Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

3rd Semester

Theory:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 301	Electric Circuit Theory	3	1	0	4	4
2	PC-EE 302	Analog Electronics	3	0	0	3	3
3	PC-EE 303	Electromagnetic field theory	3	0	0	3	3
4	ES-ME 301	Engineering Mechanics	3	0	0	3	3
5	BS-M 301	Mathematics-III	3	0	0	3	3
6	BS-EE301	Biology for Engineers	3	0	0	3	3
7	MC-EE 301	Indian Constitution	3	0	0	3	0
		TOTAL OF SEMESTER:				22	19

Practical / Sessional:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 391	Electric Circuit Theory Laboratory	0	0	2	2	1
2	PC-EE 392	Analog Electronics laboratory	0	0	2	2	1
3	PC-CS 391	Numerical Methods laboratory	0	0	2	2	1
		Total of Practical / Sessional				06	3
TOTAL OF SEMESTER:						28	22

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4th Semester

Theory:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 401	Electric machine-I	3	0	0	3	3
2	PC-EE 402	Digital Electronic	3	0	0	3	3
3	PC-EE 403	Electrical and Electronics Measurement	3	0	0	3	3
4	ES-EE 401	Thermal Power Engineering	3	0	0	3	3
5	HM-EE401	Values and Ethics in profession	3	0	0	3	3
6	MC- EE401	Environmental Science	3	0	0	3	0
		TOTAL OF SEMESTER:				18	15

Practical / Sessional:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 491	Electric machine-I laboratory	0	0	2	2	1
2	PC-EE 492	Digital electronics laboratory	0	0	2	2	1
3	PC-EE 493	Electrical and electronic measurement laboratory	0	0	2	2	1
4	ES-ME 491	Thermal power engineering laboratory	0		2	2	1
		Total of Practical / Sessional				08	4
TOTAL OF SEMESTER:						26	19

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5th Semester

Theory:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 501	Electric machine-II	3	0	0	3	3
2	PC-EE 502	Power system-I	3	0	0	3	3
3	PC-EE 503	Control system	3	0	0	3	3
4	PC-EE 504	Power electronics	3	0	0	3	3
5	PE-EE 501	A. High voltage Engineering B. Power Plant Engineering C. Renewable & Non conventional energy	3	0	0	3	3
6	OE-EE 501	A. Data structure & algorithm B. Object oriented programming C. Computer organization & architecture	3	0	0	3	3
		TOTAL OF SEMESTER:				18	18

Practical / Sessional:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 591	Electric Machine-II laboratory	0	0	2	2	1
2	PC-EE 592	Power system-I laboratory	0	0	2	2	1
3	PC-EE 593	Control system laboratory	0	0	2	2	1
4	PC-EE 594	Power Electronics laboratory	0	0	2	2	1
		Total of Practical / Sessional				08	4
TOTAL OF SEMESTER:						26	22

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6th Semester

Theory:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 601	Power System-II	3		0	3	3
2	PC-EE-602	Micro processor & micro controller	3	0	0	3	3
3	PE-EE 601	A. Digital control system B. HVDC transmission C. Electrical Machine Design	3	0	0	3	3
4	PE-EE 602	A. Electrical and Hybrid vehicle B. Power quality & FACTS C. Industrial Electrical systems	3	0	0	3	3
5	OE-EE 601	A. Digital Signal Processing B. Communication Engineering C. VLSI & Microelectronics	3	0	0	3	3
6	HM-EE 601	Economics for Engineers	3	0	0	3	3
		TOTAL OF SEMESTER:				18	18

Practical / Sessional:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 691	Power system-II laboratory	0	0	2	2	1
2	PC-EE692	Micro processor & microcontroller laboratory	0	0	2	2	1
2	PC-EE 681	Electrical & Electronic design laboratory	1	0	4	5	3
		Total of Practical / Sessional				09	05
TOTAL OF SEMESTER:						27	23

Summer Internship of 3-week duration after 6th semester. Students will be assessed based on submission of report on internship and presentation in a seminar in 7th semester

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7th Semester

Theory:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 701	Electric Drive	3	0	0	3	3
2	PE-EE 701	A. Control system Design B. Electrical Energy conservation & Auditing C. Power generation economics	3	0	0	3	3
3	OE-EE701	A. Artificial intelligence B. Internet of things C. Computer graphics	3	0	0	3	3
4	OE-EE702	A. Embedded system B. Digital image processing C. Computer network	3		0	3	3
5	HM-EE701	Principle of Management	3	0	0	3	3
		TOTAL OF SEMESTER:				15	15

Practical / Sessional:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 791	Electric Drive laboratory	0	0	2	2	1
2	PW-EE 781	Project stage-I	0	0	4	4	2
3	PW-EE782	Seminar	0	0	0	0	1
		Total of Practical / Sessional				06	04
TOTAL OF SEMESTER:						21	19

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8th Semester

Theory:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 801	Utilization of Electric Power	3	0	0	3	3
2	PE- EE 801	A. Line –commutated and active PWM rectifiers B. Power system dynamics & control C. Advanced Electric Drives D. Industrial Automation and Control	3	0	0	3	3
3	OE-EE 801	A. Soft computing Techniques B. Biomedical Instrumentation. C. Introduction to Machine learning D. Sensors and Transducers	3	0	0	3	3
		TOTAL OF SEMESTER:				09	09

Practical / Sessional:

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PW-EE 881	Project stage-II	0	0	16	16	8
		Total of Practical / Sessional				16	08
TOTAL OF SEMESTER:						25	17

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Name of the course	**ELECTRIC CIRCUIT THEORY**
Course Code: PC-EE 301	**Semester: 3rd**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	**Mid Semester Exam: 15 Marks**
Tutorial: 1 hr/week	**Assignment & Quiz: 10 Marks**
Practical: 2 hrs/week	**Attendance: 05 Marks**
Credit Points: 4+1	**End Semester Exam: 70 Marks**

Objective:

1.	To understand the structure and properties of different type of electrical circuits, networks and sources.
2.	To apply different mathematical tools & techniques for analyzing electrical networks.
3.	To apply circuit analysis techniques to simplify electrical networks..
4.	To solve problems of electrical circuits.

Pre-Requisite

1.	Basic Electrical Engineering (ES-EE-101)
2.	Mathematics (BS-M-102, Bs-M202)

Unit	Content	Hrs	Marks
1	**Introduction**: Continuous & Discrete, Fixed & Time varying, Linear and Nonlinear, Lumped and Distributed, Passive and Active networks and systems. Independent & Dependent sources, Step, Ramp, Impulse, Sinusoidal, Square, Saw tooth signals	3	
2	**Graph theory and Networks equations:** Concept of Tree, Branch, Tree link, Incidence matrix, Tie-set matrix and loop currents, Cut set matrix and node pair potentials. Duality, Solution of Problems	4	
3	**Coupled circuits:** Magnetic coupling, Polarity of coils, Polarity of induced voltage, Concept of Self and Mutual inductance, Coefficient of coupling, Modeling of coupled circuits, Solution of problems.	3	
4	**Laplace transforms:** Impulse, Step & Sinusoidal response of RL, RC, and RLC circuits. Transient analysis of different electrical circuits with and without initial conditions. Concept of Convolution theorem and its application. Solution of Problems with DC & AC sources.	8	
5	**Fourier method of waveform analysis:** Fourier series and Fourier Transform (in continuous domain only). Application in circuit analysis, Solution of Problems	6	
6	**Network Theorems:** Formulation of network equations, Source transformation, Loop variable analysis, Node variable analysis. Network theorem: Superposition, Thevenin's, Norton's & Maximum power transfer theorem. Millman's theorem and its application in three phase unbalanced circuit analysis. Solution of Problems with DC & AC sources.	8	

7	**Two port networks analysis:** Open circuit Impedance & Short circuit Admittance parameter, Transmission parameters, Hybrid parameters and their inter relations. Driving point impedance & Admittance. Solution of Problems	4	
8	**Filter Circuits:** Analysis and synthesis of Low pass, High pass, Band pass, Band reject, All pass filters (first and second order only) using operational amplifier. Solution of Problems	4	

Text books:

1. Networks & Systems, Ashfaq Husain, Khanna Book Publishing, New Delhi
2. Networks and Systems, D. Roy Chowdhury, New Age International Publishers
3. Network Analysis and Synthesis, C.L. Wadhwa, New Age International Publishers
4. Circuit and Networks: Analysis and synthesis, A. Sudhakar & S.S. Palli4th edition. Tata Mc Graw Hill Education Pvt. Ltd.
5. Circuit theory, Dr. Abhijit Chakrabarty, Dhanpat Rai & Co Pvt. Ltd.

