Enclosure to Item No.
27.5.2009

UNIVERSITY OF MUMBAI

Revised Syllabus for the
Third Year Electrical Engineering
(Semester V & VI)

(With effect from the academic year 2009-2010)

UNIVERSITY OF MUMBAI
Syllabus Structure (R-2007)
at
T.E.(ELECTRICAL ENGINEERING)

Semester V

S. No.	Subject	Scheme of Instructions, Periods per week (60 min)			Scheme of Evaluation					
		Theory	Practical	Tutorial	Paper		Term work	Practical & Oral	Oral	Total Marks
					Hours	Marks				
1	Electromagnetic Fields and Waves	4	--	2	3	100	25	--	--	125
2	Electrical Machine-II	4	2	--	3	100	25	50	--	175
3	Communication Engineering	4	2	--	3	100	25		25	150
4	Power System Analysis	4	--	2	3	100	25	--	25	150
5	Power Electronics	4	2	--	3	100	25	50	--	175
6	Environment Studies	2	--	1*	2	50	25	--	--	75
	Total	22	6	5		550	150	100	50	850

*Tutorial to be conducted class wise.

University of Mumbai			
Class: T.E.	**Branch:** Electrical Engineering	**Semester:** V	
Subject: Electromagnetic Fields and Waves (abbreviated as EFW)			
Periods per Week (Each 60 min)	Lecture	4	
	Practical	---	
	Tutorial	2	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical and Oral	--	--
	Oral	--	--
	Term Work	--	25
	Total	3	125

Module	Contents	Hours
1	**Vector Basics:** Introduction to Co-ordinate System – Rectangular – Cylindrical and Spherical Co-ordinate System – Introduction to line, Surface and Volume Integrals – Definition of Curl, Divergence and Gradient .	04
2	**Static Electric Fields:** Coulomb's Law in Vector Form – Definition of Electric Field Intensity – Principle of Superposition – Electric Field due to discrete charges, Electric field due to continuous charge distribution - Electric Field due to line charge– Electric Field on the axis of a uniformly charged circular disc – Electric Field due to an infinite uniformly charged sheet. Electric Scalar Potential – Relationship between potential and electric field - Potential due to infinite uniformly charged line – Potential due to electrical dipole - Electric Flux Density – Gauss Law – Applications.	10
3	**Static Magnetic Fields:** The Biot-Savart Law in vector form – Magnetic Field intensity due to a finite and infinite wire carrying a current I – Magnetic field intensity on the axis of a circular and rectangular loop carrying a current I – Ampere's circuital law and simple applications. Magnetic flux density – The Lorentz force equation for a moving charge and applications – Force on a wire carrying a current I placed in a magnetic field – Torque on a loop carrying a current I – Magnetic moment – Magnetic Vector Potential.	08

4	**Electric and Magnetic Fields in Materials:** Poisson's and Laplace's equation – Electric Polarization- Nature of dielectric materials- Definition of Capacitance – Capacitance of various geometries using Laplace's equation – Electrostatic energy and energy density – Boundary conditions for electric fields – Electric current – Current density – point form of ohm's law – continuity equation for current. Definition of Inductance – Inductance of loops and solenoids – Definition of mutual inductance – simple examples. Energy density in magnetic fields – Nature of magnetic materials – magnetization and permeability - magnetic boundary conditions.	10
5	**Time varying Electric and Magnetic Fields:** Faraday's law – Maxwell's Second Equation in integral form from Faraday's Law – Equation expressed in point form. Displacement current – Ampere's circuital law in integral form – Modified form of Ampere's circuital law as Maxwell's first equation in integral form – Equation expressed in point form. Maxwell's four equations in integral form and differential form.	04
6	**Wave Theory:** Derivation of Wave Equation – Uniform Plane Waves – Maxwell's equation in Phasor form – Wave equation in Phasor form – Plane waves in free space and in a homogenous material. Wave equation for a conducting medium – Plane waves in lossy dielectrics – Propagation in good conductors The importance of characteristics impedance and the propagation constant. The wave travel, the concept of phase velocity and group velocity in wave travel. The voltage standing wave ratio. Traveling wave in transmission lines.	08
7	**Power Flow:** Poynting Vector and the flow of power – Power flow in a co-axial cable – Instantaneous Average and Complex Poynting Vector.	04

Theory Examination:

1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Term work:

Term work consists of minimum seven tutorials (one on each module)and three computer progra and a written test. The distribution of the term work shall be as follows,

Tutorials and computer programs (Journal) :10 marks
Sessional Test on entire syllabus :10 marks
Attendance (Tutorial and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of Tutorial work and minimum passing in the term-work.

Text books:

1. W. Hayt., "*Engineering electromagnetic*", McGraw Hill, 4th edition, 1987.
2. Edminister,"*Schaum's series in electromagnetic*" McGraw Hill publications, 3rd edition, 198
3. N. Narayan Rao," *Elements of electromagnetic*", PHI publication, 4th edition, 2001.
4. E.C. Jordan & K.G. Balmain "Electromagnetic Waves and Radiating Systems." Prentice Hal India 2nd edition 2003. (Unit IV, V). McGraw-Hill, 9th reprint.

