DEPARTMENT OF APPLIED PHYSICS
UNIVERSITY COLLEGE OF TECHNOLOGY
UNIVERSITY OF CALCUTTA

Regulation for 3-year 6-semester B. 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 3-year, 6-semester B. Tech. degree in **Electrical Engineering**. The course is of three (3) years duration comprised of six (6) Semesters, each Semester being of six (6) months' duration.

2. A candidate who has passed the 3-year B. Sc. degree with Honours in Physics from the University of Calcutta or its equivalent degree from any other university will be eligible to apply for admission to the 6 (six) Semester Bachelor of Technology (B. Tech.) course in **Electrical Engineering** of the University of Calcutta.

3. The award of the said B. Tech. Degree in **Electrical Engineering** will be conferred to students who are successful in all of the six (6) Semester examinations. End-Semester Examination (ESE) and at 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 six (6) Semesters are given in course structure.

4. Four (4) lecture hours per week shall be allotted to each theoretical paper of 100 marks and four (4) practical hours and one (1) tutorial hour per week shall be allotted to each practical paper of 75 marks in a laboratory. For seminar, design and project phase-I papers of 100 marks each, six (6) practical hours and two (2) tutorial hours per week shall be allotted. For project phase –II paper of 200 marks twelve (12) practical hours and four (4) 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 test.

(c) Duration of End Semester Examination 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 75 marks, out of which 25 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/subject	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	26
2	29
3	29
4	29
5	27
6	20
TOTAL	160

(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/subject.

(e) The performance of a candidate in n^{th} (n = 1,2,3,4,5,6) 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 B.Tech. course, the overall performance of a candidate will be assessed by the '**Cumulative Grade Point Average' (CGPA)** to be computed as:

$$CGPA = \frac{\sum_{n=1}^{6} [C_n\, S_n\,]}{\sum_{n=1}^{6} C_n}$$

where, $C_n = \sum_k C_k$ and $\sum_{n=1}^{6} C_n$ denotes total credits of all the semesters i.e. 160 credits.

8(a) Each candidate shall opt one (1) elective paper of 100 marks from the list of elective papers to be notified in 5^{th} semester. 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 execute a Design work of 100 marks, assigned to him/her during the 6^{th} semester course and he/she has to submit a report on the same at least 5 days before the examination date. Out of 100 marks, 50 marks are earmarked for sessional work to be assessed by the internal supervisor(s) on the basis of the laboratory performance and submitted report. The assessment for the rest 50 marks of Design paper shall be done through a viva voce examination conducted by a board consisting of at least two (2) examiners.

(c) 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 6^{th} 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.

(d) Each candidate shall execute a Project work assigned to him/her during the 5^{th} and 6^{th} 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 100 marks is assigned during 5^{th} semester while Project Phase-II of 200 marks is assigned during 6^{th} 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 100 marks assigned to Project Phase-I, 50 marks is earmarked for Sessional work to be assessed by the internal supervisor(s), 50 marks for the presentation of the project and viva voce on the project work. Out of the 200 marks assigned to Project Phase-II, 100 marks is earmarked for Sessional Work to be assessed by the internal supervisor(s), 100 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.

(e) A general viva-voce test for 100 marks shall be conducted during 6^{th} Semester examination, by a board consisting of at least five (5) examiners two (2) of which 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 1st to 5th Semester examinations will be allowed to continue in the next semester classes provided he/she secures at least the following credits respectively and for the 6th semester, he/she has to secure the following credit:

Semester	Minimum Credit to be obtained
1	19
2	22
3	22
4	22
5	20*
6	20

* the minimum credit in 5th Semester includes the mandatory 4 credits of the BEP52 (Project Phase - I), that is, if a candidate fails to earn 4 credits of BEP52 he/she will be declared **'unsuccessful'** in the 5th semester and he/she will have to take readmission as per clause 11 below.

11. A candidate earning credits less than that 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 credits'** (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(s).**
(b) If he/she fails to earn the due credits 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 '**credits**' of a semester but continues to the next semester by virtue of earning minimum credits **(clause number 10),** it is necessary that, total accumulation of shortfall in credits carried by the candidate must not exceed 21 at any stage. In such a case **he/she shall not be allowed to continue the course any further.**
(b) In order to complete the B. Tech. course, a candidate will have to utilize all the allowed chances within five (5) years from the date of first admission. A candidate who fails to earn all the credits of the B. 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 B. 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 credits in that Semester.
The Semester Grade Sheet should have the following basic information:

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

16. (a) A consolidated Grade-Sheet, showing the overall performance in the B. Tech course indicated by **CGPA**, will be issued only to those successful students who have earned 160 (One Hundred Sixty) credit in the B. Tech. course.
The consolidated grade sheet shall consist of two components. The first component will have the information of the 6th Semester itself as follows:

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

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

Semester	Total credit	Credit obtained	Back credit	SGPA	Full marks	Marks obtained	Cumulative statement	
6	20				500		Total credit	160
5	27				675		CGPA	
4	29				725		Total Full marks	4000
3	29				725			
2	29				725		Marks obtained	
1	26				650		Result	#

The hash (#) in the last row of last column will contain the information regarding the final achievement of the candidate in all the examinations. This box will contain only one (1) of the following three (3) information: '1st Class' / '2nd Class' / 'Failed'.