Reference books

1. Network Analysis, M.E. Valkenburg, Pearson Education .
2. Fundamental of Electric circuit theory, D. Chattopadhay & P.C. Rakshit, S. Chand
3. Engineering Circuit Analysis, W.H. Hyat, J.E. Kemmerly & S.M. Durbin, The Mc Graw Hill Company.
4. Problems and Solutions of Electric Circuit Analysis, R.K. Mehta & A.K. Mal, CBS, New Delhi

Course Outcome: After completion of this course, the learners will be able to

1. describe different type of networks, sources and signals with examples.
2. explain different network theorems, coupled circuit and tools for solution of networks.
3. apply network theorems and different tools to solve network problems.
4. select suitable techniques of network analysis for efficient solution.
5. estimate parameters of two-port networks.
6. design filter circuits.

Special Remarks:
The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Name of the course	**Electric circuit theory**
Course Code:PC-EE391	**Semester: 3rd**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: Nil	**Continuous Internal Assessment:40**
Tutorial: Nil	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Transient response of R-L and R-C network: simulation with software & hardware
2.	Transient response of R-L-C series and parallel circuit: simulation with software & hardware
3.	Determination of Impedance (Z) and Admittance (Y) parameter of two-port network: simulation & hardware.
4.	Frequency response of LP and HP filters: simulation & hardware.
5.	Frequency response of BP and BR filters: simulation & hardware.
6.	Generation of Periodic, Exponential, Sinusoidal, Damped Sinusoidal, Step, Impulse, Ramp signal using MATLAB in both discrete and analog form.
7.	Determination of Laplace transform and Inverse Laplace transform using MATLAB.
8.	Amplitude and Phase spectrum analysis of different signals using MATLAB.
9.	Verification of Network theorems using software & hardware

Course Outcome: After completion of this course, the learners will be able to

1. determine
    - transient response of different electrical circuit
    - parameters of two port network
    - frequency response of filters.
    - Laplace transform and inverse Laplace transform
2. generate different signals in both discrete and analog form
3. analyze amplitude and phase spectrum of different signals.
4. verify network theorems.
5. construct circuits with appropriate instruments and safety precautions.
6. Simulate electrical circuit experiments using suitable software.

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Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**ANALOG ELECTRONICS**
Course Code: PC-EE 302	**Semester: 3rd**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Practical: 2 hrs/week	Attendance: 05 Marks
Credit Points: 3+1	End Semester Exam: 70 Marks

Objective:	
1.	To understand the structure and properties of different components of analog electronics.
2.	To explain principle of operation of analog electronics components and circuits.
3.	To understand the application of operational amplifier
4.	To solve problems of analog electronic components and circuits
5.	To analyze amplifiers, oscillators and other analog electronic circuits.

Pre-Requisite	
1.	Physics (10+2)

Unit	Content	Hrs	Marks
1	**Filters & Regulators**: Review of half wave and full wave rectifier**,** Capacitor filters, π-section filter, ripple factor, series and shunt voltage regulator, percentage regulation.	4	
2	**BJT circuits:** Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits	8	
3	**MOSFET circuits:** MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.	8	
4	**Feed back amplifier & Oscillators:** Concept of Feed back, Negative & Positive feedback, Voltage/Current, Series/Shunt feedback, Berkhausen criterion, Colpit , Hartley's, Phase shift, Wien bridge, & Crystal oscillators.	5	
5	**Operational amplifier:** Ideal OPAMP, Differential amplifier, Constant current source (Current mirror etc), Level shifter, CMRR, Open & closed loop circuits, importance of feedback loop (positive & negative), inverting & non-inverting amplifiers, Voltage follower/Buffer circuits.	5	

6	**Application of Operational amplifiers:** Adder, Integrator & Differentiator, Comparator, Schmitt Trigger, Instrumentation Amplifier, Log & Antilog amplifier, Trans-conductance multiplier, Precision rectifier, Voltage to current &Current to voltage converter.	5	
7	**Power amplifier:** Class A, B, AB, C, Conversion efficiency	2	
8	**Multivibrator:** Monostable, Bistable multivibrator, Monostable & Astable operation using 555 timer.	2	
9	**Special function circuits:** VCO & PLL	2	

Text books:

1. Malvino—Electronic Principles , 6/e ,TMH
2. Nagrath, Electronics: Analog and Digital, PHI, 2004
3. Mottershed, Electronics Devices & Circuits, Wiley Eastern
4. Millman & Halkias – Integrated Electronics, Tata McGraw Hill.
5. Gayakwad R.A -- OpAmps and Linear IC's, 4/e, Pearson-PHI
6. Franco—Design with Operational Amplifiers & Analog Integrated Circuits , 3/e,TMH
7. Coughlin and Drisscol – Operational Amplifier and Linear Integrated Circuits – Pearson Education Asia.
8. A.K. Maini, Analog Electronics, Khanna Publishing House, 2019
9. L.K. Maheswari, Analog Electronics, Laxmi Publications

Reference books

1. Nagchoudhuri , Microelectronic Devices, 1/e, Pearson Education, 2001
2. Natarajan, Microelectronics: Analysis & Design, 1/e 2005, TMH
3. Maheshwari and Anand , Analog Electronics, PHI
4. Boyle'stead , Nashelsky: & Kishore, Electronic Devices & Circuit theory, 1/e, PHI/Pearson.
5. Millman & Halkias: Basic Electronic Principles; TMH.
6. Tobey & Grame – Operational Amplifier: Design and Applications, Mc Graw Hill.

Course Outcome: After completion of this course, the learners will be able to

1. describe analog electronic components and analog electronics circuits
2. explain principle of operation of analog electronic components, filters, regulators and analog electronic circuits.
3. compute parameters and operating points of analog electronic circuits.
4. determine response of analog electronic circuits.
5. distinguish different types amplifier and different types oscillators based on application.
6. construct operational amplifier based circuits for different applications.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course	**Analog electronic laboratory**
Course Code:PC-EE392	**Semester: 3rd**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: Nil	**Continuous Internal Assessment: 40**
Tutorial: Nil	**External Assessment: 60**
Practical: 2 hrs/week	Credit Points:1

	Laboratory Experiments:
1.	Study of ripple and regulation characteristics of full wave rectifier with and without capacitor filter.
2.	Study of Zener diode as voltage regulator.
3.	Study of characteristics curves of B.J.T & F.E.T .
4.	Construction of a two-stage R-C coupled amplifier & study of it's gain & Bandwidth.
5.	Study of class A, C & Push-Pull amplifiers.
6.	Study of timer circuit using NE555 & configuration for monostable & astable and bistable multivibrator
7.	Study of Switched Mode Power Supply & construction of a linear voltage regulator using regulator IC chip
8.	Construction of a simple function generator using IC.
9.	Realization of a V-to-I & I-to-V converter using Op-Amps.
10.	Realization of a Phase Locked Loop using Voltage Controlled Oscillator (VCO).
11.	Study of D.A.C & A.D.C.

Course Outcome: After completion of this course, the learners will be able to

1. determine
   - characteristics of full wave rectifier with filter and without filter
   - characteristics of BJT and FET
   - characteristics of Zener diode as voltage regulator
   - characteristics of class A, C and push pull amplifiers
2. verify function of DAC and ADC
3. construct
   - function generator using IC
   - R-C coupled amplifier
   - linear voltage regulator using regulator IC chip.
   - timer circuit using 555 for monostable, astable and multistable multivibrator.
   - V to I and I to V converter with Op amps.

- phase locked loop using Voltage Controlled Oscillator (VCO)

4. work in a team
5. validate theoretical learning with practical

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course		**ELECTRO MAGNETIC FIELD THEORY**	
Course Code: PC-EE 303		**Semester: 3rd**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		**Mid Semester Exam: 15 Marks**	
Tutorial: 0 hr/week		**Assignment & Quiz: 10 Marks**	
Practical: 0 hrs/week		**Attendance: 05 Marks**	
Credit Points: 3		**End Semester Exam: 70 Marks**	
Objective:			
1.	To understand the basic mathematical tools to deal with Electromagnetic field Problem.		
2.	To understand properties and application of Electric and magnetic field.		
3.	To analyze electromagnetic wave propagation		
4.	To solve problem related to Electromagnetic field.		
Pre-Requisite			
1.	Basic Electrical Engineering (ES-EE-101)		
2.	Mathematics (BS-M-102, Bs-M202)		
3.	Physics (BS-PH 101)		
Unit	**Content**	**Hrs**	**Marks**
1	**Introduction:** Co-ordinate systems and transformation, Cartesian coordinates, Circular cylindrical coordinates, Spherical coordinates & their transformation. Differential length, area and volume in different coordinate systems. Solution of problems	4	
2	**Introduction to Vector calculus:** DEL operator, Gradient of a scalar, Divergence of a vector & Divergence theorem, Curl of a vector & Strokes theorem, Laplacian of a scalar, Classification of vector fields, Helmholtz's theorem. Solution of problems	4	
3	**Electrostatic field:** Coulomb's law, field intensity, Gauss's law, Electric potential and Potential gradient, Relation between E and V, an Electric dipole and flux lines. Energy density in electrostatic field. Boundary conditions: Dielectric-dielectric, Conductor –dielectric, Conductor-free space. Poisson's and Laplace's equation, General procedure for solving Poisson's and Laplace's equation. Solution of problems	8	
4	**Magneto static fields:** Biot- savart law, Ampere's circuit law, Magnetic flux density, Magnetic static and Vector potential, Forces due to magnetic field, Magnetic torque and moments,	8	

