DEPARTMENT OF APPLIED PHYSICS
UNIVERSITY COLLEGE OF TECHNOLOGY
UNIVERSITY OF CALCUTTA

Regulation for 2 year 4 semester M. Tech. course in Electrical Engineering
w. e. f. the academic year 2014 - 2015

1. Department of Applied Physics, University College of Technology, University of Calcutta shall provide instructions leading towards the 2-year, 4-semester M. Tech. degree in **Electrical Engineering**. The course is of two (2) years duration comprised of four (4) Semesters, each Semester being of six (6) months' duration.
2. A candidate, who has passed the 3-year B. Tech. degree in Electrical Engineering from University of Calcutta or its equivalent degree from any other university or institute approved by All India Council for Technical Education (AICTE), will be eligible to apply for admission to the 4-Semester Master of Technology (M. Tech.) course in **Electrical Engineering** of University of Calcutta.
3. The award of the said M. Tech. Degree in **Electrical Engineering** will be conferred to students who are successful in all of the four (4) Semester examinations. End-Semester Examination (ESE) **and a**t least one class test will be held for each theoretical paper in each Semester. End-semester examination will be held for each practical paper in each Semester. The schedule of both theoretical and practical papers and distribution of marks and credit for the said four (4) Semesters are given in course structure.
4. Four (4) lecture hours per week shall be allotted to each theoretical paper of 100 marks and seven (7) practical hours and one (1) tutorial hour per week shall be allotted to each practical paper of 100 marks in a laboratory. For seminar papers of 100 marks six (6) practical hours and two (2) tutorial hours per week shall be allotted. For project phase –I paper of 200 marks twelve (12) practical hours and four (4) tutorial hours per week shall be allotted. For project phase –II paper of 400 marks twenty four (24) practical hours and eight (8) tutorial hours per week shall be allotted. However, for general viva-voce paper no contact hour will be provided.

5. A candidate shall be eligible for appearing at any of the Semester examinations provided, he/she prosecutes a regular course of studies in the Department of Applied Physics maintaining the minimum percentage of attendance as specified by the University.
6. (a) Each theoretical paper of 100 marks shall be comprised of 20 marks for Teacher-Assessment (TA), 10 marks for Class Test (CT) , and 70 marks in End Semester Examination (ESE). TA and CT put together will form the sessional component of the total marks in any theoretical paper.
(b) Teacher-Assessment will be divided ordinarily into three components – attendance, group discussion and performance. Marks for each class test will be awarded by conducting at least one (1) test.
(c) Duration of ESE for each theoretical paper shall be of three (3) hours. For each theoretical paper there shall ordinarily be two (2) internal paper setters. Each theoretical paper shall be examined by the internal examiners.
(d) Each practical paper shall be of 100 marks, out of which 50 marks is assigned for Teacher Assessment (TA) to be assessed by the internal examiner(s) on the basis of performance in the laboratory and records of experiments and 50 marks for ESE. For 50 marks of ESE for each practical paper, an assessment will be made through a representative practical test and viva-voce, which shall ordinarily be made by a board of examiners consisting of at least two (2) members.
7. (a) On the basis of total marks (TA+CT+ESE) secured in each paper, **Grade (G)** and **Grade Point (GP)** shall be awarded to a student.
The equivalence between grades, grade points and the percentage marks is given by:

Percentage (%) of marks	**Grade (G)**	**Grade Point (GP)**
≥ 90	E	10
89 – 80	A	9
79 – 70	B	8
69 – 60	C	7
59 – 50	D	6
< 50	F	0

(b) Each paper shall carry **Credit (C)** according to the number of hours allotted per week and as indicated in the following table:

Paper	No. of hours / week	Credit (C) assigned
Theoretical	1	1
Tutorial	1	0.5*
Practical	1	0.5*

*: For fractional credit, calculation is to be made by rounding off.
(c) In the course structure, the credits assigned to each semester is as follows:

Semester	Credit
1	24
2	24
3	16
4	16
TOTAL	80

(d) In any paper, a candidate securing a grade higher than `F`, that is, Grade Point greater than zero, will be eligible to earn `credit` assigned to that paper. In other words, if a student is unable to secure a grade higher than 'F', that is, grade point greater than zero, he / she fails to earn any 'credit' assigned to that paper.
(e) The performance of a candidate in n^{th} (n = 1,2,3,4) Semester examination, who earns all the credits of that semester, will be assessed by the '**Semester Grade Point Average' (SGPA), 'S_n'** to be computed as:

$$SGPA\,[S_n\;] = \frac{\sum_k [C_k\, GP_k]}{\sum_k C_k}$$

where ‘k’ denotes the number of papers in a particular semester

and $\sum_k C_k$ denotes the total credits of a particular semester and GP_k is the grade point of k[th]. paper.

(f) On completion of the M. Tech. course, the overall performance of a candidate will be assessed by the ‘**Cumulative Grade Point Average’ (CGPA),** to be computed as:

$$CGPA = \frac{\sum_{n=1}^{4} [C_n\, S_n]}{\sum_{n=1}^{4} C_n}$$

where, $C_n = \sum_k c_k$ and $\sum_{n=1}^{4} C_n$ denotes total credits of all the semesters i.e. 80 credits.

8(a) Each candidate shall opt two (2) elective papers of 100 marks each, one in 1[st] and another in 2[nd] semester, from the list of elective papers to be notified in respective semesters. Such topics of elective papers may be revised from time to time as per recommendation of the Board of PG studies in Applied Physics.

(b) Each candidate shall have to submit a report on a seminar work of 100 marks assigned to him/her under the guidance of a faculty member(s) of the Department during 3[rd] semester examination. He / she has to defend his/her seminar report in an open session. The assessment of this report shall be made by a board consisting of at least three (3) examiners of whom at least one (1) shall be external.

(c) (i) Each candidate shall execute a Project work assigned to him/her during the 3rd and 4th Semester courses under faculty member(s) of the Department and he/she has to submit a report on the same at least 5 (five) days before the date of examination. The project is divided into two phases. Project Phase-I of 200 marks is assigned during 3rd semester while Project Phase-II of 400 marks is assigned during 4th semester. The candidate has to present and defend his/her project work in an open session, which shall include internal and external examiners.

Out of the 200 marks assigned to Project Phase-I, 50 marks is earmarked for Sessional work to be assessed by the internal supervisor(s), 150 marks for the presentation of the project and viva voce on the project work. Out of the 400 marks assigned to Project Phase-II, 100 marks is earmarked for Sessional Work to be assessed by the internal supervisor(s), 300 marks for the presentation of the project and viva voce on the project work. The assessment of the presentation of the project and project viva voce shall be done by a board consisting of at least five (5) examiners of whom ordinarily two (2) shall be external examiners.

(ii) A candidate may also carry out his/her project work under joint guidance of faculty member(s) of the Department and a competent person from any industry/academic institution subject to the approval of Departmental Committee. He/she may carry out his/her project work either in the department or in the concerned industry/academic institute.

(e) The general viva-voce test for 100 marks shall be conducted during 3[rd] Semester examination, by a board consisting of at least five(5) examiners. Two (2) of the board members shall be external examiners.

9. Candidates appearing in a semester examination shall join classes in the next semester immediately, wherever applicable, after completion of the examination.

10. Candidates of 1[st] to 3[rd] Semester examinations will be allowed to continue in the next semester provided he/she secures at least the following credits respectively and for the 4[th] Semester, he/she has to secure the following credit:

Semester	Minimum Credit to be obtained
1	16
2	16
3	16
4	16

11. A candidate earning less than the credits mentioned in **clause number 10** in any semester will be declared as **‘unsuccessful’** candidate in that semester examination. He/she will have to take readmission in the corresponding semester in the next academic session as per CU rules and he/she will be allowed two (2) such consecutive chances to earn the **minimum credit**.