(b) Candidates securing at least 66 (sixty six) percent of the total marks in B. Tech. Examination (total of Semester-1 to Semester-6 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 **"Bachelor 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 3-Year 6-Semester B.Tech. Degree in Electrical Engineering
w. e. f. the academic year 2014 - 2015

Semester I Examination
Theoretical

PAPER NO.	SUBJECT	PERIODS per week			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
BET11	Engineering Mathematics	4	-	-	20	10	70	100	4
BET12	Analog Electronics	4	-	-	20	10	70	100	4
BET13	Digital Electronics	4	-	-	20	10	70	100	4
BET14	Electrical and Electronic Measuring Instruments	4	-	-	20	10	70	100	4
BET15	Computer Programming Languages and Numerical Methods	4	-	-	20	10	70	100	4

PRACTICAL

PAPER NO.	SUBJECT	PERIODS per week			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
BEP11	Engineering Drawing	-	1	4	25		50	75	3
BEP12	Material Testing and Workshop Practice	-	1	4	25		50	75	3

Semester II Examination

Theoretical

PAPER NO.	SUBJECT	PERIODS per week			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
BET21	Control Theory I	4	-	-	20	10	70	100	4
BET22	Microprocessors and Peripheral Devices	4	-	-	20	10	70	100	4
BET23	DC Machine and Transformers	4	-	-	20	10	70	100	4
BET24	Network Theory and Transmission lines	4	-	-	20	10	70	100	4
BET25	Transducers and Process Measurements	4	-	-	20	10	70	100	4

PRACTICAL

PAPER NO.	SUBJECT	PERIODS per week			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
BEP21	Electrical Measurements & Measuring Instruments	-	1	4	25		50	75	3
BEP22	Computer Programming Languages	-	1	4	25		50	75	3
BEP23	Analog and Digital Electronics	-	1	4	25		50	75	3

Semester III Examination
Theoretical

PAPER NO.	SUBJECT	PERIODS per week			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
BET31	Analog and Digital Communication	4	-	-	20	10	70	100	4
BET32	Power Electronics and Power Supply	4	-	-	20	10	70	100	4
BET33	Induction and Synchronous Machines	4	-	-	20	10	70	100	4
BET34	Microcontroller and PLC Applications	4	-	-	20	10	70	100	4
BET35	Power Systems	4	-	-	20	10	70	100	4

PRACTICAL

PAPER NO.	SUBJECT	PERIODS per week			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
BEP31	Microprocessor Programming		1	4	25		50	75	3
BEP32	Electrical Machines and Power Systems		1	4	25		50	75	3
BEP33	Control Systems		1	4	25		50	75	3

Semester IV Examination
Theoretical

PAPER NO.	SUBJECT	PERIODS per week			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
BET41	Power System Stability, Load Flow Analysis and Tariff	4	-	-	20	10	70	100	4
BET42	Switchgear and Protection	4	-	-	20	10	70	100	4
BET43	Industrial Drives and Controls	4	-	-	20	10	70	100	4
BET44	Power Station, Substation Engineering and Fault Analysis	4	-	-	20	10	70	100	4
BET45	Advanced Electrical Machines	4	-	-	20	10	70	100	4

PRACTICAL

PAPER NO.	SUBJECT	PERIODS per week			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
BEP41	Advanced Electrical Machines	-	1	4	25		50	75	3
BEP42	Advanced Power Systems	-	1	4	25		50	75	3
BEP43	Power Electronics and Drives	-	1	4	25		50	75	3

Semester V Examination
Theoretical

PAPER NO.	SUBJECT	PERIODS per week			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
BET51	Industrial Economics and Business Management	4	-	-	20	10	70	100	4
BET52	Control theory II	4	-	-	20	10	70	100	4
BET53	Engineering Mechanics, Materials Science and Thermal Engineering	4	-	-	20	10	70	100	4
BET54	Special Electrical Machines and Design of Electrical Machines	4	-	-	20	10	70	100	4
BET55	Elective Paper	4	-	-	20	10	70	100	4

PRACTICAL

PAPER NO.	SUBJECT	PERIODS per week			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
BEP51	PLC, Microcontroller and Communication	-	1	4	25		50	75	3
BEP52	Project Phase – I	-	2	6	50		50	100	4

Semester VI Examination

PRACTICAL

PAPER NO.	SUBJECT	PERIODS per week			EVALUATION SCHEME				CREDITS
		L	T	P	TA	CT	ESE	TOTAL	
BEP61	Design of Electrical Machines and Systems	-	2	6	50		50	100	4
BEP62	Seminar	-	2	6	50		50	100	4
BEP63	Project Phase – II	-	4	12	100		100	200	8
BEP64	General Viva Voce	-	-	-	-	-	-	100	4

Elective Papers:

1. Microprocessor and microcontroller interfacing
2. Digital Signal Processing
3. Process automation , DCS and SCADA
4. Non-Conventional Energy Systems
5. High Voltage Engineering
6. Illumination Engineering
7. Sensor Technology

Detailed syllabus for Semester system
B.Tech. Degree in Electrical Engineering
w. e. f. the academic year 2014 - 2015