	Magnetisation in material, Magnetic boundary condition, Inductor and Inductances, Magnetic energy, Force on magnetic material. Solution of problems		
5	**Electromagnetic fields:** Faraday's law, Transformer and motional emf, Displacement current, Maxwell's equations, Time varying Potential, Time harmonic fields. Solution of problems	6	
6	**Electromagnetic wave propagation:** Wave equation, Wave propagation in lossy dielectric, Plane waves in loss less dielectric, Plane wave in free space, Plane wave in good conductor, Skin effect, Skin depth, Power & Poynting vector, Reflection of a plane wave at normal incidence, reflection of a plane wave at oblique incidence, Polarisation. Solution of problems	6	
7	**Transmission line:** Concept of lump & distributed parameters, Line parameters, Transmission line equation & solutions, Physical significance of solutions, Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation. Solution of problems	4	

Text books:

1. Elements of Electromagnetic, Mathew N.O. Sadiku, 4th edition, Oxford university press.
2. Engineering Electromagnetic, W.H. Hyat & J.A. Buck, 7th Edition, TMH
3. Theory and problems of Electromagnetic, Edminister, 2nd Edition, TMH
4. Electromagnetic field theory fundamentals, Guru & Hizroglu, 2nd edition, Cambridge University

Reference books

Course Outcome: After completion of this course, the learners will be able to

1. relate different coordinate systems for efficient solution of electromagnetic problems.
2. describe mathematical s tools to solve electromagnetic problems.
3. explain laws applied to electromagnetic field.
4. apply mathematical tools and laws to solve electromagnetic problems.
5. analyze electromagnetic wave propagation
6. estimate transmission line parameters

Special Remarks:
The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Name of the course		**ENGINEERING MECHANICS**	
Course Code: ES-ME 301		**Semester: 3rd**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the basic mathematical tools to deal with the physical bodies.		
2.	To learn different mathematical techniques to analyze physical bodies.		
2.	To learn analysis techniques of rigid bodies.		
2.	To solve problem of general motion.		
Pre-Requisite			
1.	Physics (BS-PH-101)		
2.	Mathematics (BS-M102, BS-M202)		
Unit	Content	Hrs	Marks
1	**Introduction to vectors and tensors and co-ordinate systems** Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra; Indical notation; Symmetric and anti-symmetric tensors; Eigenvalues and Principal axes.	5	
2	**Three-dimensional Rotation** Three-dimensional rotation: Euler's theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors.	4	
3	**Kinematics of Rigid Body** Kinematics of rigid bodies: Dentition and motion of a rigid body; Rigid bodies as coordinate systems; Angular velocity of a rigid body, and its rate of change; Distinction between two- and three dimensional rotational motion; Integration of angular velocity to find orientation; Motion relative to a rotating rigid body: Five term acceleration formula.	6	
4	**Kinetics of Rigid Bodies** Kinetics of rigid bodies: Angular momentum about a point; Inertia tensor: Dentition and computation, Principal moments and axes of inertia, Parallel and perpendicular axes theorems;	5	

	Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Area moment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler's laws of rigid body motion.		
5	**Free Body Diagram (1 hour)** Free body diagrams; Examples on modelling of typical supports and joints and discussion on the kinematic and kinetic constraints that they impose.	1	
6	**General Motion** Examples and problems. General planar motions. General 3-D motions. Free precession, Gyroscopes, Rolling coin.	9	
7	**Bending Moment** Transverse loading on beams, shear force and bending moment in beams, analysis of cantilevers, simply supported beams and overhanging beams, relationships between loading, shear force and bending moment, shear force and bending moment diagrams.	5	
8	**Torsional Motion** Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.	2	
9	**Friction** Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.	3	

Text books:

1. J. L. Meriam and L. G. Kraige, "Engineering Mechanics: Dynamics", Wiley, 2011.
2. M. F. Beatty, "Principles of Engineering Mechanics", Springer Science & Business Media, 1986.
3. Manoj K. Harbola, " Engineering Mechanics", Cengage Learning India Pvt. Ltd, 2018
4. D.S. Bedi & M.P. Poonia, "Engineering Mechanics", Khanna Publishing House, 2019
5. R.S. Khurmi, "Engineering Mechanics", S.Chand Publications
6. R.K. Bansal, "Engineering Mechanics", Laxmi Publications

Course Outcome: After completion of this course, the learners will be able to

1. explain the co-ordinate system, principle of three dimensional rotation, kinematics and kinetics of rigid bodies.
2. elaborate the theory of general motion, bending moment, torsional motion and friction.
3. develop free body diagram of different arrangements.

4. solve problems with the application of theories and principle of motion , friction and rigid bodies.
5. analyze torsional motion and bending moment.

Special Remarks:
The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course		**MATHEMATICS-III**	
Course Code: BS- M 301		**Semester: 3rd**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand Probability theory required an Electrical Engineer to apply in profession.		
2.	To understand numerical methods to solve engineering problem		
3.	To understand basics of Z transform to solve engineering problems.		
Pre-Requisite			
1.	Mathematics (10+2)		
Unit	Content	Hrs	Marks
1	**Probability:** Basic Probability Theory**:** Classical definition and its limitations. Axiomatic definition. Some elementary deduction: i) P(O)=0, ii) $0 \leq P(A) \leq 1$, iii) P(A')=1-P(A) etc. where the symbols have their usual meanings. Frequency interpretation of probability. Addition rule for 2 events (proof) & its extension to more than 2 events (statement only). Related problems. Conditional probability & Independent events. Extension to more than 2 events (pair wise & mutual independence). Multiplication Rule. Examples. Baye's theorem (statement only) and related problems. Random Variable & Probability Distributions. Expectation: Definition of random variable. Continuous and discrete random variables. Probability density function & probability	1 3 2	

	mass function for single variable only. Distribution function and its properties (without proof). Examples. Definitions of Expectation & Variance, properties & examples. Some important discrete distributions: Binomial & Poisson distributions and related problems. Some important continuous distributions: Uniform, Exponential, Normal distributions and related problems. Determination of Mean & Variance for Binomial, Poisson & Uniform distributions only.	2	
2	**Numerical Methods:** Approximation in numerical computation: Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors. Interpolation: Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation. Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms. Numerical solution of a system of linear equations: Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method. Numerical solution of Algebraic equation: Bisection method, Regula-Falsi method, Newton-Raphson method. Numerical solution of ordinary differential equation: Euler's method, Runge-Kutta methods, Predictor-Corrector methods and Finite Difference method.	4 5 3 6 4 6	
3	**Z transform:** Sequence, Representation of sequence, Basic operations on sequences, Z-transforms, Properties of Z-transforms, Change of scale, Shifting property, Inverse Z-transform, Solution of difference equation , Region of convergence.	4	

Text books:

1. Lipschutz S., and Lipson M.L.: Probability (Schaum's Outline Series), TMH.
2. C.Xavier: C Language and Numerical Methods.
3. Dutta & Jana: Introductory Numerical Analysis.
4. J.B.Scarborough: Numerical Mathematical Analysis.
5. Jain, Iyengar , & Jain: Numerical Methods (Problems and Solution).

6. Hwei P Hsu, " Signal and system", (Schaum's Outline Series), Mc Graw Hill education.

Reference books

1. Balagurusamy: Numerical Methods, Scitech.
2. R.S. Salaria: Numerical Methods, Khanna Publishing House.
3. S.S. Sashtry: Numerical Methods, PHI
4. Baburam: Numerical Methods, Pearson Education.
5. N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
6. Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
7. Srimanta Pal: Numerical Methods, OUP.

Course Outcome: After completion of this course, the learners will be able to

1. explain basics of probability theories, rules, distribution and properties of Z transform
2. describe different methods of numerical analysis.
3. solve numerical problems based on probability theories , numerical analysis and Z transform
4. apply numerical methods to solve engineering problems.
5. solve engineering problems using z transform and probability theory.

Special Remarks:
The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	Numerical Methods laboratory
Course Code: PC-CS 391	**Semester: 3rd**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: Nil	**Continuous Internal Assessment:40**
Tutorial: Nil	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Assignments on Newton forward /backward, Lagrange's interpolation.
2.	Assignments on numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule.
3.	Assignments on numerical solution of a system of linear equations using Gauss elimination and Gauss-Seidel iterations
4.	Assignments on numerical solution of Algebraic Equation by Regular-falsi and Newton Raphson methods.
5.	Assignments on ordinary differential equation: Euler's and Runga-Kutta methods.
6.	Introduction to Software Packages: Matlab / Scilab / Labview / Mathematica.