12. (a) The shortfall in credits, being termed as **‘due credit’** (the candidate being unsuccessful in one or more papers) of a semester will have to be earned by the candidate by appearing in the said paper(s) at the examination of the corresponding semester in the next academic session and he/she will have two (2) such consecutive chances to earn his/her **due credit.**

(b) If he/she fails to earn the due credit within permissible chances (**as per clause 12(a))**, he/she will be declared as ‘**failed**’ candidate. In such a case he/she will have to take readmission in the first semester class as per CU rules.

13. (a) For a candidate, who fails to earn all the ‘**credit**’ of a semester but continues to the next semester by virtue of earning minimum credit **(clause number 10),** it is necessary that, total accumulation of shortfall in credit carried by the candidate, must not exceed 12 (twelve) at any stage, and in such a case **he/she shall not be allowed to continue the course any further.**

(b) In order to complete the M. Tech. course, a candidate will have to utilize all the allowed chances within four (4) years from the date of first admission. A candidate who fails to earn all the credits of the M. Tech. course within the permissible chances **will not be allowed to continue the course any further**.
(c) If a candidate is unable to appear at any of the theory or practical examination(s), he/she will earn zero (0) credit in that paper(s).

14. The CU syndicate shall publish a list of successful candidates of the M. Tech. examination for each of the Semester examinations.
15. At the end of each Semester examination, a Grade-Sheet showing the Semester performance (Semester Grade-Sheet) indicated by **SGPA** will be issued to the students. However, SGPA will not be calculated for those candidates who fail to earn all the credit in that Semester.
The Semester Grade Sheet should have the following basic information:

Paper	Details of course	Full Marks	Marks obtained	Credit	Grade	Grade Point	SGPA	Remarks

16. (a) A consolidated Grade-Sheet, showing the overall performance in the M. Tech course indicated by **CGPA**, will be issued only to those successful students who have earned 80 (eighty) credit in the M. Tech. course.
The consolidated Grade-Sheet shall consist of two components. The first component will contain the information of the 4th Semester itself as follows:

Paper	Details of courses	Full Marks	Marks obtained	Credit	Grade	Grade Point	SGPA	Remarks

And the second component will contain a **summary** of all the semesters having the following basic information:

<table>
<tr><td rowspan="3">Semester</td><td rowspan="3">Total credit</td><td rowspan="3">Credit obtained</td><td rowspan="3">Back credit</td><td rowspan="3">SGPA</td><td rowspan="3">Full marks</td><td rowspan="3">Marks obtained</td><td colspan="2">Cumulative statement</td></tr>
<tr><td>Total credit</td><td>80</td></tr>
<tr><td>CGPA</td><td></td></tr>
<tr><td>4</td><td>16</td><td></td><td></td><td></td><td>400</td><td></td><td rowspan="2">Total Full marks</td><td rowspan="2">2000</td></tr>
<tr><td>3</td><td>16</td><td></td><td></td><td></td><td>400</td><td></td></tr>
<tr><td>2</td><td>24</td><td></td><td></td><td></td><td>600</td><td></td><td>Marks obtained</td><td></td></tr>
<tr><td>1</td><td>24</td><td></td><td></td><td></td><td>600</td><td></td><td>Result</td><td>*</td></tr>
</table>

The asterisks (*) in the last row of the last column will contain the information regarding the final achievement of the candidate in all the examinations. This box will contain only one of the following three information:
'1st Class' / '2nd Class' / 'Failed'.
(b) Candidates securing at least 66 (sixty six) percent of the total marks in M. Tech. Examination (total of semester 1 to semester 4 examinations) shall be placed in the 'First Class' and those securing 50 (fifty) percent marks or more but less than 66 (sixty six) percent marks shall be placed in the 'Second Class'. Candidates securing less than 50 (fifty) percent shall be declared 'Failed'.

17. The Degree of '**Master of Technology in Electrical Engineering'** from the Department of Applied Physics under the seal of the University shall be awarded to a successful candidate mentioning the grade and class he/she has obtained.

