: Advanced Measurements & Instrumentation, Dhanpat Rai & Sons. 1994 • E.O. Decblin: Measurement System– Application & design, MGH. 1975 • W.D. Cooper and A.P. Beltried: Electronics Instrumentation and Measurement Techniques, Prentice Hall International. 1987 • A. S. Moris: Principles of Measurement & Instrumentation, Prentice Hall 1993

EE 606 III DIGITAL COMMUNICATION AND INFORMATION THEORY

UNIT	CONTENTS	CONTACT HOURS
I	**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.	**8**
II	**Digital Modulation Techniques:** Various techniques of phase shift, amplitude shift and frequency shift keying. Minimum shift keying. Modulation & Demodulation.	**8**
III	**Error Probability in Digital Modulation:** Calculation of error probabilities for PSK, ASK, FSK & MSK techniques.	**8**
IV	**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.	**8**
V	**Coding:** Coding of Information, Hamming code, Single Parity-Bit Code, Linear Block code, cyclic code &convolution code.	**8**

Text Books:	Reference Books:
• R. N. Mutagi: Digital Communication, 2nd ed., Oxford. 2013 • P. Ramakrishna Rao: Communication Systems, MGH. 2013	• H. Taub & D.L. Schilling: Principles of Communication Systems, MGH. 2008 • Simon Haykin: Communication Systems, John Wiley & Sons. 2008 • Proakis: Digital Communication, MGH. 2008 • Sklar: Digital Communication, Pearson Education. 2009 • P. Chakrabarti: Principles of Digital Communications, Danpatrai & Sons. 1999 • K. Sam Shanmugam: Digital and Analog Communication System, John Wiley Sons. 2006 • Lathi, B. P.: Modern Digital &Analog Communication System, Oxford Press. 2009 • A.B. Carlson: Digital Communication Systems, MGH. 1988

EE 701 POWER SYSTEM PLANNING

UNIT	CONTENTS	CONTACT HOURS
I	Introduction of power planning, National and Regional Planning, structure of P.S., planning tools. Electricity Regulation, Electrical Forecasting, forecasting techniques modeling.	**8**
II	Generation planning, Integrated power generation cogeneration/captive power, Power pooling and power trading. Transmission and distribution planning. Power system Economics. Power sector finance, financial planning, private participation Rural Electrification investment, concept of Rational tariffs.	**8**
III	Power supply Reliability, Reliability planning. System operation planning, load management, load prediction, reactive power balance Online power flow studies, state estimation, computerized management, power system simulator.	**8**
IV	Computer aided planning, wheeling. Environmental effects, the greenhouse effect. Technological impacts. Insulation coordination. Reactive compensation.	**8**
V	Optimal power system expansion planning: Formulation of least cost optimization problem incorporating the capital, Operating and maintenance cost of candidate plants of different types (Thermal, Hydro, Nuclear, Non-conventional etc.) and minimum assured reliability constraint – optimization techniques for solution by programming.	**8**

Text Books:	**Reference Books:**
• X. Wang, J. R. Mc Donald: Modern Power System Planning, MGH. 1994 • A. S. Pabla: Electrical Power System Planning, Machmillan India Ltd. 2012	• M. Tllic, F. Faliana and L. Fink: Power System Restructuring Engineering and Economics, Kulwar Academic Publisher. 2010 • L. L. Lie: Power System Restructuring and Deregulation, John Willey & Sons UK. 2001

EE 701-P POWER SYSTEM PLANNNG LAB

1	Status of National and Regional Planning, for power system
2	Write components of Structure of power system
3	Explain in detail various planning tools.
4	Write short note on Electricity Regulation
5	Modeling of Electrical Forecasting techniques
6	Transmission and distribution planning
7	Concept of Rational tariffs
8	Rural Electrification