Course Outcome: After completion of this course, the learners will be able to

1. solve
    - problems with Newton forward /backward, Lagrange's interpolation
    - problems of numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule
    - problems to find numerical solution of a system of linear equations using Gauss elimination and Gauss-Seidel iterations.
    - problems to find numerical solution of Algebraic Equation by Regular-falsi and Newton Raphson methods.
    - ordinary differential equation by Euler's and Runga-Kutta methods.
2. find appropriate numerical methods to solve engineering problems.
3. use software package to solve numerical problems.

Special Remarks:

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course		**BIOLOGY FOR ENGINEERS**	
Course Code:BS- 301		**Semester: 3rd**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To introduce modern biology with an emphasis on evolution of biology as a multi-disciplinary field.		
2.	To make students aware of application of engineering principles in biology and engineering robust solution inspired by biological examples.		
Pre-Requisite			
1.	NIL		
Unit	Content	Hrs	Marks
1	**Introduction** Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry. Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry	2	
2	**Classification:** Purpose: To convey that classification *per se* is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructureprokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricotelic, ureotelic (e) Habitata- acquatic or terrestrial (e) Molecular	3	

	taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus.		
3	**Biomolecules** Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine. Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.	4	
4	**Macromolecular analysis:** Purpose: To analyze biological processes at the reductionistic level. Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.	5	
5	**Metabolism** Purpose: The fundamental principles of energy transactions are the same in physical and biological world. Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergonic reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO2 + H2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO2 and H2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.	4	
6	**Microbiology** Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.	3	
7	**Immunology** Purpose: How does the immune system work? What are the molecular and cellular components and pathways that protect an organism from infectious agents or cancer? This comprehensive course answers these questions as it explores the cells and molecules of the immune system. Immunology- Self vs Non-self, pathogens, human immune system, antigen-antibody reactions.	5	
8	**Information Transfer** Purpose: The molecular basis of coding and decoding genetic information is universal. Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic	4	

	code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination. s •on cell proliferation • metastasis • cell proliferation • cell death • cell •D		
9	**Cancer biology** Purpose: A basic understanding of cancer biology and treatment. The course is not designed for patients seeking treatment guidance – but it can help to understand how cancer develops and provides a framework for understanding cancer diagnosis and treatment. –cell Identification of the major types of cancer worldwide. Description of how genes contribute to the risk and growth of cancer. List and description of the ten cellular hallmarks of cancer. Definition of metastasis, and identification of the major steps in the metastatic process. Description of the role of imaging in the screening, diagnosis, staging, and treatments of cancer. Explanation of how cancer is treated.	5	
10	**Techniques in bio physics** Purpose: Biophysics is an interdisciplinary science that applies approaches and methods traditionally used in physics to study biological phenomena. The techniques including microscopy, spectroscopy, electrophysiology, single-molecule methods and molecular modeling	3	
11	**Stem cell** Purpose: Stem cells and derived products offer great promise for new medical treatments. Learn about stem cell types, current and possible uses, ethical issues.	2	

Text / References:

1. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A global approach", Pearson Education Ltd, 2014.
2. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, "Outlines of Biochemistry", John Wiley and Sons, 2009.
3. D. L. Nelson and M. M. Cox, "Principles of Biochemistry", W.H. Freeman and Company, 2012.
4. G. S. Stent and R. Calendar, "Molecular Genetics", Freeman and company, 1978.
5. L. M. Prescott, J. P. Harley and C. A. Klein, "Microbiology", McGraw Hill Higher Education, 2005.
6. Lewis J. Kleinsmith. "Principles of cancer biology", Pearson, 2016

Course Outcome: After completion of this course, the learners will be able to

1. describe with examples the biological observations lead to major discoveries.
2. explain
   - the classification of kingdom of life
   - the building blocks of life
   - different techniques of bio physics used to study biological phenomena.
   - the role of imaging in the screening, diagnosis, staging, and treatments of cancer.
3. identify DNA as a genetic material in the molecular basis of information transfer
4. analyze biological processes at the reductionistic level.
5. apply thermodynamic principles to biological systems.
6. identify microorganisms.

Special Remarks:
The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**INDIAN CONSTOTUTION**
Course Code: MC-EE 301	**Semester: 3rd**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Practical: 0 hrs/week	Attendance: 05 Marks
Credit Points: 0	End Semester Exam: 70 Marks

Objective:	
1.	To have basic knowledge about Indian Constitution.
2.	To understand the structure and functioning of union, state and local self-government.
3.	To understand the structure, jurisdiction and function of Indian judiciary.
Pre-Requisite	
1.	NIL

Unit	Content	Hrs	Marks
1	**Indian Constitution:** Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy	5	
2	**Union government and its administration:** Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha. **State government and its administration:** Governor: Role and Position, CM and Council of ministers, State Secretariat: Organisation, Structure and Functions	10	
3	**Supreme court:** Organization of supreme court, procedure of the court, independence of the court, jurisdiction and power of supreme court. **High court:** Organization of high court, procedure of the court, independence of the court, jurisdiction and power of supreme court. **Subordinate courts:** constitutional provision, structure and jurisdiction. National legal services authority, Lok adalats, family courts, gram nyayalays. Public interest litigation (PIL): meaning of PIL, features of PIL, scope of PIL, principle of PIL, guidelines for admitting PIL	10	
4	**Local Administration:**	10	

	District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.		

Text books:

1. Indian polity, M, Laxmikanth, MC Graw Hill education, 5th Edition.

Reference books

1. DD Basu, " Introduction to the constitution of India", 21st Edition, Lexis Nexis Books Publication ltd, India

Course Outcome: After completion of this course, the learners will be able to

1. describe
    - different features of Indian constitution..
    - power and functioning of Union, state and local self-government.
    - structure, jurisdiction and function of Indian Judiciary.
    - basics of PIL and guideline for admission of PIL.
    - Functioning of local administration starting from block to Municipal Corporation.
2. identify authority to redress a problem in the profession and in the society.

Special Remarks:
The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Semester-IV

Name of the course		**ELECTRIC MACHINE-I**	
Course Code: PC-EE-401		**Semester: 4th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To review the concept of magnetic fields and magnetic circuits		
2.	To learn the principle of production of electromagnetic force and torque.		
3.	To learn the basic principle of operation of DC machine		
4.	To learn the principle of operation and characteristics of DC motor and generator		
5.	To learn the principle of operation, connections and different tests on Transformers		
6.	To acquire problem solving skills to solve problems of DC machines and Transformers		
Pre-Requisite			
1.	Basic Electrical Engineering (ES-EE-101)		
2.	Electric Circuit Theory (PC-EE-301)		
3.	Electromagnetic Field Theory (PC-EE-303)		
Unit	**Content**	**Hrs**	**Marks**
1	**Magnetic fields and magnetic circuits:** Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart Law; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.	3	
2	**Electromagnetic force and torque:** B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency	5	
3	**DC machines:** Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an	8	

	armature coil. Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.		
4	**DC machine - motoring and generation:** Armature circuit equation for motoring and generation, Types of field excitations – separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines	7	
5	**Transformers:** Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.	12	

Text books:

1. Electrical Machines-I, P.S. Bimbhra, Khanna Publishing House (AICTE)
2. Electrical Machinery, P.S. Bimbhra, 7th Edition, Khanna Publishers
3. Electric machines, D.P. Kothari & I.J Nagrath, 3rd Edition, Tata Mc Graw-Hill Publishing Company Limited
4. Electrical Machines, P.K. Mukherjee & S. Chakrabarty, 2nd edition, Dhanpat Rai Publication.
.

Reference books:

1. Electric Machinery & Transformers, Bhag S. Guru and H.R. Hiziroglu, 3rd Edition, Oxford University press.
2. Electrical Machines, R.K. Srivastava, Cengage Learning
3. Theory of Alternating Current Machinery, Alexander S Langsdorf, Tata Mc Graw Hill Edition.
4. The performance and Design of Alternating Current Machines, M.G.Say, CBS Publishers & Distributors.
5. Electric Machinery & transformer, Irving L Koskow, 2nd Edition, Prentice Hall India

Course Outcome:
After completion of this course, the learners will be able to
1. describe the function of different components of magnetic circuit, DC machines and transformers
2. explain the principle of operation of different types of DC machines and transformers
3. solve numerical problems of DC machines and transformers.
4. estimate the parameters and efficiency of transformer.
5. determine the characteristics of DC machines
6. recommend methods to control output of DC machines.