Course structure for 2-Year 4-Semester
M.Tech. Degree in Electrical Engineering (w. e. f. the academic year 2014 - 2015)

Semester I Examination
Theoretical

PAPER NO.	SUBJECT	PERIODS			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
MET11	Computational Methods	4	-	-	20	10	70	100	4
MET12	Advanced Electrical Machines	4	-	-	20	10	70	100	4
MET13	Embedded Systems	4	-	-	20	10	70	100	4
MET14	Elective Paper I	4	-	-	20	10	70	100	4

Practical

PAPER NO.	SUBJECT	PERIODS			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
MEP11	Advanced Electrical Machines Lab	-	1	7	50	-	50	100	4
MEP12	Embedded Systems Lab	-	1	7	50	-	50	100	4

Semester II Examination
Theoretical

PAPER NO.	SUBJECT	PERIODS			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
MET21	EHVAC, HVDC Transmission and FACTS	4	-	-	20	10	70	100	4
MET22	Advanced Electric Drives	4	-	-	20	10	70	100	4
MET23	Advanced Control System	4	-	-	20	10	70	100	4
MET24	Elective Paper II	4	-	-	20	10	70	100	4

Practical

PAPER NO.	SUBJECT	PERIODS			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
MEP21	Electric Drives and Control Lab	-	1	7	50	-	50	100	4
MEP22	Advanced Power Systems Lab	-	1	7	50	-	50	100	4

Semester III Examination

PAPER NO.	SUBJECT	PERIODS			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
MEP31	Seminar	-	2	6	50	-	50	100	4
MEP32	Project Phase I	-	4	12	50	-	150	200	8
MEP33	General Viva Voce	-	-	-	-	-	-	100	4

Semester IV Examination

PAPER NO.	SUBJECT	PERIODS			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
MEP41	Project Phase II	-	8	24	100	-	300	400	16

Detailed syllabus for Semester system for
2-Year 4-Semester M.Tech. Degree in Electrical Engineering
w. e. f. the academic year 2014 – 2015

Semester I

Theoretical Papers:

MET11 Computational Methods

Wavelet Techniques: Introduction to Wavelet Transform and its application in signal processing.
Fuzzy Sets: Classical sets and fuzzy sets, fuzzy sets and probability, fuzzy numbers, operations and properties, membership functions and its types. Fuzzy inference mechanism, fuzzy rule base and reasoning – linguistic variables, concept of approximate reasoning. Engineering examples.
Artificial Neural Network (ANN): Neuron model – Biological neuron, artificial neuron, activation function, mathematical model. ANN architecture – feed-forward network, single layer and multi layer, Learning mechanism in ANN.
Optimization Techniques: Classification of optimization problems, classical optimization techniques. Evolutionary algorithms-GA and PSO and their operators. Ideas of other stochastic algorithms like ACO, HS, GSA etc. Engineering examples.

MET12 Advanced Electrical Machines

Review of conventional electrical machines: Transformer, DC machine, Polyphase induction machine and Synchronous machines.
Generalized theory of electrical machines: Rotational frame; Holonomic and non holonomic reference frame, quasi holonomic reference frame. Impedance matrix, torque matrix, rotational matrix, flux and current density matrices.
Modeling and analysis of different electrical machines. Analysis of machines in Clarke, Park and dqo planes.
Dynamics of electrical machines: Need for study of machine dynamics. Dynamics of DC machine – open loop and closed loop model and its responses, speed control of separately exited DC motor. Dynamics of synchronous machines – Parallel operation of alternators, swing equation of single machine connected to infinite bus and its stability considerations in light of Lyapunov stability theory.

MET13 Embedded Systems

Microcontroller based system: Introduction to Intel 8051 MCU architecture, addressing modes, structure of internal RAM, handling of ports, timer and counters, interrupt structure, serial communication, programming using assembly and C language.
PIC Microcontroller family with hardware details, handling of peripherals – ADC, timer and counter, SPI, I2C, external memory interfacing, PWM and compare modes.
DSP processor based system: The components of DSP core, peripherals and interfaces, registers, memory, interrupts.
FPGA based system: Overview of Field Programmable Gate Arrays- CPLD, FPGA. Types of FPGA, basic components. Overview of Spartan 3E FPGA board with some case studies.
RTOS: Real time specifications, real time kernels, AVR based systems, inter-task communications and synchronizations.