Semester I Examination

BET11 Engineering Mathematics

Fourier Transform: Fourier integrals and its interpretation, Fourier transformation, Frequency spectrum, FT of different time functions, Fourier transform theorem, Inverse Fourier transform;
Laplace Transform :two sided and one sided Laplace Transform, Laplace Transform of standard time function, LT of periodic and other time functions, Theorems of Laplace Transform, Inverse Laplace Transform, Lerch's Theorem, Solution of differential equations, boundary value problems, Solving circuit problems using LT.
Special Functions: Bessel function: differential equation, functions of first and second kind, properties, recurrence relations.
Linear Algebra: Linear transformation of vector spaces; sum, product, polynomial and invertible transformations; matrix representation of linear transformation; Solution of linear equations. Eigen values and eigen vectors, matrix polynomial; bilinear, quadratic and Hermitian forms,
Functions of complex variable and conformal transformation: Analytical complex function: Cauchy-Rieman differential equations, harmonic function, line integral of complex function, Cauchy's integral theorem, derivative of analytical function, modulus and real value theorem.
Taylor and Laurent series, residue and Cauchy's residue theorem; Definite integrals by the method of residue; Jordan's lemma, Mapping of complex functions: Conformal mapping, critical point of transformation.

BET12 Analog Electronics

Opto-electronic devices: LED, LCD, Laser diode, photodiodes, photoconductive cells, photovoltaic cells, phototransistors, Light activated SCRs, phototriacs
Special semiconductor devices: Tunnel diode, CCD, MIS diode
Operational Amplifier Fundamentals: Characteristics. Different applications
Linear Op-Amp Circuits: V-I Converter with floating and grounded load, Current amplifier, Difference amplifier, Instrumentation amplifier,
Non-linear Op-Amp Circuits: Schmitt trigger and applications, Precision rectifiers, Analog switches, Peak detectors, S/H circuits.
Practical Op-Amp limitations: DC errors, Slew rate, Frequency response, Noise effect, Frequency compensation. Ideal and Practical Integrators, Differentiators and solution of differential equations.
Multivibrators : Astable, Monostable, Bistable.
Integrated Circuit: Timer 555 and its applications
Log/Antilog Amplifiers, Analog Multipliers and their applications.
Voltage Controlled Oscillators, PLL and its applications, IC Voltage regulators, Introduction to Switched-Capacitor Circuits.
Filters : Filter classification Lowpass, highpass, bandpass and bandstop filter, Passive filters, Advantage of active filters, Transfer function approximation:- Butterworth, Chebychev and other approximations, realization of active filters, all pass filter, characteristic impedance of active filters

BET13 DIGITAL ELECTRONICS

Number systems and codes - Position number system, Radix conversion, Different types of codes- BCD, ASCII, EBCDIC, Gray.
Binary Arithmetic - R's and (R-1)'s complement representation, Subtraction using 1's and 2's complement representation, Concept of overflow, BCD addition.
Combinational Logic Design –Truth Table, SOP and POS realization from truth table, Logic minimization using K-map, Minterms and Maxterms, Minimization with don't care terms, Quine-McClusky's method of logic minimization, Error detection & correction: Hamming code.
Concept of combinational hazard, Examples of combinational logic design : Adder / Subtractor circuits; 2's complement ripple carry adder/subtractor circuit, Parity generator/checker circuit, Circuit for Binary to Gray and Gray to Binary conversion.
Encoder, Decoder, Demultiplexer and Multiplexer, Function realization using decoder and multiplexer
Sequential machine design : Concept of Moore and Mealy machine, State transition diagram and State transition table, Various memory elements, NAND-latch and its use, Clocked flip-flops, S-R, J-K, D, T. Timing constraints on edge triggered flip-flops; Changing one type of Flip-flop to another type, Design of sequence detector. Asynchronous and synchronous counter design. Different types of registers.
Programmable Logic Devices – PROM, PLA, PAL, FPGA.
Integrated Circuit Logic Families - TTL, PMOS, NMOS, CMOS, ECL.
Semiconductor memories - ROM, RAM.
Digital to Analog and Analog to Digital Converters.

BET14 Electrical and Electronic Measuring Instruments

Standardization: classification, quantum standard
Measurement of resistance : high, medium and low
Measurement of inductance (self, mutual), capacitance and frequency by ac bridge methods- Owen's, Heaviside-Campbell, Scherring bridges, Wagner Earthing device.
DC and AC potentiometers: Crompton potentiometer, Drysdale polar type and Gall Coordinate type potentiometer, application of potentiometers, Magnetic Measurements.
General features of electrical measuring instruments: controlling, damping, and balancing of moving systems.
Instruments mechanism and dynamics: vibration galvanometer, Permanent magnet moving coil, moving iron, electro-thermal, rectifier, induction type and electrodynamic instruments for measuring voltage, current and power. Basic electrostatic instruments: voltmeters, wattmeters
Measurement of three phase power, Measurement of energy, Single Phase and Three Phase induction watthourmeters, , Power factor meters, frequency meters.
Electronic Instruments: True R.M.S Voltmeter, Peak Response Voltmeter, Electronic Ohmmeters.
Cathode ray oscilloscopes: Dual-Trace Oscilloscopes, Oscilloscope Controls, Oscilloscope Probes, storage oscilloscope.
Digital instruments: Basic Digital Displays – LEDs and LCD panels.
Digital Voltmeters, digital phase and frequency meter;.
Arbitrary Waveform Generator, Wave analyzer, spectrum analyzer, distortion factor measurement, high frequency measurement using twin T systems, Q meter and its applications.