EE 702 POWER SYSTEM ANALYSIS

UNIT	CONTENTS	CONTACT HOURS
I	Percent and per unit quantities. Single line diagram for a balanced 3-phase system **Admittance Model**: Branch and node admittances Equivalent admittance network and calculation of Y bus. Modification of an existing Y bus.	8
II	**Impendence Model**: Bus admittance and impedance matrices. Thevenin's theorem and Z bus. Direct determination of Z bus. Modification of an existing bus. **Symmetrical fault Analysis**: Transient on a Transmission line, short circuit of a synchronous machine on no load, short circuit of a loaded synchronous machine. Equivalent circuits of synchronous machine under sub transient, transient and steady state conditions. Selection of circuit breakers, Algorithm for short circuit studies. Analysis of thrEE phase faults.	8
III	**Symmetrical Components**: Fortescue 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. **Fault Analysis**: Analysis of single line to ground faults using symmetrical components, connection of sequence networks under the fault condition.	8
IV	**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. Analysis of unsymmetrical shunt faults using bus impedance matrix method.	8
V	**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.	8

Text Books:	Reference Books:
• J. J. Grainger, William, D. Stevenson Jr.: Power System Analysis, MGH. 2003 • T. K. Nagsarkar & M. S. Sukhija: Power System Analysis, Oxford University Press. 2007	• J. D. Glover, M. S. Sharma & T. J. Overbye: Power System Analysis and Design, Cengage Learning. 2007 • Nasser Tleis: Power System Modelling and Fault Analysis, Elsevier. 2007 • Kothari & Nagrath: Modern Power System Analysis, MGH. 2011 • Haadi Saadat: Power System Analysis. 2002

EE 702-P POWER SYSTEM MODELLING AND SIMULATION LAB

1	Simulate Swing Equation in Simulink (MATLAB)
2	Modeling of Synchronous Machine.
3	Modeling of Induction Machine.
4	Simulate simple circuits using Circuit Maker.
5	(a) Modeling of Synchronous Machine with PSS (b) Simulation of Synchronous Machine with FACTS device.
6	(a) Modeling of Synchronous Machine with FACTS device (b) Simulation of Synchronous Machine with FACTS devices.
7	FACTS Controller designs with FACT devices for SMIB system.

EE 703 ARTIFICIAL INTELLIGENCE TECHNIQUES

UNIT	CONTENTS	CONTACT HOURS
I	**Artificial Intelligence:** Introduction to AI and knowledge based Expert systems, Introduction, Importance and Definition of AI, ES, ES building tools and shells.	8
II	**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.	8
III	**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.	8
IV	**Basic Concepts in Learning ANN:** Supervised learning, Back propagation algorithm, unsupervised learning, Kohonen's top field network & Algorithm.	8
V	**Fuzzy Logic:** Fuzzy logic concepts, Fuzzy relation and membership functions, Defuzzification, Fuzzy controllers, **Genetic Algorithm:** concepts, coding, reproduction, crossover, mutation, scaling and fitness.	8

Text Books:	Reference Books:
• Saroj Kaushik: Artificial Intelligence, Cengage Learning. 2007 • Elaine Rich and Kevin Knight: Artificial Intelligence 3/e, MGH 2004	• Padhy: Artificial Intelligence & Intelligent Systems, Oxford 2005 • James Anderson: An introduction to Neural Networks. 1995 • Dan. W Patterson: Artificial Intelligence and Expert Systems. 1990 • Kumar Satish: Neural Networks, 2nd ed., MGH. 2004 • S. Rajsekaran & G. A. Vijayalakshmi Pai: Neural Networks, Fuzzy Logic and Genetic Algorithm- Synthesis and Applications, Prentice Hall of India. 2003 • Siman Haykin: Neural Netowrks, Prentice Hall of India. 2004

EE 704 NON CONVENTIONAL ENERGY SOURCES

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction:** World energy situation, conventional and non-conventional energy sources, Indian energy scene. **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.	8
II	**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.	8
III	**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. **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.	8
IV	**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 hybridand cold fusion.	8
V	**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.	8