MET14 Elective Paper I

Practical Papers:

MEP11 Advanced Electrical Machines Lab.
MEP12 Embedded Systems Lab

Semester II

Theoretical Papers:

MET21 EHVAC, HVDC Transmission and FACTS

EHVAC Transmission; Choice of working voltage and line length, common operating problems of uncompensated EHVAC transmission lines, Need for compensation. Voltage Stability in Power Transmission: Controls and Improvements. Technical problems in EHVAC system,
HVDC Transmission: Advantages, principles, terminal equipment, necessity of control of a DC link, power reversal of DC link, different conversion techniques, CSC and VSC Transmission, Multilevel Transmission. Harmonics and filters: Generation of harmonics by converters, characteristics of harmonics, effect of control system, non-characteristic harmonic. Harmonic model and equivalent circuit, use of filter, filter in the AC and DC sides. Fault and protection schemes in HVDC systems: Nature and types of faults, faults on AC side and DC side of the systems, protection thereof. Multi-terminal HVDC systems: Types, parallel operation aspect of MTDC. Control of power in MTDC. Multilevel DC systems.
FACTS: Definition, concepts, classification, Types of Compensation: series / shunt etc. capacitor, synchronous compensator, SVC, Tap changing transformer.
Static Shunt Compensators: SVC and STATCOM, principle of operation and applications.
Static Series Compensators: GCSC, TSSC, TCSC, SSSC, principle of operation and applications.
Static Voltage and Phase angle Regulator: TCVR, TCPAR, principle of operation and applications.
Combined Compensators: UPFC, IPFC, principle of operation and applications.

MET22 Advanced Electric Drives

Drive Concept: Different machine and load characteristics, equilibrium and steady state stability, four quadrant operation, referred inertia and load torque for different coupling mechanism, thermal selection of machines.
DC machine speed control: State feedback control and sliding mode control of separately excited dc machine, modeling and control of separately excited dc machine in field weakening region and discontinuous converter conduction mode, control of dc series motor.
Induction machine drive: Review of variable frequency operation of three phase symmetrical induction machine, 12 pulse / 18 pulse inverter, scalar control methods (constant volts/Hz and air gap flux control), vector control of induction machine, methods of flux sensing/estimation, PWM control.
Traction drives: important features of traction drive, conventional ac and dc drives, diesel electric traction, ac traction, dc traction.
Special machines drive: Speed control of BLDC machine, SRM, PMSM, linear induction motor.
Soft computing approach for speed control of DC motor drive and three phase induction motor drive. Adaptive speed control for induction motor drives using neural network.

MET23 Advanced Control Theory

Review of Controllability and Observability concepts and criterion, Concept of state feedback systems and Luenberger observer systems.
Stability issues – Equilibrium points, BIBO and asymptotic stability. Lyapunov's stability criteria for linear and nonlinear systems.
System Identification and Adaptive control (Classical approach): experimental planning, model structure selection, parameter estimation for system identification. Adaptive control concept, self-tuning regulator, model reference adaptive control, design of adaptive control law from Lyapunov stability concept.
Optimal control: integral performance index, Euler equation, state function of Pontryagin, basic and general optimal control problem, Pontryagin's maximum principle, Time-optimal control/ Bang- Bang control, External control application, Quadratic Performance Index, Parameter optimization problem, Matrix-Ricaati equation.
Piecewise constant orthogonal function; comparison with sine -cosine function, mean squared error; Walsh and block pulse function, operational matrices for integration, differentiation; time scaling; Control system analysis in Walsh and block pulse domain, Correlation and convolution; control system identification using block pulse functions.
Fuzzy Logic Control: Need for fuzzy control, Mamdani and Takagi-Sugeno models, fuzzy PD and fuzzy PI controller design concept.
Takagi-Sugeno type adaptive fuzzy controller design from Lyapunov stability concept. Parameter optimization of fuzzy controllers using stochastic optimization technique.