Special Remarks (if any)
The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course		**DIGITAL ELECTRONICS**	
Course Code: PC-EE-402		**Semester: 4th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To learn the fundamentals of Digital systems and principle of operation of Logic families.		
2.	To learn the principle of operation of Combinational digital circuits.		
3.	To learn the principle of operation of sequential circuit and systems.		
4.	To learn the principle of operation of A/D and D/A converter		
5.	To learn the principle of operation of semiconductor memories and Programmable logic devices.		
6.	To acquire problem solving skills to solve problems of Digital circuits		
Pre-Requisite			
1.	Analog Electronics (PC-EE-302)		
Unit	**Content**	**Hrs**	**Marks**
1	**Fundamentals of Digital Systems and logic families:** Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.	7	
2	**Combinational Digital Circuits:** Standard representation for logic functions, K-map representation, simplification of Logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.	7	
3	**Sequential circuits and systems:** A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T and D types flipflops, applications of flipflops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple(Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of	7	

	counters.		
4	**A/D and D/A Converters:** Digital to analog converters: weighted resistor/converter, R-2R Ladder, D/A converter, specifications for D/A converters, examples of D/A converter, lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs.	7	
5	**Semiconductor memories and Programmable logic devices:** Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).	7	

Text books:

1. Digital Principles & Application, 5th Edition, Leach & Malvino, Mc Graw Hill Company.
2. Modern Digital Electronics, 4th Edition, R.P. Jain. Tata Mc Graw Hill Company Limited
3. Fundamental of Digital Circuits, A. Anand Kumar, 4th Edition, PHI.
4. Digital Electronics, R. Anand, Khanna Publishing House (2018).

Reference books:

1. Digital Logic Design, Morries Mano, PHI.
2. Digital Integrated Electronics, H. Taub & D. Shilling, Mc Graw Hill Company.
3. Digital Electronics, James W. Bignell & Robert Donovan, Thomson Delman Learning.
4. Fundamental of logic Design, Charles H. Roth, Thomson Delman Learning.

Course Outcome:

After completion of this course, the learners will be able to

1. describe the function of different building blocks of digital electronics, semiconductor memories and programmable logic devices.
2. explain the principle of operation of combinational and sequential digital circuits, A/D and D/A converter
3. solve numerical problems of Boolean algebra, number system, combinational & sequential digital circuits and A/D and D/A converter.
4. specify applications of combinational and sequential digital circuits.
5. determine specifications of different digital circuits.
6. design combinational and sequential digital circuits

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**ELECTRICAL & ELECTRONICS MEASUREMENTS**
Course Code: PC-EE-403	**Semester: 4th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:	
1.	To learn methods of measurement, errors in measurement and its classification.
2.	To learn the principle of operation of analog and digital meters.
3.	To learn the basic principle of operation of instrument transformers.
4.	To learn the principle of operation of cathode ray oscilloscope and different sensors and transducers.
5.	To learn the principle of measurement of power, energy and different electrical parameters
6.	To acquire problem solving skills to solve problems on the topics studied.
Pre-Requisite	
1.	Basic Electrical Engineering (ES-EE-101)
2.	Electric Circuit Theory (PC-EE-301)

Unit	Content	Hrs	Marks
1	**Measurements:** • Method of measurement, Measurement system, Classification of instruments, Definition of accuracy, Precision, Resolution, Speed of response, Error in measurement, Classification of errors, loading effect due to shunt and series connected instruments. **Analog meters:** • General features, Construction, Principle of operation and torque equation of Moving coil, Moving iron, Electrodynamometer, Induction instruments , Principle of operation of the Electrostatic, Thermoelectric, Rectifier type instruments, Extension of instrument ranges and multipliers.	7	
2	**Instrument transformer:** • Disadvantage of shunt and multipliers, Advantage of Instrument transformers, Principle of operation of Current & Potential transformer, errors. **Measurement of Power:** • Principle of operation of Electrodynamic & Induction type wattmeter, Wattmeter errors **Measurement of Energy:** • Construction, theory and application of AC energy meter, testing of energy meters.	9	
3	**Measurement of resistance:** • Measurement of medium, low and high resistances, Megger **Potentiometer:** • Principle of operation and application of Crompton's DC potentiometer, Polar and Co-ordinate type AC potentiometer, applications	8	

	AC Bridges: • Measurement of Inductance, Capacitance and frequency by AC bridges		
4	**Cathode ray oscilloscope (CRO):** • Measurement of voltage, current, frequency & phase by oscilloscope. Frequency limitation of CRO. Sampling and storage oscilloscope, Double beam CRO. **Electronic Instruments:** • Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator, Digital Storage oscilloscope.	7	
5	**Sensors & Transducers:** • Introduction to sensors & Transducers, Strain gauge, LVDT, Temperature transducers, Flow measurement using magnetic flow measurement.	4	

Text books:

1. A course in Electrical & Electronic Measurements & Instrumentation, A.K. Sawhney, Dhanpat Rai & sons.
2. Electrical Measurement & Measuring Instruments, E.W. Golding & F.C. Wides, Wheeler Publishing
3. Sensors & Transducers, D. Patranabis, PHI, 2nd edition.

Reference books:

1. Electronic Instruments, H.S. Kalsi, Tata Mc-Graw hill, 2nd Edition.
2. Digital Instrumentation, A.J. Bouwens, Tata Mc-Graw hill.
3. Modern Electronic instrumentation & Measuring instruments, A.D. Heltric & W.C. Copper, Wheeler Publication
4. Instrument transducers, H.K.P. Neubert, Oxford University press.
5. All-in One Electronics Simplified, A.K. Maini, Khanna Book Publishing Co. (2018)

Course Outcome:

After completion of this course, the learners will be able to

1. explain the terms accuracy, precision, resolution, speed of response, errors in measurement, loading effect
2. describe methods of measurement of power, energy by instruments and resistance, capacitance and inductance by bridges and potentiometer
3. explain the principle of operation of analog meters, instrument transformer, digital multimeter, digital voltmeter, digital frequency meter, signal generator, strain gauge, LVDT and temperature transducers

4. explain the different building block, principle of operation of oscilloscope and measurement techniques of voltage, current, frequency and phase by oscilloscope
5. solve numerical problems related to analog meters, instrument transformer, measurement of power, energy, resistance, inductance and capacitance
6. specify applications of analog and digital measuring instruments, sensors and transducers

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course		**THERMAL POWER ENGINEERING**	
Course Code:ES-EE-401		**Semester: 4th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To learn the principle of operation of different types of boilers and Turbines		
2.	To learn the principle of operation of IC engines and Gas turbines		
6.	To acquire problem solving skills to solve problems of boilers, turbines, IC engines and Gas turbines		
Pre-Requisite			
1.	Mathematics (BS M102 & BS M201)		
Unit	**Content**	**Hrs**	**Marks**
1	**Boilers:** Water Tube & Fire Tube boilers, Circulating Principles, Forced Circulation, Critical pressure, Superheaters, Reheaters, attemperators, induced draught, forced draught and secondary air Fans, Boiler performance analysis and heat balance. Combustion Systems, Environmental Protection – ESP, Cyclone Separator, Dust Collector etc.	12	
2	**Turbines:** Rotary Thermodynamic devices – Steam turbines & their classifications – Impulse & Reaction typeTurbines, Thermodynamics of compressible fluid-flow, equation and continuity – Isentropic flow throughnozzles, velocity diagram, Blade efficiency, optimum velocity ratio, multi-staging, velocity & pressurecompounding, losses in turbines, erosion of turbine blades, turbine governing, performance analysis ofturbine, Condensing system.	12	
3	**IC Engines:** IC Engines – classification, Analysis of a standard cycle, fuel characteristic of SI & CI Engine,Combustion, Engine performance Automotive Engine exhaust emission and their control	6	
4	**Gas Turbines:** Gas turbine Analysis – Regeneration - Reheating, Isentropic efficiency Combustion efficiency	5	

Text books:

1. Engineering Thermodynamics, P.K. Nag, 6th Edition , Mc Graw Hill Education Pvt. Ltd
2. Power Plant Engineering, P K Nag, 4th Edition, Mc Graw Hill Education Pvt. Ltd
3. Thermal Engineering , P.S. Ballaney, 25th Edition, , Khanna publishers

4. Power Plant Engineering, Domkundwar, Arora, Dhanpat Rai & Co.

Reference books:

1. Thermodynamics , Cengel , 6th Edition, Tata Mc Graw- Hill Education.
2. Power Plant Technology ,M M Ei-Wakil 1st Edition, Tata McGraw Hill
3. Heat and Thermodynamics, M W Zemansky & R.H.Dittman , 8th Edition, McGraw Hill

Course Outcome:

After completion of this course, the learners will be able to
1. describe the function of different components of boilers. Engines and turbines
2. explain the principle of operation of different types of boilers, turbines, IC engines and Gas turbines.
3. solve numerical problems of boilers, turbines, IC engines and Gas turbines.
4. analyze the performance of boilers, engines and turbines.
5. determine efficiency of boilers, engines and turbines.
6. explain methods to control boiler, engines and turbines parameters.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**VALUES AND ETHICS IN PROFESSION**
Course Code: HM-EE-401	**Semester: 4th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Practical: 0 hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:	
1.	To inculcate Human values to grow as a responsible human beings with a proper personality.
2.	To instill Professional Ethics to maintain ethical conduct and discharge professional duties.
Pre-Requisite	
1.	Not applicable