BET15 COMPUTER PROGRAMMING LANGUAGES AND NUMERICAL METHODS

Concepts of operating systems, Introduction to high level programming Languages, Algorithm & Flow Charts, algorithms and flow charts, Operators and its precedence, Expressions in C, Various data types in C, Data input and output, Storage classes in C, Decision making and loop formation, arrays, Handling Character, structures and unions, user-defined functions, pointers, pointers to structures, pointers to functions, file handling, Dynamic data structure, Command line arguments, graphics, Introduction to object oriented programming in $C^{++.}$

Errors in numerical computations; solution of algebraic and transcendental equations: graphical approach, methods of bisection and inverse linear interpolation, Newton-Raphson method, method of quadratic factors.
Solution of system of equations: Matrix inversion method, method of elimination, Jacobian and Gauss- Seidel iterative methods.
Interpolation and curve fitting: Polynomial curve fitting, Lagrangian interpolation, interpolation with finite differences, forward, backward, central and divided difference formulae, least square approximation and data smoothing. Solutions of ordinary differential equations: Taylor and Euler methods, predictor-corrector methods, Runge-Kutta method. Numerical integration techniques: quadrature formula, trapezoidal and Simpson's Rule.

PRACTICAL PAPERS :

BEP11 Engineering Drawing
BEP12 Material Testing and Workshop Practice

Semester II Examination

THEORETICAL PAPERS

BET21 CONTROL THEORY I

Control system: block diagram, transfer function, signal flow graph, Mason's gain formula, mathematical model of dynamic system: electrical, electro-mechanical and fluidic system; Concept of stability: Routh-Hurwitz stability criteria, root locus concept, polar plot, Bode plot, log-magnitude vs. phase plot, Nyquist stability criteria, relative stability, gain and phase margin; Frequency response, constant magnitude and phase shift loci in G-plane.
Processs control : Open loop, closed loop, manual, automatic, feedback and feedforward.
Basic definitions : Controlled variable, measured variable, load variable, control action, set point, deviation etc.
Types of process control actions : On/off, floating, P, PI, PID control
Basic rules of representing a control loop component, basic control loops.
Control system components: signal comparator, synchro, servomotor, tachogenerator, stepper motor, control valve-construction, principle and characteristics, pneumatic actuators, power cylinder, example of control systems.

BET22 Microprocessors and Peripheral Devices

Architecture of 8085: CPU, ALU, Registers organization, pin details, instruction set and addressing modes; programming examples, Fetch cycle, Instruction cycle, machine cycle, timing diagram; Interrupt structure, Data transfer schemes, synchronous, asynchronous, Interrupt driven mode, polled interrupt : software and hardware polling.

Interfacing devices: tristate devices, buffers and latches.
Subroutines, nested subroutines, multiple ending subroutine.
Hardware Interfacing- memory interfacing, I/O interfacing, memory mapped I/O and I/O mapped I/O, programmable I/O (8212, 8155, 8755, 8255), programmable interrupt controller 8259, ADC and DAC interfacing.

BET23 DC MACHINE AND TRANSFORMERS

Single phase transformer: principle, construction and operation, phasor diagrams, equivalent circuits, parameters from open and short circuit tests, load tests, temperature rise, short heat run test, different losses, efficiency, regulation, polarity test, parallel operation,
Current transformers and potential transformers – their design and performance characteristics, phasor diagrams, magnitude error, phase angle error, composite error, difference with power and distribution transformers, testing of CT and PT, metering and protection CT.
DC Machines: Electromechanical energy conversion, basic principle, construction: armature winding, armature reaction, commutation, interpoles and compensating winding, DC generator: types, operating principle, characteristics, parallel operations; DC motors: types, operating principle, characteristics, starting and speed control, testing, losses and efficiency of generators and motors. Uses of DC Machines, trouble shooting of motors and generators.

BET24 NETWORK THEORY AND TRANSMISSION LINES

Three phase circuits: balanced network, Symmetrical components, unbalanced networks, delta - star transformation;.
Generalized mesh and nodal analysis, Duality of network. Network theorems: analysis with dependent and independent sources, current and voltage sources, network minimization, numerical examples.
Two-port network: ABCD parameters: cascading of two port networks. Networks Graphs and Topology: Determination of incidence matrix, cut-set matrix, loop matrix and mesh matrix of large networks**.**
Network synthesis: driving point impedance and admittance functions, positive reality concept. realizability conditions, Hurwitz and Sturm tests, general energy functions, two-elements realizability requirements, canonical realization methods, transfer-function synthesis.
Transmission lines : Lumped and distributed parameters, transmission line parameters, primary and secondary constants, distortionless transmission line. Transmission line equation, T and π models. Losses in a transmission line, Lossless line: equation, voltage and current distribution, characteristics, uses of transmission line as circuit elements. Stub and its location.
Reflection in transmission line, reflection co-efficient, standing wave and traveling wave, standing wave ratio Smith transmission line chart: its origin and applications.