MET24 Elective Paper II:
Practical Papers:

MEP21 Electric Drives and Control Lab.
MEP22 Advanced Power Systems Lab.

OPTIONAL PAPER I

MEO11 Advanced Engineering Mathematics

Nonlinear differential equations: graphical and analytical methods of solutions; Perturbation and variation of parameter methods; Ritz and Galerkin method; Riccati, vander Pol, Duffing.Matheu equations; Approximate solution of integral equations; Nonlinear integral equation;Operation research and quality control: Estimation of parameters, testing of hypothesis,decisions; Quality control, acceptance, sampling, non-parametric tests, fitting of straight lines; operational research
Fourier Transform: Fourier integrals and its interpretation, Fourier transformation, Frequency spectrum,
Linear transformation of vector spaces; sum and scalar multiplication, product, polynomial and invertible transformations; matrix representation of linear transformation; Solution of linear equations;. Eigen values and eigen vectors, matrix polynomial; Cayley-Hamilton theorem and its application; computation of matrix functions. Canonical representations: Jordan and rational canonical form; bilinear, quadratic and Hermitian forms, positive and negative definite and semi definite form, Sylvester's criteria.

MEO12 Digital Signal Processing

Digital signal processing and its benefits. Application areas, Discrete time signals and systems in time domain; discrete time signals in transform domain Z transform; Orthogonal transforms: Hadamard.. Walsh transform. Discrete Fourier Transform(DFT), Discrete inverse Fourier transform, DFT properties, computational complexity of the DFT, The decimation-in-time and decimation-in-frequency fast Fourier transform algorithm, inverse fast Fourier transform, computational advantages of FFT discrete convolution, discrete correlation.
Digital processing of continuous-time signals; Digital filters: approximations, transformations, IIR and FIR filters, FIR filter design, window method, optimal method, frequency sampling method, realization structure for FIR filters, FIR implementation techniques; design of IIR filters : pole zero placement method, impulse invariant method, matched z-transform method and bilinear z-transform method of coefficient calculation; realization structure for IIR filters, IIR implementation techniques, Analysis of finite word length effects in fixed point digital signal processing.
Multidimensional digital signal processing; Application in image processing.

MEO13 Fundamentals of Soft Computing and Its Applications

Soft computing, Difference with hard computing, Idea of knowledge based systems and expert systems.
Fuzzy logic and its applications, Difference with conventional logic, Basics of fuzzy sets- fuzzy set theory; properties of fuzzy set and its operations, Fuzzy relations- Operation on fuzzy relations and extension principle, Fuzzy logic and approximate reasoning-linguistic variables; fuzzy propositions; fuzzy if-then statements, Representing set of rules- Mamdani vs. Godel; properties, completeness; consistency; continuity and interactions of a set of rules. Structure of fuzzy knowledge based controller design and its applications.
Artificial Neural Network, Perceptron, Feed forward network and supervised learning, Back propagation, Un-supervised learning, Neuro-Fuzzy controller design. Genetic Algorithms and its Applications.

MEO14 Power System Stability and Protection

Power system stability: Basic concept, angle stability, voltage stability, classification of angle stability.
Steady state stability: definition, limit, margin, Swing of a machine, swing equation.
Transient stability: definition, phenomenon, equal area criterion, critical clearing angle, time, applications in power system, network performance equations, solutions, solution techniques, preliminary calculations, modified Euler's method, R-K method, Numerical problems.
Review of Relay and Circuit Breakers. Protection of transformers, protection of motors, protection of generators. Distance relay: Generalized relay equation, deduction of characteristic equations for impedance, reactance, mho relays and other related relays, critical applications; Power swing conditions.
Static relays: current, voltage and impedance relays, standard relaying; Computer and microprocessor applications in protection schemes; DSP based relays, Numerical relays. Protection scheme design, Relay co-ordination.
Application of modern computational techniques in power system protection.