Unit	Content	Hrs	Marks
1	**Human values:** Morals, Values, and Ethics – Integrity –Trustworthiness – Work Ethics – Service-Learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty –Courage – Value Time – Co-operation – Commitment – Empathy – Self-confidence – Spirituality- Character.	5	
2	**Principles for harmony:** Truthfulness – Customs and Traditions -Value Education – Human Dignity – Human Rights – Fundamental Duties – Aspirations and Harmony (I, We & Nature) – Gender Bias – Emotional Intelligence – Salovey – Mayer Model – Emotional Competencies – Conscientiousness	5	
3	**Engineering ethics and social experimentation:** History of Ethics – Need of Engineering Ethics – Senses of Engineering Ethics- Profession and Professionalism —Self Interest – Moral Autonomy – Utilitarianism – Virtue Theory – Uses of Ethical Theories – Deontology- Types of Inquiry –Kohlberg's Theory – Gilligan's Argument – Heinz's Dilemma – Comparison with Standard Experiments — Learning from the Past – Engineers as Managers – Consultants and Leaders – Balanced Outlook on Law – Role of Codes – Codes and Experimental Nature of Engineering.	8	
4	**Engineers' responsibility towards safety and risk for sustainable development:** The concept of Safety – Safety and Risk – Types of Risks – Voluntary v/s Involuntary Risk – Consequences – Risk Assessment –Accountability – Liability – Reversible Effects – Threshold Levels of Risk – Delayed v/s Immediate Risk – Safety and the Engineer – Designing for Safety – Risk-Benefit Analysis-Accidents.	5	
5	**Engineers' duties and rights:** Concept of Duty – Professional Duties – Collegiality – Techniques for Achieving Collegiality – Senses of Loyalty – Consensus and Controversy – Professional and Individual Rights – Confidential and		

	Proprietary Information – Conflict of Interest-Ethical egoism – Collective Bargaining – Confidentiality – Gifts and Bribes – Problem solving-Occupational Crimes- Industrial Espionage- Price Fixing-Whistle Blowing.	7	
6	**Global issues:** Globalization and MNCs –Cross Culture Issues – Business Ethics – Media Ethics – Environmental Ethics – Endangering Lives – Bio Ethics – Computer Ethics – War Ethics – Research Ethics - Intellectual Property Rights.	5	

Text books:

1. Professional Ethics & Human Values, Premvir Kapoor, Khanna Publishing House, Delhi (AICTE Recommended Textbook).
2. A text book on professional Ethics & Human values, R.S. Naagarazan, New Age international Publishing.
3. Engineering Ethics, M. Govindarajan, S. Natarajan , V.S. Senthilkumar, Prentice Hall India.
4. Human value and professional Ethics, Jayshree Suresh, B.S. Raghvan, S. Chand Publishing

Reference books:

1. Ethics in Science and Engineering, James G. Speight & Russel Foote, Wiley.

Course Outcome:

After completion of this course, the learners will be able to
1. illustrate different aspects of human values, ethics, engineers' responsibility and duties
2. explain different principles, different theories and laws of engineering ethics and social experimentation
3. identify different factors in the light of Engineers' responsibility towards safety and risk
4. correlate ethics of different work environment.
5. explain the need for intellectual property rights.

Special Remarks (if any)

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course		**ENVIRONMEMTAL SCIENCE**	
Course Code: MC-EE-401		**Semester: 4th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 0		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the environment and its relationships with human activities		
2.	To be able to apply the fundamental knowledge of science and engineering to assess environmental and health risk		
3.	To understand environmental laws and regulations to develop guidelines and procedures for health and safety issues		
4.	To acquire the skill to solve problem related to environment and pollution		
Pre-Requisite			
1.	Basic knowledge of science		
Unit	**Content**	**Hrs**	**Marks**
1	Basic ideas of environment, basic concepts, man, society & environment, their interrelationship (1L) Mathematics of population growth and associated problems, Importance of population study in environmental engineering, definition of resource, types of resource, renewable, non-renewable, potentially renewable, effect of excessive use vis-à-vis population growth, Sustainable Development (2L). Materials balance: Steady state conservation system, steady state system with non-conservative pollutants, step function (1L). Environmental degradation: Natural environmental Hazards like Flood, earthquake, Landslide-causes, effects and control/management; Anthropogenic degradation like Acid rain-cause, effects and control. Nature and scope of Environmental Science and Engineering (2L)	6	
2	Elements of ecology: System, open system, closed system, definition of ecology, species, population, community, definition of ecosystem- components types and function (1L). Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundar ban); Food chain [definition and one example of each food chain], Food web (2L) Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur] (1L) Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity.(2L)	6	
	Atmospheric Composition: Troposphere, Stratosphere,		

3	Mesosphere, Thermosphere, Tropopause and Mesopause (1L) Energy balance: Conductive and Convective heat transfer, radiation heat transfer, simple global temperature model [Earth as a black body, earth as albedo], Problems.(1L) Green house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food. Global warming and its consequence, Control of Global warming. Earth's heat budget.(1L) Lapse rate: Ambient lapse rate Adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion).(2L) Atmospheric dispersion: Maximum mixing depth, ventilation coefficient, effective stack height, smokestack plumes and Gaussian plume model.(2L) Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN (2L) Smog, Photochemical smog and London smog. Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green-house gases, effect of ozone modification. (1L) Standards and control measures: Industrial, commercial and residential air quality standard, control measure (ESP. cyclone separator, bag house, catalytic converter, scrubber (ventury), Statement with brief reference). (1L)	11	
4	Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds. (2L) River/Lake/ground water pollution: River: DO, 5-day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river [deoxygenation, reaeration], COD, Oil, Greases, pH. (2L) Lake: Eutrophication [Definition, source and effect]. (1L) Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only)(1L) Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition. (2L) Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury, Cadmium, and Arsenic (1L)	9	
5	Environmental impact assessment, Environmental Audit, Environmental laws and protection act of India, Different international environmental treaty/ agreement/ protocol. (3L)	3	

Text books:

1. Environmental Studies, M.P. Poonia & S.C. Sharma, Khanna Publishing House
2. Introduction to Environmental Engineering and Science, G.M. Masters, Prentice-Hall of India Pvt. Ltd.,1991.

Reference books:

1. Environmental Chemistry, A. De, New Age International
2. Text Book for Environmental Studies, Erach Bharucha, UGC
3. Elements of Environmental Pollution Control, O.P. Gupta, Khanna Publishing House (AICTE Recommended Book).

Course Outcome:

After completion of this course, the learners will be able to
1 understand the natural environment and its relationships with human activities
2 apply the fundamental knowledge of science and engineering to assess environmental and health risk
3 develop guidelines and procedures for health and safety issues obeying the environmental laws and regulations
4 acquire skills for scientific problem-solving related to air, water, noise& land pollution.

Special Remarks (if any)

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**ELECTRIC MACHINE-I LABORATORY**
Course Code:PC-EE491	**Semester: 4th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 0 hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Determination of the characteristics of a separately excited DC generator.
2.	Determination of the characteristics of a DC motor
3.	Study of methods of speed control of DC motor
4.	Determination of the characteristics of a compound DC generator (short shunt)
5.	Determination of speed of DC series motor as a function of load torque.
6.	Polarity test on a single phase transformer
7.	Determination of equivalent circuit of a single phase transformer and efficiency.
8.	Study of different connections of three phase transformer.
9.	Study of Parallel operation of a single phase transformers.
10.	Determination of temperature rise and efficiency of the transformer.(Back to back test)

Course Outcome:

After completion of this course, the learners will be able to

1. identify appropriate equipment and instruments for the experiment.
2. test the instrument for application to the experiment.

3. construct circuits with appropriate instruments and safety precautions
4. validate different characteristics of DC machine , methods of speed control of DC motor and parallel operation of the transformer
5. work effectively in a team

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**DIGITAL ELECTRONICS LABORATORY**
Course Code:PC-EE492	**Semester: 4th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 0 hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Realization of basic gates using Universal logic gates.
2.	Code conversion circuits- BCD to Excess-3 & vice-versa.
3.	.4-bit parity generator & comparator circuits.
4.	Construction of simple Decoder & Multiplexer circuits using logic gates.
5.	Design of combinational circuit for BCD to decimal conversion to drive 7-segment display usingmultiplexer.
6.	Construction of simple arithmetic circuits-Adder, Subtractor.
7.	Realization of RS-JK & D flip-flops using Universal logic gates.
8.	Realization of Universal Register using JK flip-flops & logic gates.
9.	Realization of Universal Register using multiplexer & flip-flops.
10.	Construction of Adder circuit using Shift Register & full Adder.
11.	Realization of Asynchronous Up/Down counter
12.	Realization of Synchronous Up/Down counter
13.	Design of Sequential Counter with irregular sequences.