BET25 Transducers and Process measurements

Instrument transducers: description, functional element, active and passive transducers, input-output configuration, static and dynamic characteristics.
Working principle of transducers: elastic deformation, resistance, capacitance, and inductance change, thermoelectric, piezoelectric and photoelectric electro-mechanical, electro-chemical, and ultrasonic principles, digital transducers.
Measurement of displacement, velocity and acceleration: potentiometer, LVDT, capacitive transducer, Tachogenerators, tachometers, stroboscopes, encoders, seismic accelerometers- piezoelectric and piezoresistive types.
Proximity sensors**:** Inductive, optical, magnetic, capacitive, ultrasonic.
Measurement of pressure and vacuum**:** manometers, elastic pressure sensors - Bourdon tube, bellows, diaphragm and capsule, Bourdon tube pressure gauge, pressure switch, electronic pressure transmitters - capacitive, piezo-resistive and resonator type, installation of pressure measuring devices, accessories for pressure measurement - chemical seal and snubbers. Vacuum measurement using Mcleod gauge, thermal conductivity gauge, ionization gauge.
Measurement of flow : Bernoulli's theorem, Differential pressure flow elements : orifices, venturies, flow nozzles, pitot tube.
Temperature Measurement: temperature measurement using change in physical properties: liquid filled system, gas filled system, mercury filled system; thermocouple, RTD, thermistors

PRACTICAL PAPERS:

BEP21 Electrical Measurements and Measuring Instruments
BEP22 Computer Programming Languages
BEP23 Analog and Digital Electronics

Semester III Examination

THEORETICAL PAPERS

BET31 Analog and Digital Communication

Introduction to communication systems, concepts of baseband signal, transmitter, transmission medium/ channel, Noise, Receiver, past history and different types of communication systems.

Analog communication: Concepts of signal, Noise, Power, SNR, Spectral Density, analog signal sources, Modulation- AM, FM, PM, Double sideband suppressed carrier, Single sideband, Amplitude compensated single sideband and vestigal sideband. If stages, Detection techniques, PLL, transmission bandwidth and distortion.

Digital Communication: Digital signals, Bandwidth of signals and Noise, Concepts of Pulse Amplitude Modulation, Pulse code modulation, Differential Pulse code modulation, Delta Modulation, Coding : Huffman and CRC, Time Division Multiplexing, Frequency Division Multiplexing, Inter Symbol Interference, Digital signaling formats, Spectral Efficiency, Bit Error Rate, Synchronisation, Spread Spectrum Systems- DSSS and FHSS.

BET32 Power Electronics and Power Supply

Power Semiconductor Devices: Diodes, Power BJT, Power MOSFET. The thyristor family: SCR, triac, gate turn-off thyristor (GTO), Insulated gate bipolar transistor (IGBT); basic structure, firing circuit, commutation techniques, basic characteristics, turn-on and turn-off characteristics, paralleling of devices, protective circuits, heat sinks.

Converters: Single Phase Uncontrolled and Controlled Rectification, Half wave Converter and Full wave Converter and half Controlled Converter: with R, Rl , RLE Load.

Inverters : Single Phase Series Inverter, Parallel Inverter, Single-phase H- bridge inverter circuits with R, RL Load. Inverter Control: Hysteresis Control, Different PWM Control techniques, Analysis of Inverter Performance, Current Source Inverters (CSI)

Chopper Circuits: Step up and Step down, Step up/down Chopper. Chopper performance analysis, Classes of chopper for different applications.

Power Supply: Unregulated vs. regulated power supplies, design of regulated power supply, switched mode power supply (SMPS), UPS.

BET33 INDUCTION AND SYNCHRONOUS MACHINES

Polyphase induction machine: construction, rotating magnetic field, simplified theory with constant flux, vector diagram, torque slip curve, power slip curve, effects of rotor resistance; frequency changer, equivalent circuit, circle diagram, performance calculations using circle diagram, performance test, starting, braking .

Synchronous machine: principle of operation, construction, windings; emf equation, generated emf of 3 phase alternator, pitch factor, distribution factor, different reactance, armature reaction, equivalent circuit, regulation: old AIEE method, Potier reaction method, synchronous impedance method. Parallel operation of synchronous generators, Synchronising circuits, synchronizing current, torque, phasor diagram, Load- frequency curve. .

BET34 Microcontroller and PLC Applications

Microcontroller – MCS-51 Family : Introduction, Architecture, Memory Organisation, Internal Ram structure, Special Function Registors and their functions, their orientation within the SFR space, I/O ports and their multiplexed functions, Concept of bit address and the bit addressable memory space organization, Interrupts, ISR space allocation and interrupt control, Timer/Counter- various modes of operations, UART for serial communication & its various modes and controls. Internal schematics of timers or serial controller.

Basic assembly programming techniques- Data transfer, Arithmetic program shifting and rotating, Boolean logic, Bit testing, Branches and Jumps, Subroutines and ISR, General purpose I/O, Interrupt driven I/O, Serial I/O.

Programmable Logic Controller: characteristic function, classification, block diagram representation of processor, memory layout, different languages used in PLC, types of program loaders. Input and output module, coils and contacts, PLC function block timers, function block counters, arithmetic function blocks, real time LADDER diagram; programming examples for maintenance and control.

PLC communication protocol, RS-232 communication interface, DF1 Full duplex protocol, DF1 half duplex slave protocol, DH-485 communication protocol, I^2C and SPI protocol, PLC interfacing technique.

BET35 Power Systems

Electrical Power transmission and distribution systems, choice of frequency and transmission voltages.

Distribution: feeders, distributors, copper efficiency of three phase transmission.