Reference books:

1. Fenmann, "*Lectures on physics*", Vol – 2, Addition Wesley, 1965
2. S. Seely, "*Introduction to electromagnetic fields*", McGraw Hill, 1958.
3. David K. cheng, "*Field and electromagnetic*", Addison Wesley, 2nd edition, 1999.
4. Corson and lerrain, "*Electromagnetic*", CBS publications, 2nd edition, 1986.
5. Ramo, Whinnery and Van Duzer: "Fields and Waves in Communications Electronics" John Wiley & Sons (3rd edition 2003)
6. M.N.O.Sadiku: "Elements of Engineering Electromagnetics" Oxford University Press, Third edition.
7. David K.Cherp: "Field and Wave Electromagnetics - Second Edition-Pearson Edition.
8. David J.Grithiths: "Introduction to Electrodynamics- III Edition-PHI.
9. Shevgaonkar, *electromagnetic waves, Tata McGraw Hill.*

University of Mumbai			
Class: T.E.	**Branch:** Electrical Engineering	**Semester:** V	
Subject: Electrical Machines- II (abbreviated as EMC-II)			
Periods per Week (Each 60 min)	Lecture	4	
	Practical	2	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical and Oral	2	50
	Oral	---	---
	Term Work	---	25
	Total	5	175

Module	Contents	Hours
1	Three Phase Transformers: Construction, Parallel operation, Excitation Phenomenon, Switching in transient phenomenon, Oscillating neutral, harmonics, connections and phasor groups, V connection , Scott connection, Mechanical Stresses, Sumpner test, impulse test, ON load and OFF load Tap changer.	16
2	Three phase induction motors: Construction, principle of operation, equivalent circuit, torque-speed characteristics, power stages, no load and block rotor test, circle diagram, speed control methods including V/f method, starting methods, high torque motors, Cogging and crawling, Induction Generators.	24
3	Single phase Induction Motor: Principle of operation,, double field revolving theory, equivalent circuit, determination of equivalent circuit parameters by no load and block rotor test, Staring methods-split phase, capacitor start, capacitor start and run, shaded pole. Calculation of Capacitor at starting.	08

Theory Examination:

6. Question paper will comprise of total 7 questions, each of 20 marks.
7. Only 5 questions need to be solved.
8. Q.1 will be compulsory and based on the entire syllabus.
9. Remaining questions will be mixed in nature.
10. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Practical and Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:

Term work consists of minimum eight experiments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Laboratory Experiments:

1. Load test on three phase squirrel cage IM
2. Load test on three phase slip ring IM
3. No load and Blocked rotor test on three phase IM
4. Circle diagram of three phase IM
5. Load test on Single phase IM
6. No load and Blocked rotor test on Single phase IM
7. Open circuit & Short circuit test on three phase transformer
8. Parallel operation of transformers
9. Study of starting methods of Induction motors.
10. Scott connection of transformer
11. Open Delta connection of transformer

Text Books:

1. 'Electrical Machinery', by Dr. P.S.Bhimhra, VII Edition, Khanna Publisher
2. 'Generalized Theory of Electrical Machines', by Dr. P.S.Bhimhra, V Edition, Khanna Publisher
3. 'Electrical Machines', by Nagrath and Kothari.TMH Publication.
4. 'Electrical Machines', by Charles I. Hubert, Pearson Education

Reference Books:

1. 'Performance and Design of AC Machines', by M.G.Say, CBS Publisher
2. 'Electrical Machines', by Fitzgerald and Kingsley
3. 'Electrical Machines',by S.K.Bhattacharya, Tata McGraw Hill Publishing company l second edition, 1998
4. 'Electrical Machines, Drives, and Power System', by Theodore Wildi,Pearson Educatic
5. Bhag S. Guru, Huseyin R. Hiziroglu, Electric Machinery & Transformers, 3rd editi Oxford University Press.

University of Mumbai			
Class: T. E.	**Branch:** Electrical Engineering	**Semester:** V	
Subject: Communication Engineering (abbreviated as CE)			
Periods per Week (Each 60 min)	Lecture	04	
	Practical	02	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical and Oral	--	--
	Oral		25

	Term Work	--	25
	Total	3	150

Module	Contents	Hours
1	**Signal Representation**-- Types of signals, Signal spectrum, Fourier Transform & properties,	04
2	**Analog Communication** 1) Introduction of Analog Communication System. 2) Analog Modulation Demodulation Techniques.- AM, FM, PM. 3) Radio Receivers TRF and Superhytrodyne receivers, AGC Methods, FM Receivers	10
3	**Digital Communication** 1) Introduction of Digital Communication System 2) Basic Information Theory. – Concept of information, Entropies of discrete system, Rate of transmission-redudancy, Efficiency and channel capacity, Source encoding Huffman technique, Transmission rate and channel capacity of noisy channels, Shanon's theorem, sampling theorem.	10
4	**Digital Modulation and Demodulation Techniques** 1) PCM, Delta Modulation and adaptive delta modulation. 2) ASK, FSK, PSK, BPSK, DPSK.	10
5	**Coding Techniques (Algorithmic Approach) -** Linear block codes, cyclic codes and convolution codes.	10
6	**Telemetry** -1) Basic concept & Introduction	04

Theory Examination:

11. Question paper will comprise of total 7 questions, each of 20 marks.
12. Only 5 questions need to be solved.
13. Q.1 will be compulsory and based on the entire syllabus.
14. Remaining questions will be mixed in nature.
15. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Term work:

Term work consists of minimum Eight experiments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :10 marks

Test (at least one) :10 marks
Attendance (Practical and Theory) :05 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Oral Examination:
Oral examination will be based on entire syllabus.