Text Books:	Reference Books:
• G. D. Rao: Renewable Energy 2010 • 2 B. H. Khan: Non-Conventional Energy Resources, MGH. 2006	• A. N. Mathur: Non-Conventional Resources of Energy. 2010 • Boyle: Renewable Energy, 3rded Oxford. 2007 • Bent Sorensen, 4th ed.: Renewable Energy, Elsevier. 2009 • V. V. N. Kishore: Renewable Energy Engineering and Technology, TERI. 2006 • Garg & Prakash: Solar Energy : Fundamentals and Applications, MGH 2000 • David Boyles: Bio Energy, Elis Horwood Ltd., 1984

EE 705 POWER SYSTEM ENGINEERING

UNIT	CONTENTS	CONTACT HOURS
I	**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.	**8**
II	**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.	**8**
III	**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.	**8**
IV	**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. **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.	**8**
V	Tap Changing transformer, phase angle control and phase shifting transformer. Series compensation of transmission lines, location and protection of series capacitors, advantages and problems. Introduction to power system security. Introduction to voltage stability.	**8**

Text Books:	Reference Books:
• J. Nagrath and D.P. Kothari: Power System Engineering 2/e, MGH. 2011 • J. J. Grainger and W. D. Stevenson: Power System Analysis, MGH. 2003	• B. R. Gupta: Power System Analysis and Design, Third Edition, S. Chand & Co. 2008 • C. L. Wadhwa: Electrical Power Systems, New age international Ltd. Third Edition 2009 • W. D. Stevenson: Element of Power System Analysis, MGH. 1955 • B. R. Gupta: Generation of Electrical Energy, S. Chand Publication. 2009

EE 706 I ELECTROMAGNETIC FIELD THEORY

UNIT	CONTENTS	CONTACT HOURS
I	**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	8
II	**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.	8
III	**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.	8
IV	**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.	8
V	**Transmission Lines:** The high-frequency circuit. LCR ladder model. The transmission Lin equation. Solution for loss-less lines. Wave velocity and wave impedance. Reflection and Transmission coefficients at junctions. VSWR.	8

Text Books:	Reference Books:
• Hayt: Engineering Electromagnetics, 7/e, (With CD), MGH 2012 • Matthew N. O. Sadiku: Principles of Electromagnetics, 4th ed., Oxford 2009	• G. S. N. Raju: Electromagnetic Field Theory and Transmission Lines, Pearson. 2006 • J. D. Kraus: Electromagnetic. 5th edition, MGH. 1999 • S. Baskaran and K. Malathi: Electromagnetic Field and Waves, Scitech Pub. 2013 • R. S. Kshetrimayum, Electromagnetic Field Theory, Cengage Learning. 2012 • V.V. Sarwate: Electromagnetic Field and Waves, Willey Eastern Ltd. 1993 • Bhag Guru: Electromagnetic Field Theory Fundamentals, Cambridge Uni. Press. 2004

EE 706 II COMPUTER AIDED DESIGN OF ELECTRICAL MACHINES

UNIT	CONTENTS	CONTACT HOURS
I	**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.	8
II	**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.	8
III	**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.	8
IV	**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.	8
V	**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.	8

Text Books:	Reference Books:
• A. K. Sawhney: A Course in Electrical Machine Design, Dhanpat Rai & Sons. 1984 • B. Edikins: Generalized Theory of Electrical Machines. 1995	• Fitzegerald: Electrical Machinery, Kingsley. 2002 • M. G. Say: The Performance and Design of AC Machines, Pitman & Sons. 1958 • R. K. Agrawal: Electrical Machine Design 2009

EE 706 III ECONOMIC OPERATION OF POWER SYSTEMS

UNIT	CONTENTS	CONTACT HOURS
I	**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	**8**
II	**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	**8**
III	**Hydro Thermal coordination:** Advantages of combined operation, base load peak load operation requirement, combined working of run-off river and steam plant. Reservoirs hydroplants and thermal plants (long term operational aspects), short term hydro thermal coordination, coordination equations, scheduling methods and applications.	**8**
IV	**Parallel Operations of Generators:** Conditions, synchronizingcurrent 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.	**8**
V	**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	**8**