Overhead transmission lines: (a) Mechanical considerations: poles, towers, calculation of sag, effects of wind pressure and ice coating, choice of span length. (b) Line parameters of single phase and three phase systems (symmetrical and asymmetrical),

Transmission line calculations : Short, medium and long transmission lines, phasor diagram, losses, efficiency, regulation, Ferranti effect.

Underground cable : Different types, electrical characteristics, grading.

Relays: Torque equation of a relay, Construction, principle of operation, characteristics and application of directional and non-directional over current and earth fault relays, different connections of directional relays and their use..

Circuit breaker: arc formation, quenching, restriking voltage, and recovery voltage; circuit breaker rating; rated current; tripping of circuit breakers by relays

Power system economics: cost of electric supply, standing cost and running cost, factor effecting the cost of supply, load factor, diversity factor, demand factor.

Practical papers:

BEP31 Microprocessor Programming
BEP32 Electrical Machines and Power systems
BEP33 Control Systems

Semester IV Examination

THEORETICAL PAPERS

BET41 Power System Stability, Load Flow Analysis and Tariff

Power system Tariff, its need and structure, Block Rate, two part and multirate tariff, areas of use of each type; 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: active, reactive and apparent energy : Introduction to SMART Metering.

Economics of power factor improvement; instruments and techniques.

Power system stability: Basic concept, angle stability, voltage stability, classification of angle stability, steady state stability, definition, limit, margin, analysis for SMIB system, direct and indirect conditions, improvement. Swing of a machine, swing equation, coherent and non coherent swing; Transient stability, definition, phenomenon, equal area criterion, critical clearing angle, time, applications in power system, Methods of improvement of stability margin, dynamic stability,

Energy system at steady state, system modeling and load flow analysis, network model formulation and computation, load flow calculations : G-S method, N-R method and fast decoupled method, Energy system in steady state: optimum operating strategies, optimum allocation with and without line loss. Use of different power system software for steady state and transient load flow analysis.

BET42 Switchgear and Protection

Introduction to current and potential transducers: EMCT, MOCT, Rogowski coil, EMPT, CVT. Faults, overloads and switching overcurrents, introduction to protection, closing and tripping circuit of a circuit breaker, functional characteristics of a relay, primary and back up protection, zone protection. Fuse, Torque equation of a relay.

Generator protection: overcurrent and earthfault schemes, differential and percentage differential schemes, protection against stator unbalance, and stator inter-turn, restricted earth fault, voltage sensitive overcurrent, rotor earth fault, failure of excitation, failure of prime mover.

Transformer protection: overcurrent and earthfault, directional and non-directional, percent differential relays, magnetising inrush, harmonic restraint, biased differential relay, Buchholtz protection, protection for generator transformer unit.

Motor protection: single phasing and thermal overload protection of motors

Transmission line protection: selection of relays, time and current graded scheme, Distance protection: generalized relay equation, characteristics of different distance relays e.g. impedance, reactance, admittance and off-set mho relays.

Modern relaying technology: Pilot wire and carrier current protection, Introduction to Static relays, Microprocessor relays and Numerical relays.

Circuit breakers: Arc phenomenon, interruption, theories, high pressure arc, vacuum arc, interruption of inductive, capacitive and resistive arc, classification o9f CB, system requirement, of CB**,** construction and operation of BOCB, MOCB, ACB, ABCB, SF_6 , VCB, GIS, comparison of different types. Testing and maintenance of CB, Rating of CB, Relevant IS specification. HVDC circuit breakers;

BET43 Industrial Drives and Controls

Introduction of Electrical drives: Dynamics of electrical drives, closed loop control, selection of motor power ratings. Different components of drive: speed measurement, torque measurement, current measurement, phase locked loop, zcd etc…

DC motor drive: DC motor characteristics, braking, speed control methods of DC motor. Contactor based DC motor speed control, Controlled rectifier based DC motor drive, Chopper fed Dc Drive, PLC based DC Drive.

Induction Motor Drive: Induction motor characteristics, NEMA classification, Braking, Different methods of speed control: voltage control, frequency control, Variable Voltage variable frequency Control, rotor resistance control, slip power recovery control: Static Scherbius drive, Static Kramer drive, VSI: 120 and 180 degree mode of conduction , CSI, Cycloconverter used in AC drive.

Synchronous Motor drive: Synchronous motor Characteristics, Method of speed control.

Traction Drive: General overview of traction and Indian traction services, Different drives for different electrical motors and their different operating modes: Electrical traction service, nature of traction load, braking

Application of electric drive in Industry.

BET44 Power Station, Substation Engineering and Fault analysis

Station Engineering: Thermal power station: thermodynamic cycle, Fuels, surface-to-volume ratio, process flow diagram, different subsystems, operation of equipment: furnace, superheater, reheater, LP heater, HP heater, boiler, feed pump, condenser, turbine, condensate pump, deaerator, ID,FD and PA fan. Unit control room, a few automatic control loop.

Nuclear, hydel and Non-conventional power station: principle of operation and layout.