Scope of the Lab :

1. AM principle and demodulation using diode detector circuit.
2. Balanced Modulator
3. FM generation
4. Radio receiver characteristics like sensitivity, selectivity, image rejection
5. ASK System
6. FSK system.
7. PSK system – BPSK, DPSK
8. Signal sampling
9. Pulse code modulation
10. Linear block codes.

Text books:

1. Tomasi W. Advanced Electronics Communication systems, PHI, 4th Edition 1998
2. Taub & Schilling, principles of communication systems, McGraw Hill, 2nd Ed. 1987
3. John C. Proakis "Digital Communication" McGraw Hill International, 1995
4. Haykin S Communication systems, John Wiley & Sons, 3rd Ed. 1995.

Reference Books:

1. Lathi B. P. - ModernDigital and Analog Communication System, Oxford University Press, 1998, 3rd edition
2. Dennis Roddy and John Coolen- Electronic Communications, Prentice Hall of India, 3rd Ed 1992.

University of Mumbai			
Class: T.E.	**Branch:** Electrical Engineering	**Semester:** V	
Subject: Power System Analysis (abbreviated as PSA)			
Periods per Week (Each 60 min)	Lecture	4	
	Practical	---	
	Tutorial	2	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical and Oral	--	--

	Oral	--	25
	Term Work	--	25
	Total	3	150

Module	Contents	Hours
1	**Symmetrical Fault Analysis:** ▪ Transient on a Transmission line, ▪ Short Circuit of a Synchronous Machine: no load and loaded conditions. ▪ Selection of Circuit Breakers. ▪ Short circuit MVA ▪ Algorithm for short circuit studies. ▪ ZBUS formulation.	8
2	**Symmetrical Components:** ▪ Symmetrical Component transformation. ▪ Phase shift in star-delta transformers. ▪ Sequence impedances and sequences network of transmission lines, synchronous machine and transformer. ▪ Power invariance. ▪ Construction of sequence network of a Power System.	6
3	**Unsymmetrical Fault Analysis** ▪ Symmetrical fault analysis of unsymmetrical faults, ▪ Single line to ground (SLG) fault. Line to Line (LL) fault. Double line to ground (LLG) fault. ▪ Open conductor faults. ▪ Bus impedance matrix method for analysis of unsymmetrical shunt faults.	6
4	**Power System Transients:** **Transients** ▪ Transient in simple circuits	8

	▪ Recovery transient due to removal of short circuit. ▪ Arching grounds, capacitance switching, current chopping. ▪ Measures to reduce over voltages **Traveling Waves** ▪ Traveling Waves on Transmission lines, wave equation, reflection and refraction of waves, typical cases of line terminations, attenuation, Bewley lattice diagram, corona loss and effective shunt conductance. **Lightening** ▪ Lightening phenomenon, mechanism of lightning stroke, shape of lightning voltage wave, over voltages due to lightening, lighting protection problem, tower footing résistance, insulator flashover and withstand voltages, probability of occurrence of lightning stroke currents, ▪ Protection against surges, surge arresters, surge capacitor, surge reactor and surge absorber. ▪ Lightning arrestors and protective characteristics, dynamic voltage rise and addressor rating, insulation coordination based on lightning	
5	**Insulation Coordination:** ▪ Volt-time curve. ▪ Over voltage protection. Ground wires. ▪ Surge protection of rotating machines & transformers.	5
6	**Corona:** ▪ Phenomenon of Corona. ▪ Corona pulses-their generation and properties ▪ Disruptive critical voltage, Visual critical voltage.	5

	Coronal loss, charge voltage diagram(q-V) ▪ Attenuation of traveling waves due to corona loss ▪ Advantages and disadvantages ▪ Factors affecting corona loss, corona ring ▪ Radio interference (RI), Television interference (TVI) due to corona, conductor size selection ▪ Practical considerations corona in bundled conductor lines. ▪ Corona in HVDC lines	
7	**Voltage Gradients of Conductor** • Field of:- point charge, sphere gap, line charge,2-conductor line • Charge potential relation for multi conductor line • Maximum charge condition • Surface voltage gradient on conductors: - single conductor, two conductor bundle • Mangoldt Formula • Gradient factor and uses	5
8	**Reactive Power and Voltage** • Generation and absorption of reactive power • Role of reactive power on voltage and voltage regulation, system load line • Incremental reactive power, active power and voltage at a node • P-V and Q- V Nose Curve. • Real and reactive power operating contours • Reactive power requirement of line • Various methods of voltage control:- Series, shunt, Static VAR system, transformer	5

	• Effect of voltage and frequency on load	

Theory Examination:

16. Question paper will comprise of total 7 questions, each of 20 marks.
17. Only 5 questions need to be solved.
18. Q.1 will be compulsory and based on the entire syllabus.
19. Remaining questions will be mixed in nature.
20. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Oral Examination:

Oral examination will be based on the entire syllabus.

Term work:

Term work consists of minimum eight tutorial / computer programs and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal)	:10 marks
Test (at least one)	:10 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Text Books:

1. Kothari D.P Nagrath I.J. Power System Engineering, TMH Publications, Second editio .2008.
2. Wadhawa C.L. Electrical Power Systems, New Age International, Fourth Edition, 2007
3. Gupta B.R. Power System Analysis and Design, Wheeler Publishing, third edition, 199
4. Begamudre R D. Extra High Voltage Ac Transmission Engineering, New Age International Publishers, Third Edition 2007
5. Grainger J.J Stevenson Jr W. D, Power System Analysis, Mc GRAW-HIL Internationa Edition
6. Chakrabarti .A Soni M.L Gupta P.V Bhatnagar U.S, Power System Engineering, Dhan Rai & CO Ltd, Edition 2006.