MEO15 Power Plant instrumentation

Role of instrumentation, Instrument layout, Instrument schedule Instrument test pocket; Desk panel layout. control room layout; Burner management system auto control loops; Drum level control, Mill air flow and outlet temperature control Superheated steam temperature control; Instrument wiring diagram; Transmitter grouping annunciation system; SCADA system; Plant performance and outage.

MEO16 High Voltage Engineering

Different types of breakdown in solid and liquids, Partial discharge and its measurement techniques. Basic Equations of Electric field analysis. Electric Field Analysis by Finite Difference Method – in 2D and Axi-Symmetric Systems with equal and unequal nodal distances,
Measurement of High Voltages, Electrostatic Voltmeters, Compensated ac and impulse peak voltmeters, Different types of voltage dividers and their characteristics, Surge current and voltage recorders, Surge crest ammeter and Klydanograph. High Voltage Schering Bridge. Microprocessor based measurement techniques.

MEO17 Power System Analysis

Short Circuit Studies using ZBUS: its necessity, contributors to fault current.
Symmetrical fault: consideration of load current, fault current calculations using computer in n-bus system,
Asymmetrical fault: introduction to symmetrical components, sequence networks for generators, transformer and transmission line, single line to ground, double line to ground, and line to line fault, analysis of a complete power system, Computer aided calculations; Application of fault analysis in power system co-ordination.
Reflection in transmission line: reflection co-efficient, standing wave and traveling wave, standing wave ratio Smith transmission line chart: its origin and applications.
Power system Tariff: its need and structure, Availability Based Tariff (ABT), its background, need, basic principle, areas of use and achievements in restructured power system.
Power system measurement: energy: active, reactive and apparent, Demand and maximum demand, trivector meter ; digital metering, SMART Metering.

OPTIONAL PAPER II

MEO21 Power System Communication and SCADA

Power System communication: Evolution of power system communication, Power line communication, Optical Fiber Communication, Computer Communication Technology: Types Of Communication Interface, Types Of Networking Channels,Parallel and serial communication Interface,Communication Mode, Synchronization And Timing In Communication, Standard Interface, Software Protocol, ASCII Protocol, HART Protocol, Manufacturer Specific Protocol, Network Topology, Media Access Methods, Open System Interconnection (OSI) Network Model, Device Bus and Process Bus Network,Controller Area Network (CAN), Devicenet, Controlnet, Ethernet, Proprietory Network, Smart Distributed System, Interbus – S, Seriplex Bit-Wide Device Bus Network, AS-I Interface, Foundation fieldbus, Profibus
Distributed Control System, Supervisory Control and SCADA systems: client layer and data structure layer, Real time database processing, server-client and server-server communication, dynamic data exchange (DDE), object linking and embedding (OLE), redundancy, functionality, SCADA application in plant automation and power system.

MEO22 Advanced Control Techniques

Idea of 'good control', Controller performance index, Different tuning methods and their comparative study, Advanced tuning techniques. Idea of MIMO systems, Tuning of MIMO systems, Relative gain array, Optimizing control.
Special control techniques- Selective control, Override control, Limit control, Idea of Statistical process control.
Self-tuning control- Deterministic self-tuning regulators, Stochastic and predictive self-tuning regulators.

Adaptive control- what is adaptive control, properties of adaptive systems, stochastic adaptive control, auto-tuning, gain scheduling, Optimal control, control with constrains, time optimal control, Continuous Kalman Filter, Square root Kalman filter. Non-linear system optimization, Gradient optimization techniques, steepest ascent and decent in parameter plane.
Introduction to Fuzzy mathematics, Fuzzy reasoning and rule base, Structure of fuzzy control, Fuzzy control- real time expert systems, knowledge based controller design, non-linear fuzzy control, Inference engine, sliding mode control.
Adaptive fuzzy control- Performance monitoring and evaluation, Adaptation mechanism.
Neural Fuzzy controllers- Neural Fuzzy controllers with hybrid structure, Fuzzy adaptive learning control network, Structure learning of Neural-Fuzzy controllers.