Substation Engineering: Substation classification, equipments, layout, busbar arrangement, busbar material, use of current limiting reactors, Grounding: types, grounding practice, Substation automation: metering and protection. UPS used in substations. Overhead line insulators: materials, types, insulators in strings, string efficiency. Protection against surges : lighting arrester

Fault Analysis: its necessity, contributors to fault current, symmetrical faults, consideration of load current, fault current calculations using computer in n-bus system, current limiting reactors, construction, operation, rating, placement in power system, protection, asymmetrical fault: sequence networks for generators, single line to ground, double line to ground, and line to line fault, sequence network for transformer and transmission line, analysis of a complete power system, Computer aided calculations; Application of fault analysis in power system co-ordination using different power system software,

BET45 Advanced Electrical Machines

DC Machines: Building up of a self excited shunt generator, causes of inability to build up, armature reaction and compensating winding, commutation and interpole winding, problem in the parallel operation of over compound generator and equaliser connection, torque in a motor and motor stability.

Three phase transformer: constructional features, insulation, operation, oscillation of neutral, group connection, parallel operation, erection, commissioning, testing, relevant ISS, IE rules. Special transformer: Auto transformer, Scott, V-V connection, three winding transformer, Earthing transformer, Pulse transformer; Welding transformer, their operation and uses. Sizing of different types of transformers.

Induction motors: Stability, crawling and cogging, high torque motors, harmonic torque, speed control methods, single phasing, rotor circuit unbalance, commissioning tests, relevant IS specifications, selection of motors. Induction generators.

Synchronous machines: Synchronous motor, starting, phasor diagram, characteristics, torque-angle relationship, uses. Synchronous condenser: steady state operation, uses, excitation systems.

Salient pole machine: two reaction theory, direct axis and quadrature axis reactance, phasor diagram, Torque-angle characteristic.

Steady state stability: Synchronous machines connected to bus system, operational chart, parallel operation,

Transient analysis: equivalent circuit diagram, transient and sub transient reactance time constants, sudden short circuit, dynamic behavior of synchronous machine.

PRACTICAL PAPERS :

BEP41 Advanced Electrical Machines
BEP42 Advanced Power Systems
BEP43 Power Electronics and Drives

Semester V Examination

Theoretical Papers

BET51 INDUSTRIAL ECONOMICS AND BUSINESS MANAGEMENT

Nature and significance of economics, Concepts of demand, supply, equilibrium, short and long term analysis, static and dynamic state, macro and micro economics, want and utility, marginal analysis: cost, money and real cost. Taxand profit, competition, monopoly, distribution. Economic systems: capitalism, socialism, mixed economy, Factors of production,, national income land labour capital, organization and enterprise. Laws of return, pnp, nnp and national income

Economic development of India: features, industrialization, labour economics, agriculture, economic planning, banking and international trade.

Business Management

Management, administration: planning, decision making, organization and staff, controlling, communication. Location of factory: building and plant layout, Material handling: maintenance dept procedure. Industrial relation: personnel selection and recruitment, training and placement, transfer and promotion, discipline, redress of grievances. Labour turnover: prevention of accident and safety measure, Welfare scheme, Union relation: worker's participation in management. Wage administration, method of wage payment, Production : projection planning, scheduling, routing of work order, flow chart, inspection and avoidance of waste, time and motion study.

BET52 Control Theory II

Mathematical model, Time domain analysis and specification, steady state and transient response, static and dynamic error, system optimization, State space analysis: state model, canonical representation ; solution of linear state dynamical equation, fundamental and state transition matrices, stability from state variables, Linear system design: cascade and feedback compensations; lag, lead and lag-lead compensations, case study

Digital control system: sampling, aliasing, reconstruction; zero, first and fractional order holds; Theory of z transform , inverse z transform, pulse transfer function, Modified z transform, Time response, stability analysis, Routh stability criteria, Schur-Cohn criterion, Jury's stability test.

BET53 Engineering Mechanics, Material Science and Thermal Engineering

Mechanics of solids: Theory of structure, Generalized Hooke's law, Theory of thin shells, Theory of bending, bending moments and shearing force diagram; Torsion of cylindrical shafts; Theory of columns; Compound stress and strains;

Theory of machines: shaft connections, coupling, Hooke's joint, friction clutches, Belt and rope drive, Gear trains, pulley system, flywheel and governors; Theory of machine elements, balancing of rotating mass, vibration of mechanical system

Mechanical behaviour of materials: Concept of stress, Plane stress analysis; methods of testing of materials; chemical bonding, structure of solids; mechanical behavior of materials: elsticity, anelasticity and viscoelasticity; Features of edge and screw type of dislocations, dislocation interactions, deformation of solids; Failure of materials: brittle and ductile fracture, creep failure, fatigue failure, failure due to corrosion.

Engineering materials : Metals and alloys, Insulating materials - gaseous, liquid and solids. Magnetic materials, Conducting materials and Superconducting materials- their classifications and behaviours.

Thermal Engineering : Steam properties: Steam and two phase systems, steam charts; method of testing of steam qualities; Different types of boilers, furnaces.

Fuels: Solid, liquid and gaseous fuels, combustion calculations; excess air calculations, experimental methods of estimation of calorific value of fuels.

Steam and vapor power cycles; principle of operation of steam turbine; nozzle flow; principle of operation of gas turbine and IC engines.

BET54 Special Electrical Machines and Design of Electrical Machines

Fractional horse power motor: unified theory: mmf, flux density, current sheet; generalized equation of torque for dc, single phase and three phase motors,

Single phase induction motor: construction, equivalent circuit, design parameter, torque and starting; split phase, shaded pole and capacitor motors, universal motor: performance, electromagnetic torque, improvement of torque and power factor.