Reference Books:

1. Saadat Hadi, Power System Analysis, TMH Edition, 2003.
2. Gonen Turan, Electric Power Transmission System Engineering, Analysis and Design, JOHN WILEY & SONS, A Wiley International Edition 1988

	Engineering		
Subject: Power Electronics (Abbreviated as PE)			
Periods per Week (Each 60 min)	Lecture	04	
	Practical	02	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	03	100
	Practical and Oral	02	50
	Oral	---	--
	Term Work	---	25
	Total	05	175

Module	Contents	Hours
1	**Silicon Controlled Rectifiers** Principle of operation of SCR, Static & Dynamic characteristics, Gate characteristics, Methods of turning on (Type of Gate Signal), Firing circuits (using R, R-C, UJT),Commutation Circuit, Protection of SCR	08
2	**Other Switching Devices** Principle of operation, characteristics, rating and applications of Triac, Diac, GTO, MOSFET, IGBT and Power BJT, Driver circuits for Power transistors.	04
3	**Controlled Rectifiers** Introduction, Half wave controlled rectifiers with R, R-L load, Full Wave controlled rectifiers (Half controlled & Fully controlled) with R, R-L load (effect of source inductance not included),Single phase dual converter, Three phase half controlled & Fully controlled rectifiers with R load only, Applications, Numerical based on calculation of output voltage.	13
4	**Inverters** Introduction, Principle of operation, Performance parameters, Single phase bridge Inverters, 3 phase bridge Inverters(120^0 and 180^0 conduction mode) with R & R-L load, , Voltage control of 1 phase inverters, Voltage control of single phase using PWM techniques, Harmonic neutralization of Inverters, Applications, Numerical with R load only.	13

5	**Choppers** Basic principle of step up & step down choppers, DC-DC switching mode regulators – Buck, Boost, Buck-Boost, Cuk regulators, (CCM mode only), Applications, Numerical included	6
6	**AC Voltage Controllers** Introduction of AC Voltage Controllers, Principle of On-Off Control, Principle of Phase Control, Single Phase bidirectional control with R & R-L load, Applications. Numerical included	3
7	**Cyclo Convertor** Introduction, Single Phase and three phase Cyclo-converters, Applications	1

Theory Examination:

21. Question paper will comprise of total 7 questions, each of 20 marks.
22. Only 5 questions need to be solved.
23. Q.1 will be compulsory and based on the entire syllabus.
24. Remaining questions will be mixed in nature.
25. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Term work:

Term work consists of minimum eight experiments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Practical and Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Suggested List of Practicals:

1. VI Characteristic of SCR
2. Characteristic of any one high switching frequency devices
3. Firing circuit of SCR
4. Commutation circuit of SCR
5. Experiment based on controlled rectifiers
6. Experiment based on inverters
7. Experiment based on choppers
8. Experiment based on AC regulators
9. Experiment based on cycloconverters
10. Light dimmer circuit using triac
11. Speed control of motors

Suggested List of Simulations:

1. Simulation of controlled rectifiers
2. Simulation of single phase bridge inverters
3. Simulation for 120 and 180 mode of conduction
4. Implementation of PWM technique
5. Simulation of any one DC to DC converters
6. Simulation of AC controllers
7. Simulation of Cycloconverters

Text Books:

1. "Power Electronics" M.H.Rashid, Prentice-Hall of India
2. "Power Electronics" Ned Mohan, Undeland, Robbins, John Wiley Publication
3. "Power Electronics", V.P. Moorti, Oxford University Press, New Delhi.
4. " Thyristors & their applications" Ramamurthy
5. "Power Electronics & its Applications" ---Alok Jain, Penram International Publishing (India) Pvt. Ltd.
6. "Power Electronics" ---Vedam Subramanyam, New Age International

Reference Book:

1. "Power Electronics" ---Landers, McGraw Hill
2. "Power Electronics" ---M.D. Singh, K.B.Khanchandani, Tata McGraw Hill
3. "Modern Power Electronics" ---P.C.Sen, Wheeler Publication
4. Related Websites

University of Mumbai			
CLASS: T.E. **Electrical Engineering**		**Semester - V**	
SUBJECT: Environmental Studies			
Periods per week (each of 60 min.)	Lecture	2	
	Practical	-	
	Tutorial	1*	
		Hours	Marks
Evaluation System	Theory Examination	2	50
	Practical examination	-	-
	Oral Examination	-	-
	Term Work	-	25
	Total		75
* Class wise Tutorial			

Objective: This course is to create environmental awareness, of variety of environmental concerns.