Text Books:	Reference Books:
• J. Wood & B. F. Wollenburg: Power Generation, Operation and Control, John Wiley. 2013 • D. P. Kothari & I. J. Nagrath: Modern Power System Analysis, MGH. 2003	• O. I. Elgerd: Electric Energy System Theory, MGH. 1983 • P. Kundur: Power System Stability and Control, MGH. 1994 • Arthur R. Bergen and Vijay Vittal: Power System Analysis, Second Edition. PHI. 1999 • C. L. Wadhwa: Electrical Power Systems, Newage International (P) Ltd. 2000 • C. Gross, Power Systems Analysis, 2nd Edition. John Wiley &Sons. 1986

EE 707-P INDUSTRIAL ECONOMICS &MANAGEMENT

UNIT	CONTENTS	CONTACT HOURS
I	**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.	**8**
II	**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.	**8**
III	**Production Management:** Production planning and control, inventory control, quality control and Total quality management. ISO standards Related to quality/Environment/safety etc. **Tools of Project Management:** CPM, PERT, project information systems. Marketing functions, management of sales and advertising marketing research.	**8**
IV	**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.	**8**
V	**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, breakeven analysis, budgeting and budgetary control.	**8**

EE 801 EHV AC/DC TRANSMISSION

UNIT	CONTENTS	CONTACT HOURS
I	**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.	**8**
II	**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).	**8**
III	**Voltage Control:** No load receiving end voltage and reactive power generation. Methods of voltage control. Synchronous phase modifier. Shunt capacitors and reactors, saturable reactors, Thyristorised static VAR compensators- TCR, FC-TCR and TSC- TCR.	**8**
IV	**FACTS:** Introduction to FACTS controllers, types of FACTS controllers, Brief description of STATCOM, Thyristor controlled series capacitors and unified power flow controller.	**8**
V	**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.	**8**

Text Books:	Reference Books:
• E. W. Kimbark: Direct Current Transmission, Vol. 1, Wiley Interscience. 1971 • K. R. Padiyar: HVDC Power Transmission System, Wiley Eastern Ltd. 1990	• K. R. Padiyar: HVDC Power Transmission Systems. NEW AGE PUB 1992 • J. Arrillaga: H.V.D.C Transmission, Peter Peregrines. 1983 • J. Arrillaga HVDC et. al, : Computer Modelling of Electrical Power System. John Wiley. 1993

EE 802 ELECTRIC DRIVES AND THEIR CONTROL

UNIT	CONTENTS	CONTACT HOURS
I	**Dynamics of Electric Drives:** Fundamental torque equations, speed-torque conventions and multi-quadrant operation, Nature and classification of load torques, steady state stability, load equalization, close loop configurations of drives.	8
II	**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.	8
III	**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.	8
IV	**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.	8
V	**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).	8

Text Books:	Reference Books:
• G. K. Dubey: Fundamentals of Electrical Drives, Narosa Publishing House, New Delhi. 2002 • B. K. Bose: Power Electronics and Motor Drives, Elsevier. 2010	• V. Subrahmanyam: Electric Drives- Concepts and Applications, MGH. 2011 • Theodore Wildi: Electrical Machines, Drives and Power Systems, Pearson 2007 • S. K. Pillai: A First Course on Electrical Drives, Wiley Eastern limited, India. 1989 • N. K. De and Prashant K. Sen: Electric Drives, Prentice Hall of India Ltd. 1999

EE 802-P 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 a 3-phase BLDC motor.
10	Control speed of a 3-phase PMSM motor using frequency and voltage control
11	Control speed of universal motor using AC voltage regulator.
12	Study 3-phase dual converter.
13	Study speed control of dc motor using 3-phase dual converter.
14	Study thrEE phase cycloconverter and speed control of synchronous motor using cycloconverter.
15	Control of 3-Phase Induction Motor in variable frequency V/f constant mode using 3-phase inverter