MEO23 Sustainable Power Generation And Supply

Different forms of sustainable power sources : Solar, biogas, wind, tidal, geothermal
Basic bio-conversion mechanism, mechanism of generation of electricity, isolated operation and operation of the system with grid.
Wind and tidal energy generation; special characteristics, turbine parameters and optimum operation, Ocean thermal energy conversion, Geothermal energy- hotsprings and steam injection, power plant based on Wind, Tidal, OTEC and geothermal springs, operation of such plants with grid
Energy from the sun : Fundamentals of the technology, increase of efficiency, study of nano-structures, supply of power to Grid. limitation of photovoltaics efficiency. Fuel cells, peak load demands, developments in fuel cells and applications.
Direct energy conversion methods : Photoelectric, thermo-electric, thermionic, MHD (magnetohydrodynamics) and electro chemical devices, photovoltaic and solar cells.
Fusion energy : Controlled fusion of hydrogen, helium etc. Energy release rates, present status and problems, future possibilities. Integrated energy packages using solar, biomass, wind.
Comparative study of non-conventional energy sources, cost considerations and economics.

MEO24 Power System Harmonics, Quality and Reliability

Power system disturbances: types, definitions, Harmonics: sources, analysis, effects, computation of harmonic flows, reduction of harmonics, passive and active filters, their controls and uses.
Power system Quality: Different factors, definitions, measurements techniques, effects on power system operation and control.
Power system Restructuring: Need of restructuring, basis of restructuring, Distributed Generation, Co-generation, importance of power quality in restructured environment.
Power system reliability : Its necessity, basic principles, different techniques to improve reliability.

MEO25 Artificial Intelligence and Robotics

Problem solving methods: Control strategies, Heuristic search, Reasoning, Breadth, depth and best search; Knowledge representation, Predicate Logic, Non monotonic reasoning, statistical and probabilistic reasoning, Semantic nets, Conceptual dependency; AI languages, Important characteristics. Expert system: structure, interaction with experts, Design examples;
Origin and types, Degree of freedom, Asimov's law, Dynamic stabilization; Power sources, and sensors,: Hydraulic, pneumatic, and electric drives, mechanical design, electrical speed control, path determination; Machine vision, ranging, Manipulators, Actuators and Grippers: constructions, dynamics and force control. design consideration; Kinematics and path planning, Solution of inverse kinematics problem; work envelop, hill climbing technique, Robot programming languages; Applications.

MEO26 Special Electrical Machines

Special Machines: Reluctance Motor, Switched Reluctance Motor, Brushless DC motor, Hysteresis motor, servomotor, stepper motor, PCB motor. Electronic excitation schemes for these. PM synchronous motor and generator. 1-phase alternator, linear induction motors. Energy efficient motor. Induction Regulators: Basic Principles.
Study of the doubly-fed slip-ring machine and the induction generator for synchronisation to the grid. Microcontroller DSP and PLC application to motor drives. Introduction to AI application to Machine drives. Feedback system components like tachogenerators, optical encoders, Hall-effect sensors.

MEO28 Smart Grid Systems

Smart Grid Architectural Designs
Introduction – Comparison of Power grid with Smart grid, General View of the Smart Grid Market Drivers, Stakeholders. Functions of Smart Grid Components.
Smart Grid Communications Protocols
Communication Protocols – RS 232, RS 485, SCADA, ZigBee/PLC, CRC.
Phasor Measurement Unit (PMU), Smart Meters, Wide area monitoring systems (WAMS), Advanced metering infrastructure.
Performance Analysis Tools For Smart Grid Design
Different Load flow techniques for smart grid design, contingencies studies for smart grid.
Stability Analysis Tools For Smart Grid
Voltage Stability Assessment Techniques, angle stability assessment in smart grid, approach of smart grid to State Estimation, Energy management in smart grid.
Renewable Energy And Storage
Renewable Energy Resources, demand Response Issues, Electric Vehicles and Plug-in Hybrids-PHEV Technology. Storage Technologies, Grid integration issues of renewable energy sources.