Module	Contents	Hrs
1	The Multidisciplinary nature of environmental studies Definition, scope and importance Need for public awareness	1
2	Natural resources Renewable and non-renewable resources Natural resources & associated problem. a. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. b. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d. Food resources: World food problems overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e. Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. f. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.	4
3	• Ecosystems • Concepts of an ecosystem. • Structure and function of an ecosystem. • Producers, consumers and decomposers. • Energy flow in the ecosystem.	3

	• Ecological succession. • Food chains, food webs and ecological pyramids. • Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)	
4	Biodiversity and its conservation • Introduction-Definition: genetic species and ecosystem diversity • Bio-geographical classification of India • Value of biodiversity : Consumptive use, productive use, social, ethical, aesthetic and option values • Bio-diversity at global, national, local levels • India as a mega diversity nation • Hot spots of bio-diversity • Threats to biodiversity: Habitat loss, poaching of wild life, man-wildlife conflicts • Endangered and endemic species of India • Conservation of biodiversity: In- situ and Ex-situ conservation of biodiversity	4
5	Environmental Pollution Definition – • Causes, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear Hazards • Solid waste management: Causes, effect and control measures of urban and industrial wastes • Role of an individual in prevention of pollution • Pollution case studies • Disaster management: floods, earthquake, cyclone and land slides	4
6	Social issues and environment • From unsustainable to sustainable development • Urban problems related to energy • Water conservation, rain water harvesting, watershed management • Re-settlement and rehabilitation of people: Its problems and concerns. Case studies. • Environmental ethics: issues and possible solution • Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. • Wasteland reclamation • Consumerism and waste products • Environment protection act • Air(Prevention and control of pollution) act • Water (Prevention and control of pollution) act • Wildlife protection act	4

	• Forest conservation act • Issues involved in enforcement of environmental legislation • Public awareness	
7	Human population and the environment • Population growth, variation among nations • Population Explosion- family welfare program • Environment and human health • Human rights • Value education • HIV/AIDS • Women and child welfare • Role of information technology in environment and human health • Case studies	4
8	**Understanding Existence and Co-existence** Interrelation and Cyclicity between Material order, Bio-order, Animal order and Human order **Understanding the human conduct:** Relationship in Family, Justice in Relationship, Relationship of Human with Nature (Environment), Human Behavior, Human Values, Nature and Morality **Understanding the human society** Dimensions of Human Endeavor and Objectives, Interrelationship in Society, Mutual Fulfillment and Cyclicity in Nature.	6

Theory Examination:

1. Question paper will be comprising of total 7 questions, each of 10 marks.
2. Only 5 questions need to be solved.
3. Question number 1 will be compulsory and covering the all modules
4. Remaining questions will be mixed in nature. (e.g.- suppose Q 2 has part (a) from, module 3 then part (b) will be from any module other than module 3.)
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Term work:

Term work shall consist of minimum five projects (PROJECTS SHALL BE DESIGNED ON THE SAME GUIDE- LINE OF GIVEN TEXT BOOK) and a written test.
The distribution of marks for term work shall be as follows,
Laboratory work (Tutorial/Project and Journal) : 15 marks
Test (at least one) : 10 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Recommended Books:

1. Erach Bharucha, text book of environmental studies, Universities Press/Orient Blackswan
2. Jagdish Krishnaswami, R J Ranjit Daniels, 'Environmental Studies", Wiley India Private Ltd. New delhi
3. Anindita Basak, 'Environmental Studies", Pearson
4. Deeksha Dave, "Text book of , 'Environmental Studies", Cengage learning, Thomason India edition
5. Benny Joseph , 'Environmental Studies", Tata McGRAW HILL
6. D L Manjunath, , 'Environmental Studies",Pearson
7. R Rajgopalan, , 'Environmental Studies", Oxford
8. Alok Debi, 'Environmental science and Engineering", University press
9. A. Nagraj, Jeevan Vidya- A Primer

UNIVERSITY OF MUMBAI
Syllabus Structure (R-2007)
at
T.E.(ELECTRICAL ENGINEERING)

Semester VI

Sr.No	Subject	Scheme of Instructions, Periods per week (60 min)			Scheme of Evaluation					
		Theory	Practical	Tutorial	Paper Hours	Paper Marks	Term work	Practical & Oral	Oral	Total Marks
1	Control System-I	4	2	--	3	100	25	--	--	125
2	Protection and Switchgear Engineering	4	2	--	3	100	25	--	25	150
3	Signal Processing	4	--	2	3	100	25	--	--	125
4	Electrical Machine-III	4	2	--	3	100	25	50	--	175
5	Microprocessor and Microcontrollers	4	2	--	3	100	25	--	25	150
6	Project Management	4	--	1	3	100	25	--	--	125
Total		24	8	3		600	150	50	50	850

University of Mumbai			
Class: T.E.	**Branch:** Electrical Engineering	**Semester:** VI	
Subject: Control System Engineering – I (abbreviated as CSE-I)			
Periods per Week (Each 60 min)	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical and Oral	--	--
	Oral	--	--
	Term Work	--	25
	Total	3	125

Module	Contents	Hours
1	**Concept of Open loop & Closed loop control systems:** Examples and applications of open loop and closed loop systems. Brief idea of multivariable control systems, control system components, AC & DC servo motors, stepper motor, potentiometer , tacho generators	4
2	**Mathematical modeling:** Representation of physical system (Electro-mechanical)by differential equations. Determination of transfer function by block diagram reduction technique signal flow graph method.	8
3	**State Variable Analysis:** Concepts of state, state variables and state model. State models for linear continuous-time systems. Diagonalization Transfer functions. Solution of state equations. Concepts of controllability and observability	5
4	**Time response Analysis:** Time response Analysis of first order and second order system. Steady state error and error constants, Definition of root locus, Rules for plotting root loci, Stability analysis using root locus. Effect of addition of pole and zeros, Root locus with dead time, Sensitivity & root locus	10
5	**Stability of the system:** Absolute stability and relative stability, Routh's stability criterion, Stability and steady state error in state space	7
6	**Frequency Response Analysis:** Polar Plot, Bode plot, Design specification in frequency domain and their co-relation with time domain, Nyquist Stability Criteria	10
7	**Elementary ideas of compensating networks:** Lag, Lead and Lad-Lead networks , feedback compensation and cascade	4

	compensation, Concept of proportional, derivative and integral controller.(No numerical)	