Construction and Operation of Reluctance motor and repulsion motors. Hysteresis motor, Brushless DC motor, Spindle motor, Stepper motor.

Commutator motor: Performance, torque expression

Design of Electrical Machines : Fundamental aspects of electrical machine design. Windings, core materials.

Transformer design : Design of core, calculation of window dimensions, design of yoke, design of low and high voltage windings, calculation of resistance and leakage reactance. calculation of regulation, losses and efficiency. No-load current. Calculation of temperature rise and design of tank.

Main dimensions : Electric loading, magnetic loading, output equation, basic dimension.

Induction motor design : Main dimensions, design of stator and rotor, calculation of no-load current, calculation of loss component, calculation of short circuit current and efficiency.

Electric Distribution Design

BET55 Elective Paper:

PRACTICAL PAPERS:

BEP51 PLC, Microcontroller and Communication
BEP52 Project Phase – I

Semester VI Examination

PRACTICAL PAPERS :

BEP61 Design of Electrical Machines and Systems
BEP62 Seminar
BEP63 Project Phase – II
BEP64 General viva-voce

ELECTIVE PAPERS

1. **Microprocessor and microcontroller interfacing**

Microprocessor based data acquisition and expert instrument design: monitoring of voltage, current, speed and temperature.

SDK 85 : Design criteria for interfacing of keyboard and display unit, general purpose I/O, timer,. Bank concept of ROM & RAM interfacing, idea of single stepping, signature analysis, on circuit emulation.

Interfacing of MCS-51 with ADC, DAC, ZCD, Peak detector , Keyboard and 7-segment LED's. Stepper motor control.

Interfacing of computer keyboard, LCD display, Phase control of power electronic devices to have variable ac and dc voltages, Infrared remote control encoder and decoder, interfacing of serial EPROM / flash memory, Flash programming technique of microcontroller.

2. 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: Walsh transform. Discrete Fourier Transform(DFT), Discrete inverse Fourier transform, DFT properties
Digital processing of continuous-time signals; Digital filters: approximations, transformations, IIR and FIR filters, FIR filter design, 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.
Digital signal processing hardware – discussion of either TMS320CXX based or ADSPXXX based system

3. Process automation , DCS and SCADA

Process Automation: Automation defined, types of automation, Manufacturing Process and Concepts, Mathematical modeling, Automation Strategies, Concept of Flexible manufacturing, Production Economics, Computerized production Control, Computer Integrated Manufacturing (CIM)
DCS: Computer based control, History and definition of DCS, Concept of centralized and distributed control systems, system architecture, brief view on operator station, engineering station, field control station, communication techniques between different modules, concept of different standard panels over view, graphic, tuning, control, alarm etc., applications.
SCADA: Computer based data acquisition, definition and history of SCADA, primitive and modern SCADA architecture, SCADA hardware and software, modem use in SCADA, communication techniques, RTU structure, comparison of DCS, SCADA and PLC, SCADA applications.

4. Non-Conventional Energy Systems

Introduction **:** Energy and environment**.**
Conventional sources of energy.
Different forms of non conventional Energy sources **:** Solar, biogas, wind, tidal, geothermal etc.
Basic bio-conversion mechanism**,** sources of waste, simple digesters, composition and calorific value of biogas.
Wind and tidal energy generation**;** special characteristics, turbine parameters and optimum operation, Electric power generation from wind/tidal energy. Ocean thermal energy conversion, Geothermal energy- hot springs and steam injection, power plant based on OTEC and geothermal springs.
Energy from the sun **:** Techniques of collection, storage and utilization, type of solar collectors, selective surfaces, solar thermal processes, heating, cooling, drying, power generation etc. Photovoltaics, amorphous semiconductors, 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 etc.
Comparative study of non-conventional energy sources, cost considerations and economics.

5. High Voltage Engineering

Electrostatic fields, Behaviour of solid, liquid and gas under High voltage. Corona discharge, Corona Loss and radio interference, Suppression of corona and its ill effects Travelling wave equations, Reflection and refraction of travelling waves, Line terminations, Ladder diagram, Travelling waves in multi-conductor systems Causes of lightning overvoltages, Interaction between lightning and power system, Causes of switching surges and power-frequency over voltages, Estimation of switching surges in power system High voltage testing of transformer, generator, motor, insulator, cables and relevant IS specification.

6. Illumination Engineering

Illumination engineering: photometry, primary standard of light, photometric measurements.
Light sources: incandescent sources, discharge lamps, energy saving compact fluorescence lamps, lamp starters, igniters, ballasts; Illumination calculations: calculations using point, line and circular sources. Lighting design: lumen method, zonal cavity method, Interior and outdoor lighting; choice of luminaries: residential, industrial office, hospital and yards.

7. Sensor Technology

Sensors: Classification and Characteristics.
Development schemes of different types of conventional sensors with examples. Contrast between conventional and micro/nano sensors. General description of micro-sensor and nano-sensor technologies. sensor design and packaging. Techniques of crystal growing, ion-implementation, doping, etching, masking, embedding, deposition, erosion, encapsulation and packaging. Techniques of metal-semiconductor "plating" for developing sensors for thermal, electrical, magnetic and mechanical parameter sensing.Thin and thick film processes. Single-chip electro-analytic sensor technology, photonic sensors, smart sensors in microelectronic systems, Interface and data acquisition systems. Sensor modeling and design optimization.