EE 803 PROTECTION OF POWER SYSTEM

UNIT	CONTENTS	CONTACT HOURS
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. **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).	**8**
II	**Overcurrent Protection:** HRC fuse and thermal relay. Overcurrent 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_0, 60_0 and 90_0 connections. Earth fault relay. Brief description of overcurrent protective schemes for a feeder, parallel feeders and ring mains.	**8**
III	**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).	**8**
IV	**Transformer Protection:** Percentage differential protection, magnetizing inrush current, percentage differential relay with harmonic restraint. Buchholz relay. Differential protection of generator transfer unit. **Busbar Protection:** Differential protection of busbars. High impedance relay scheme, frame leakage protection	**8**
V	**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. **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	**8**

Text Books:	Reference Books:
• Badri Ram: Power System Protection and Switchgear, MGH. 2011 • Ravindra Nath M. Chander: Power System Protection and Switch Gear, John Wiley Eastern. 1977	• Sunil S. Rao.: Power System Protection and Switch Gear, Khanna Publishers. 1999 • Oza: Power System Protection and Switchgear, MGH. 2010

EE 804 I UTILIZATION OF ELECTRICAL POWER

UNIT	CONTENTS	CONTACT HOURS
I	**Electric Heating:** Different methods of electric heating. Principle of high frequency induction and dielectric heating. Construction, operation, performance and applications of arc furnace and induction furnace **Electric Welding:** Welding process, welding transformer, Classification of Electric Welding: arc welding, resistance welding, welding of various metals.	8
II	**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.	8
III	**Electrolytic Process:** Principles and applications of electrolysis, electro-deposition, Manufactures of chemicals, anodizing, electro-polishing , electro-cleaning, electroextraction, electro-refining, electro-stripping (parting) power supplies for electrolytic process.	8
IV	**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.	8
V	**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.	8

Text Books:	Reference Books:
• C. L. Wadhwa: Utilization of Electric Traction Electric Power. 1989 • H. Partab: Art and Science of Electrical Energy, Dhanpat Rai & Sons. 1975	• H. Partab:Modern Electric Traction, Dhanpat Rai & Sons 1973

EE 804 II FACTS DEVICES & THEIR APPLICATIONS

UNIT	CONTENTS	CONTACT HOURS
I	Problems of AC transmission systems, power flow inparallel 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.	8
II	**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. **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.	8
III	**Static Series Compensators:** Concept of series capacitive compensation, voltage and transient stabilities, power oscillation and sub synchronous oscillation damping. Introduction to thyristors witched series capacitor (TSSC), thyristor controlled series capacitor (TCSC), and static synchronous series compensator, - operation, characteristics and applications.	8
IV	**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.	8
V	**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. **IPFC:** Interline Power Flow Controller (IPFC), basic operating principles and characteristics. Applications of IPFC.	8

Text Books:	Reference Books:
• K. R. Padiyar: Flexible AC Transmission Systems 2009 • N. G. Hingorani, L. Gyugyi: Understanding FACTS: IEEE Press Book. 2000	• Yong Hua Song, Allan T Johns : Flexible AC Transmission Systems FACTS 1999 • Xiao Ping Zhang, Christian Rehtanz, Bikash Pal: Flexible AC Transmission Systems. 2006 • R. Mohan & R. M. Mathur: Thyristor-based FACTS Controllers for Electrical Transmission Systems, John Wiley 2002

EE 804 III POWER SYSTEM TRANSIENTS

UNIT	CONTENTS	CONTACT HOURS
I	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.	8
II	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.	8
III	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.	8
IV	Mechanism of Lightning Discharge Types of Lightning strokes, Harmful effects of lighting, protections against lightning, overhead Ground wires.	8
V	Lightening Arresters, Types of lightening arresters, Surge Absorber simulation of surge diverters in transient analysis. Fourier integral and z transform methods in power system transient	8

Text Books:	Reference Books:
• C. S. Indulkar and D. P. Kothari: Power System Transients, NEW AGE. 2010 • Lou Van der Sluis: Transients in Power Systems, John Wiley 2001	• N. R. Watson, J. Arrillaga: Power Systems Electromagnetic Transients, John Wiley 2001

EE 805-P 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.

EE 806-P 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.