Theory Examination:

26. Question paper will comprise of total 7 questions, each of 20 marks.
27. Only 5 questions need to be solved.
28. Q.1 will be compulsory and based on the entire syllabus.
29. Remaining questions will be mixed in nature.
30. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Term work:

Term work consists of minimum five experiments and four programs/simulations and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal)	:10 marks
Test (at least one)	:10 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Text Books:

1. Modern Control Engineering by Katsuhiko Ogata, Prentice Hall of India Pvt. Ltd.
2. Control System Engineering" by Norman Nise, 2nd edition,1995.
3. S.P. Eugene Xavier, Josheph Cyril Babu,J., First Edition , S chand
4. Control system engineering by I G Nagrath & M. Gopal , wiley Eastern Ltd 5th edition,2000.

Reference Books:

1. Modern Control engineering" by Richard C Dorf s H Bishop Eighth edition Addition Wesley 1998
2. Linear Control System Analysis and Design With Matlab, J. J. D'Azzo, C. H. Houpis and S. N. Sheldon, Marcel Dekker (2003) ISBN 0824740386.
3. Feedback Control of Dynamic Systems, G. F. Franklin, Pearson Higher Education (2002) ISBN 0130980412.
4. Control System Engineering, Shivanagraju S. Devi L., New Age International, First Edition

University of Mumbai			
Class: T.E.	**Branch:** Electrical Engineering	**Semester:** VI	
Subject: Protection and Switchgear Engineering (abbreviated as PSE)			
Periods per Week (Each 60 min)	Lecture	4	
	Practical	2	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical and Oral	--	--
	Oral		25
	Term Work	--	25
	Total	3	150

Module	Contents	Hours
1	**Principles of circuit Breaking** Initiation of arc, arc extinction, D.C & A.C circuit breaking, arc voltage and current waveforms in an A.C circuit. Definition of transient recovery, rate of rise of TRV, expression for TRV for different values of arc resistance, current chopping. Theories of arc extinction, arc control devices, HRC fuse. Rating and specifications of circuit breakers, making and breaking capacities, short circuit testing, Acquaintance of ISI standards.	13
2	**Low Tension Switchgear** Different types of LT switchgears: (a) Air Circuit Breaker (ACB) : construction and working (b) Miniature circuit breakers (MCB) and Mounded case circuit Breakers (MCCB), Contact shapes and materials, contact bounces.	08
3	**Medium and High Tension Switchgear** Principle of arc quenching in : (a) Air Blast circuit Breaker (ABCB) (b) Bulk oil circuit Breaker (BOCB) (c) Minimum oil circuit Breaker (MOCB) (d) Vacuum circuit breaker. (e) SF6 Circuit Breaker	08
4	**Protection Relaying** Objective of protective relaying (a) Protective zones, Primary and backup Protection. (b) Desirable qualities. Electromagnetic Relays, Static Relays, uP based Protective schemes (programming or interfacing excluded)	08

	Principles and characteristics of (a) Over current relays – Time setting, plug setting, IDMT relays. (b) Directional Relays. (c) Distance Relay – Resistance, Reactance, Impedance, MHO relays. (d) Differential Relay.	
5	**Power System Protection** Relevant protection for different types Earth faults. Protection of transmission lines & feeders. Pilot wire relaying. Protection of Generators, Protection against loss of prime mover and loss of excitation, field suppression, out of step relaying. Protection of induction motors against single phasing and over current, Earth Leakage circuit Breakers; Introduction to DSP based protection (only simple schemes, advantages, etc.)	11

Theory Examination:

31. Question paper will comprise of total 7 questions, each of 20 marks.
32. Only 5 questions need to be solved.
33. Q.1 will be compulsory and based on the entire syllabus.
34. Remaining questions will be mixed in nature.
35. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Term work:

Term work consists of minimum eight experiments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Tutorials and Journal) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Oral Examination:

Oral examination will be based on entire syllabus.

Text books:

1. Badri ram and vishwakarma D.N. Power system protection and Switchgear TMH Publication first edition 1994
2. Ravindranath & chander, Switchgear & protection ,Wiley Eastern LTD first Ed 1997
3. Paithankar Y.G .and Bhide S.R Fundamentals of Power system Protection P.H.I Publication EEE 2003
4. Rao Sunil S Switchgear & protection , Khanna publication, fourth Ed 1997
5. Rao.Madhav ,static relays, TMH publication second Ed 1994

Reference books:

1.GEC relay guide
2.Phadke A.G. & Thorpe J.S. "computer Relaying for power systems ," john wiley & sons Ed. ,1990

University of Mumbai			
Class: T.E.	**Branch:** Electrical Engineering	**Semester:** VI	
Subject: Signal Processing (abbreviated as SP)			
Periods per Week (Each 60 min)	Lecture	04	
	Practical	–	
	Tutorial	02	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical and Oral	--	--
	Oral		
	Term Work	--	25
	Total	3	125

Module	Contents	Hours
1	Definition and classification of signals and systems, operations on signals, power spectrum(amplitude &phase spectrum),Energy and power spectral density ,Convolution	10
2	Z-Transform, Single &double sided Z-Transform, ROC determination. Inverse Z-Transform. Solution of difference equation ,pole –zero diagram,Causility & stability, magnitude and phase response of LTI system,	12
3	Frequency Domain Analysis of DT systems- -- Pole –Zero diagram Frequency. Domain Analysis using analytical and graphical techniques .System classification based on pass band .System classification based on phase response as minimum phase, maximum phase, mixed phase. Stability analysis	12
4	DTFT,&DFT ,DFT properties,FFT (Radix -2 DIT)	10
5	DSP Processor: Need for special Architecture. Difference between DSP processor and microprocessor. Architecture of DSP Processor.	04

Theory Examination:

36. Question paper will comprise of total 7 questions, each of 20 marks.
37. Only 5 questions need to be solved.
38. Q.1 will be compulsory and based on the entire syllabus.
39. Remaining questions will be mixed in nature.

40. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Term work:

Term work consists of at least six programs and four assignments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal)	:10 marks
Test (at least one)	:10 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of suggested Programs:

1. Generation of Standard DT Signals
2. Linear Convolutions.
3. Circular Convolution.
4. Pole –zero plot.
5. Magnitude & phase response of LTI system.
6. DFT.
7. FFT (DIT).
8. FFT (DIF).

Text books:

1. Salivahan S.,"Digital Signal Processing",TMH Publication, 2001
2. Oppenhein&Schafer," DiscreteTime Signal Processing",PHI Publication, 1989
3. Haykin S and Van Veen B. , Signal & Systems, Wiley publications, 2nd Ed. 2002.
4. Linder D.K. , Introduction to Signal & Systems, McGraw Hill International. 1999
5. Ambardar, Analog & Digital signal processing, Thomson learning, 2nd Ed.
6. CHI-TSONG Chen, "Digital Signal Processing", Oxford University Press, New Delhi.

Reference Books:

1.Proakis,D.G.Manolakis J.G.," Digital Signal Processing" PHI Publications,1995
2. Lathi B.P., Signal & Systems, Oxford University press, 2nd Ed. 1998.
3.Oppenheim and Schaffer. Discrete time Signal Processing, PHI Publication, 1989
4. Mitra S. K. , " Digital Signal Processing" , TMH publication, 2001.

University of Mumbai		
Class: T.E.	**Branch:** Electrical Engineering	**Semester:** VI
Subject: Electrical Machine III (abbreviated as EMC-III)		
Periods per Week (Each 60 min)	Lecture	4
	Practical	2

	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical and Oral	2	50
	Oral	---	---
	Term Work	---	25
	Total	5	175

Module	Contents	Hours
1	Synchronous Generator: Construction, emf induced, winding factors, armature reaction, phasor diagram, OC and SC test, voltage regulation by EMF, MMF, ZPF, ASA, Saturated synchronous method, power flow and maximum power conditions, parallel operation, effect of field current on alternator connected to infinite bus, salient pole generators, Blondel's two reaction theory, power angle characteristics, synchronizing power and torque.	28
2	Synchronous Motor: Principle of operation, phasor diagram, power flow and maximum power conditions, excitation circles, power circles, V curves and O curves, power factor control(Effect of change in excitation on power factor), Hunting, starting methods, starting against high torques, Dampers, Measurement of Xd and Xq.	14
3	Special purpose Machines: Stepper motor and their types, working principles, drive circuits. Variable Reluctance Motor, construction, principle of operation.	06

Theory Examination:

41. Question paper will comprise of total 7 questions, each of 20 marks.
42. Only 5 questions need to be solved.
43. Q.1 will be compulsory and based on the entire syllabus.
44. Remaining questions will be mixed in nature.
45. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Practical and Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:

Term work consists of minimum six experiments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal)	:10 marks
Test (at least one)	:10 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Laboratory Experiments:

12. Regulation of alternator by direct loading.
13. Regulation of alternator by EMF and MMF method
14. Regulation of alternator by ZPF, ASA and saturated synchronous method.
15. Excitation required to keep terminal voltage of an alternator constant.
16. V and inverted V curves of synchronous motor
17. Determination of Xd and Xq by slip test.
18. Parallel operation of alternators

Text Books:

5. Electrical Machinery by P.S.Bhimhra, VII Edition, Khanna Publisher
6. Generalized Theory of Electrical Machines by Dr. P.S.Bhimhra, V Edition, Khanna Publisher
7. Electrical Machines by Nagrath and Kothari.TMH Publication.
8. 'Electrical Machines', by Charles I. Hubert, Pearson Education

Reference Books:

6. Performance and Design of AC Machines by M.G.Say, CBS Publisher
7. Electrical Machines by Fitzgerald and Kingsley
8. 'Electrical Machines',by S.K.Bhattacharya, Tata McGraw Hill Publishing company ltd, second edition, 1998
9. 'Electrical Machines, Drives, and Power System', by Theodore Wildi,Pearson Education

University of Mumbai		
Class: T.E.	**Branch:** Electrical Engineering	**Semester:** VI
Subject: Microprocessors And Microcontrollers (abbreviated as MPMC)		

Periods per Week (Each 60 min)	Lecture	4	
	Practical	2	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory	3	100
	Practical and Oral	--	--
	Oral	--	25
	Term Work	--	25
	Total	3	150

Module	Contents	Hours
1	8085 Microprocessor: Basic 8085 Microprocessor architecture and its functional blocks, 8085 Microprocessor IC pinouts and signals, address, data and control buses. Clock signals, instruction cycles, machine cycles and timing states, instruction timing diagram. Programming of 8085 Microprocessor: Basic instruction set of 8085, addressing modes	4
2	8086 microprocessors: architecture and organization of 8086Microprocessor family , bus interface unit,8086hardware pin signals, timing diagram of 8086 family Microprocessor, simplified read/write bus cycles,8086 minimum and maximum modes of operation,8086/8088 memory addressing ,address decoding, memory system design of 8086 family, timing consideration for memory interfacing, input/output port addressing and decoding	8
3	8086 Assembly language programming : Addressing modes,8086 instruction formats and instruction set ,data transfer ,arithmetic, bit manipulation string, program execution transfer and processor control instructions, machine codes for 8086 instruction, assembly language syntax, assembler directives, initialization instructions, simple sequential and looping programs in assembly language, debugging assembly language programs.	10
4	Input Output interface circuit and LSI peripheral devices: 8255a programmable peripheral interface, Memory mapped I/O port, 8254 Programmable Interval Timer, 8237 Programmable direct memory access Controller, Serial communication interface,8251 USART.	6
5	Comparing microprocessor and microcontroller, four bit to thirty two bit microcontroller introduction, development system for microcontroller, 8051 Architecture	8
6	Basic assembly language programming concept, moving data,	8

	logical operation, Arithmatic operation, Jump and call instruction, Simple programming.	
7	Application of 8051 1.Seven Segment LED display 2. A/D and D/A converter 3. Pulse measurement	04

Theory Examination:

46. Question paper will comprise of total 7 questions, each of 20 marks.
47. Only 5 questions need to be solved.
48. Q.1 will be compulsory and based on the entire syllabus.
49. Remaining questions will be mixed in nature.
50. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus

Term work:

Term work consists of minimum ten programs (four programs based on 8086 & three programs based on 8051 and two programs based on Interfacing) and a written test. The distribution of the term work shall be as follows,

Laboratory work (Programs and Journal) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Oral Examination:

Oral examination will be based on entire syllabus.

Text Books:

1. The 8088 and 8086 Microprocessors, walter A Triebel, Awtar Singh, Pearson Education, Fourth Edition
2. The 8086 Microprocessors, Kenneth J. Ayala, Thomson India Edition, ISBN: 81-315-0180
3. The 8051 microcontroller, Kenneth J. Ayala, Delmar Cengage Learning, 3rd edition, ISBN: 81-315-0200-7
4. PIC Micro Controller And Embedded System, Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey, Pearson Education, first impression, ISBN:978-81-317-1675-5

Reference Books:

1. Fundamentals of Microcontrollers and Embedded System, Ramesh Gaonkar, PENRAM international India Pvt. Ltd. ISBN: 81-87972-29-7

2. Microcontrollers : Features and Applications, Yadv D.S., A.K. Shing, New Age International, second edition
3. Microcontrollers: Theory and Applications, Deshmukh Ajay, Second Edition, Tata Macgraw Hill
4. Programming and Catorrizing the 8051 microcontroller, Predco Myk, Tata MacGraw Hill, First Edition
5. Programming the PIC Microcontroller with Mbasic, Smith Jack R., Elsevere India Pvt. Ltd. First reprint

University of Mumbai			
Class: T.E.	**Branch:** Electrical Engineering	**Semester:** VI	
Subject: Project Management (abbreviated as PM)			
Periods per Week (Each 60 min)	Lecture	4	
	Practical	--	
	Tutorial	1	
		Hours	Marks
Evaluation System	Theory Examination	3	100
	Practical and Oral	--	--
	Oral		
	Term Work	--	25
	Total	3	125

Module	Contents	Hours
1	Project management & it organization. Nature & purpose of P.M –concept of project, project identification, formula, analysis, risk, planning. Project design & n/w analysis, project report, appraisal, Project organization, Establishing a project organization	12
2	Contract administration Contract law, Contract & payment structure	06
3	Account & finance, Financing the project, Cost estimation, Cost control, Controlling cash & credit	10
4	Planning & scheduling, Planning with charts, Critical path methods, Resources scheduling.	10
5	Managing project material, Material planning & control, Project purchasing, Inspection & expectation, Project risk management, project quantity management.	10

Theory Examination:

51. Question paper will comprise of total 7 questions, each of 20 marks.
52. Only 5 questions need to be solved.
53. Q.1 will be compulsory and based on the entire syllabus.
54. Remaining questions will be mixed in nature.
55. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Term work:

Term work should consist of at least eight tutorials properly recorded and graded

Laboratory work (Tutorial)	:10 marks
Test (at least one)	:10 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Text Books:

1. Hand book of project management, Denis lock, second edition, JPH
2. Project management - Vasant Desai, HPH.

Reference Books:

1. Projects, planning ,Analysis, financing, implementation & review Prasanna Chandra, fifth edition, Ta McGraw hill.
2. A guide to the project management body of knowledge (PMBOK guide) pro management institute, Newtown square, Pennsylvania, USA.