14.	Realization of Ring counter & Johnson's counter.
15.	Familiarization with A/D and D/A circuits

Course Outcome:

After completion of this course, the learners will be able to

1. identify appropriate equipment and instruments for the experiment
2. test the instruments for application to the experiment
3. construct decoder , multiplexer, adder and subtractor circuits with appropriate instruments and precaution
4. realize RS-JK and D flip flop, universal register with gates, multiplexer and flip-flops and asynchronous and synchronous up down counters
5. validate the operation of code conversion circuit –BCD to Excess 3 & vice versa, 4 bit parity generator & comparator circuits,
6. work effectively in a team

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**ELECTRICAL & ELECTRONICS MEASUREMENT LABORATORY**
Course Code:PC-EE493	**Semester: 4th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 0 hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Instrument workshop- Observe the construction of PMMC, Dynamometer, Electrothermal and Rectifier type of instruments, Oscilloscope and Digital multimeter.
2.	Calibrate moving iron and electrodynamometer type ammeter/voltmeter by potentiometer.
3.	Calibrate dynamometer type wattmeter by potentiometer.
4.	Calibrate AC energy meter.
5.	Measurement of resistance using Kelvin double bridge.
6.	Measurement of power using Instrument transformer.
7.	Measurement of power in Polyphase circuits.
8.	Measurement of frequency by Wien Bridge.
9.	Measurement of Inductance by Anderson bridge
10.	Measurement of capacitance by De Sauty Bridge.
11.	Measurement of capacitance by Schering Bridge.

Course Outcome:

After completion of this course, the learners will be able to

7. identify appropriate equipment and instruments for the experiment
8. test the instrument for application to the experiment
9. construct circuits with appropriate instruments and safety precautions
10. evaluate and adjust the precision and accuracy of AC energy meter, moving iron and dynamometer type ammeter, voltmeter and wattmeter by potentiometer
11. measure voltage, current, power, energy, phase , frequency, resistance, inductance, capacitance
12. work effectively in a team

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**THERMAL POWER ENGINEEING LABORATORY**
Course Code: ES-ME-491	**Semester: 4th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 0 hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Study of Cut Models – Boilers IC Engines: Lanchashire Boiler, Bahcock & Willcox Boiler, Cochran Boiler, Vertical Tubular Boiler, Locomotive Boiler, 4S Diesel Engine, 4S Petrol Engine, 2S Petrol Engine
2.	Load Test on 4 Stroke Petrol Engine & Diesel Engine by Electrical Load Box.
3.	Load Test on 4 Stroke Diesel Engine by Rope Brake Dynamometer.
4.	Heat Balance on 4 Stroke Diesel Engine by Rope Brake Dynamometer & by Electrical Load Box.
5.	Valve Timing Diagram on 4S Diesel Engine Model & 4S Petrol Engine Model
6.	To find the Calorific Value of Diesel Fuel & Coal by Bomb Calorimeter
7.	To find the Flash Point & Fire Point of Petrol & Diesel Fuel
8.	To find the Cloud Point & Pour Point of Petrol & Diesel Fuel
9.	To find Carbon Particle Percentage in Diesel Engine Exhaust Smoke by Smokemeter and trace the BHP Vs. % Carbon Curve
10.	Measurement of the Quality of Steam – Enthalpy & Dryness fraction

Course Outcome:

After completion of this course, the learners will be able to

1. identify appropriate equipment and instruments for the experiment
2. construct experimental setup with appropriate instruments and safety precautions
3. indentify different parts of Lanchashire Boiler, Bahcock & Willcox Boiler, Cochran Boiler, Vertical Tubular Boiler, Locomotive Boiler, 4S Diesel Engine, 4S Petrol Engine, 2S Petrol engine
4. test 4 stroke petrol engine by electrical load box and diesel engine by electrical load box and rope brake dynamometer
5. find calorific value, flash point, fire point, cloud point, pour point of fuel.
6. work effectively in a team

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Semester-V

Name of the course	**ELECTRIC MACHINE-II**
Course Code: PC-EE-501	**Semester: 5th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:	
1.	To understand the arrangement of windings of AC machines.
2.	To understand the principle of production of pulsating and revolving magnetic fields.
3.	To understand the principle of operation and characteristics of three phase Induction machines
4.	To understand the principle of operation and characteristics of single phase Induction machines
5.	To understand the principle of operation and characteristics of synchronous machine
6.	To understand the principle of operation and characteristics of special electromechanical devices.
7.	To solve problems of Induction machines, synchronous machines and special eletromechanical devices.

Pre-Requisite	
1.	Basic Electrical Engineering (ES-EE-101)
2.	Electric Circuit Theory (PC-EE-301)
3.	Electromagnetic field theory (PC-EE-303)
4.	Electric Machine-I (PC-EE-401)

Unit	Content	Hrs	Marks
1	**Fundamentals of AC machine windings:** Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis,3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding-concentrated and distributed, Sinusoidally distributed winding, winding distribution factor	5	
2	**Pulsating and revolving magnetic fields:** Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.	5	
3	**Induction Machines:** Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.	10	
	Single-phase induction motors:		

4	Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications	5	
5	**Synchronous machines:** Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.	10	
6	**Special Electromechanical devices:** Principle and construction of switched Reluctance motor, Permanent magnet machines, Brushless DC machines, Hysteresis motor, Stepper motor, Tacho generators.	5	

Text books:

1. Electrical Machines -II , P.S. Bimbhra, Khanna Book Publishing House.
2. Electrical Machinery, P.S. Bimbhra, Khanna Publishing House.
3. Electrical Machines, Nagrath & Kothary, TMH
4. Electrical Machines, P.K. Mukherjee and S. Chakravorti, Dhanpat Rai Publications.
5. Electrical Machines, Theory & Applications, M.N. Bandyopadhyay, PHI

Reference books:

1. Electric Machinery & Transformer, Bhag S. Guru and H.R. Hiziroglu, 3rd Edition, Oxford University press.
2. Electric Machinery & Transformes, Irving L. Kosow, PHI
3. Electric Machinery, A.E.Fitzgerald, Charles Kingsley,Jr. & Stephen D. Umans, 6th Edition, Tata McGraw Hill Edition.
4. Electrical Machines, R.K. Srivastava, Cengage Learning
5. Theory of Alternating Current Machinery, Alexander S Langsdorf, Tata Mc Graw Hill Edition
6. The performance and Design of Alternating Current Machines, M.G.Say, CBS publishers & distributors
7. Electric Machines, Charles A. Gross, CRC press.
8. Problems in Electrical Engineering, Parker smith, 9th Edition, CBS publishers & distributors.

Course Outcome:

After completion of this course, the learners will be able to

1. describe the arrangement of winding of AC machines.
2. explain the principle of operation of Induction machines, Synchronous machines and special machines.
3. solve numerical problems of Induction machines, Synchronous machines and Special machines.
4. estimate the parameters and efficiency of Induction machines and Synchronous machines.
5. determine the characteristics of Induction machines and Synchronous machines.
6. select appropriate methods for starting , braking and speed control of Induction machines.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course		**POWER SYSTEM-I**	
Course Code: PC-EE-502		**Semester: 5th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Practical: hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the basic principle of generation of Electricity from different sources		
2.	To find parameters and characteristics of overhead transmission lines and cables.		
3.	To find different parameters for the construction of overhead transmission line		
4.	To determine the performance of transmission lines.		
5.	To understand the principle tariff calculation.		
6.	To solve numerical problems on the topics studied.		
Pre-Requisite			
1.	Basic Electrical Engineering (ES-EE-101)		
2.	Electric Circuit Theory (PC-EE-301)		
3.	Electromagnetic field theory (PC-EE-303)		
Unit	**Content**	**Hrs**	**Marks**
1	**Basic Concepts:** Evolution of Power System and present day Scenario. Structure of power system: Bulk power grid and Micro Grid. **Generation of Electric Power:** General layout of a typical coal fired power station, Hydro electric power station, Nuclear power station, their components and working principles, comparison of different methods of power generation. Introduction to Solar & Wind energy system. **Indian Electricity Rule-1956:** General Introduction.	10	
2	**Overhead transmission line:** Choice of frequency, Choice of voltage, Types of conductors, Inductance and Capacitance of a single phase and three phase symmetrical and unsymmetrical configurations. Bundle conductors. Transposition. Concept of GMD and GMR. Influence of earth on conductor capacitance. **Overhead line construction:** Line supports, Towers, Poles, Sag, Tension and Clearance, Effect of Wind and Ice on Sag. Dampers. **Corona:** Principle of Corona formation, Critical disruptive voltage, Visual critical corona discharge potential, Corona loss, advantages & disadvantages of Corona. Methods of reduction of Corona.	12	
3	**Insulators:** Types, Voltage distribution across a suspension insulator string, String efficiency, Arching shield & rings, Methods of improving voltage distribution across Insulator strings, Electrical tests on line Insulators.	05	

4	**Cables:** Types of cables, cable components, capacitance of single core & 3 core cables, dielectric stress, optimum cable thickness, grading, dielectric loss and loss angle.	04	
5	**Performance of lines:** Short, medium (nominal, T) and long lines and their representation. A.B.C.D constants, Voltage regulation, Ferranti effect, Power equations and line compensation, Power Circle diagrams.	06	
6	**Tariff:** Guiding principle of Tariff, different types of tariff.	03	

Text book:

1. Electrical Power System, Subir Roy, Prentice Hall
2. Power Systems, A. Ambikapathy, Khanna Publishing House
3. Power System Engineering, Nagrath & Kothery, TMH
4. Elements of power system analysis, C.L. Wodhwa, New Age International.
5. Electrical Power System, Ashfaq Hussain, CBS Publishers & Distributors

Reference books

1. Electric Power transmission & Distribution, S.Sivanagaraju, S.Satyanarayana,, Pearson Education.
2. A Text book on Power system Engineering, Soni, Gupta, Bhatnagar & Chakrabarti, Dhanpat Rai & Co.
3. Electric Power distribution system Engineering, 2nd Edition, T. Gonen, CRC Press.
4. www.powermin.nic.in/acts_notification/pdf/ier**1956**.pdf

Course Outcome:

After completion of this course, the learners will be able to

1. explain the principle of generation of Electric power from different sources
2. determine parameters of transmission lines and its performance
3. explain the principle of formation of corona and methods of its reduction
4. conduct electrical tests on insulators
5. solve numerical problems related to overhead transmission line, cable, insulators and tariff
6. analyze overhead transmission line based on short medium and long lines.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**CONTROL SYSTEM**
Course Code: PC-EE-503	**Semester: 5th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs./week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:	
1.	To find mathematical representation of LTI systems.
2.	To find time response of LTI systems of different orders
3.	To find the frequency response of LTI systems of different orders
4.	To understand stabilityof differentLTI systems.
5.	To analyze LTIsystems with state variables.
6.	To solve problems of mathematical modelling and stability of LTI systems

Pre-Requisite	
1.	Basic Electrical Engineering (ES-EE-101)
2.	Electric Circuit Theory (PC-EE-301)
3.	Electromagnetic field theory (PC-EE-303)
4.	Electric Machine-I (PC-EE-401)

Unit	Content	Hrs	Marks
1	**Introduction to control system:** Concept of feedback and Automatic control, Effects of feedback,Objectives of control system, Definition of linear and nonlinear systems, Elementary concepts ofsensitivity and robustness. Types of control systems, Servomechanisms and regulators, examples offeedback control systems. Transfer function concept. Pole and Zeroes of a transfer function. Propertiesof Transfer function.	04	
2	**Mathematical modeling of dynamic systems:** Translational systems, Rotational systems, Mechanicalcoupling, Liquid level systems, Electrical analogy of Spring–Mass-Dashpot system. Block diagramrepresentation of control systems. Block diagram algebra. Signal flow graph. Mason's gain formula. Control system components: Potentiometer, Synchros, Resolvers, Position encoders. DC and ACtacho-generators. Actuators. Block diagram level description of feedback control systems for positioncontrol, speed control of DC motors, temperature control, liquid level control, voltage control of anAlternator.	08	
3	**Time domain analysis:** Time domain analysis of a standard second order closed loop system. Concept of undamped natural frequency, damping, overshoot, rise time and settling time. Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems. Effects of Pole and Zeros on transient response. Stability by pole location. Routh-Hurwitz criteria and applications. **Error Analysis:** Steady state errors in control systems due to step,	08	

	ramp and parabolic inputs. Concepts of system types and error constants.		
4	**Stability Analysis:** Root locus techniques, construction of Root Loci for simple systems. Effects ofgain on the movement of Pole and Zeros. **Frequency domain analysis of linear system:** Bode plots, Polar plots, Nichols chart, Concept ofresonance frequency of peak magnification. Nyquist criteria, measure of relative stability, phase andgain margin. Determination of margins in Bode plot. Nichols chart. M-circle and M-Contours inNichols chart.	10	
5	**Control System performance measure:** Improvement of system performance through compensation. Lead, Lag and Lead- lag compensation, PI, PD and PID control.	05	
6	**State variable Analysis:** Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.	10	

Text books:

1. Modern Control Engineering, K. Ogata, 4th Edition, Pearson Education
2. Control System Engineering, I. J. Nagrath & M. Gopal. New AgeInternational Publication.
3. Control System Engineering, D. Roy Choudhury, PHI
4. Control System, A. Ambikapathy, Khanna Publishing House
5. Automatic Control Systems, B.C. Kuo & F. Golnaraghi, 8th Edition, PHI

Reference books

1. Control Engineering Theory & Practice, Bandyopadhyaya, PHI
2. Control systems, K.R. Varmah, Mc Graw hill
3. Control System Engineering, Norman Nise, 5th Edition, John Wiley & Sons
4. Modern Control System, R.C. Dorf & R.H. Bishop, 11th Edition, PearsonEducation.
5. Control System Design, C. Goodwin Graham, F. Graebe F. Stefan, Salgado.E. Mario, PHI
6. Modeling & Control of dynamic system, Macia&Thaler, Thompson
7. Modern Control Technology Components & Systems, 3rd edition, C.T Kilian,Cengage Learning
8. Modern Control Engineering, Y. Singh & S. Janardhanan, Cengage Learning
9. Control System Engineering, R. Anandanatarajan& R. Ramesh Babu, ,SCITECH
10. Automatic Control system, A. William, Wolovich, Oxford

Course Outcome:

After completion of this course, the learners will be able to

1. developmathematical model of mechanical, electrical, thermal, fluid system and different control system components like servomotors, synchros, potentiometer, tacho-generators etc.
2. analyse stability of LTI system using routh-hurtwitz (RH) criteria, root locus techniques in time domain and bode plot and nyquist technique in frequency domain.
3. design different control law or algorithms like proportional control, proportional plus derivative(PD) control, proportional plus integration(PI) control, and proportional plus integration plus derivative (PID) control and compensators like lag, lead, lag-lead for LTI systems.
4. apply state variable techniques for analysis of linear systems.
5. analyze the stability of linear discrete system.
6. solve numerical problems on LTI system modelling, responses, error dynamics and stability .

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course		**POWER ELECTRONICS**	
Course Code: PC-EE-504		**Semester: 5th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs./week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Practical: hrs./week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the functioning and characteristics of power switching devices.		
2.	To understand the principle of operation of converters.		
3.	To understand different triggering circuits and techniques of commutation of SCR		
4.	To find external performance parameter of converters.		
5.	To analyze methods of voltage control, improvement of power factor and reduction of harmonics of the converter		
6.	To solve numerical problems of converters		
Pre-Requisite			
1.	Electric Circuit Theory (PC-EE-301)		
2.	Analog Electronics (PC-EE-302)		
3.	Electromagnetic field theory (PC-EE-303)		
4.	Digital Electronics (PC-EE-402)		
Unit	**Content**	**Hrs**	**Marks**
1	**Introduction:** Concept of power electronics, application of power electronics, uncontrolled converters,advantages and disadvantages of power electronics converters, power electronics systems,power diodes, power transistors, power MOSFETS, IGBT and GTO.	04	
2	**PNPN devices:** Thyristors, brief description of members of Thyristor family with symbol, V-Icharacteristics and applications. Two transistor model of SCR, SCR turn on methods,switching characteristics, gate characteristics, ratings, SCR protection, series and paralleloperation, gate triggering circuits, different commutation techniques of SCR.	05	
3	**Phase controlled converters:** Principle of operation of single phase and three phase half wave, half controlled, full controlled converters with R, R-L and RLE loads, effects of freewheeling diodes and source inductance on the performance of converters. External performance parameters of converters, techniques of power factor improvement, single phase and three phase dual converters	06	
	DC-DC converters:		

4	Principle of operation, control strategies, step up choppers, types of choppers circuits based on quadrant of operation, performance parameters, multiphase choppers.	05	
5	**Inverters:** Definition, classification of inverters based on nature of input source, wave shape of outputvoltage, method of commutation & connections. Principle of operation of single phase andthree phase bridge inverter with R and R-L loads, performance parameters of inverters,methods of voltage control and harmonic reduction of inverters.	10	
6	**Resonant Pulse Converters:** Introduction, Series Resonant inverter, Parallel Resonant inverter, Zero-Current Switching Resonant converters, Zero-Voltage Switching Resonant converter, Two quadrant Zero-Voltage Switching Resonant converter, Resonant DC link inverter.	05	
7	**Applications:** Speed control of AC and DC motors. HVDC transmission. Static circuit breaker, UPS,static VAR controller.	05	

Text books:

1. Power Electronics, M.H. Rashid,4th Edition, Pearson
2. Power Electronics, P.S. Bimbhra, Khanna Publishing House.
3. Power Electronics, V.R. Moorthi, Oxford.
4. Power Electronics, M.D. Singh and K.B. Khanchandani, Tata Mc Graw Hill.

Reference books

1. Modern Power Electronics & AC drives, B.K. Bose, Prentice Hall
2. Power Electronics, Mohan,Undeland&Riobbins, Wiley India
3. Element of power Electronics, Phillip T Krein, Oxford.
4. Power Electronics systems, J.P. Agarwal, Pearson Education.
5. Analysis of Thyristor power conditioned motor, S.K. Pillai, University Press.
6. Power Electronics, M.S. Jamal Asgha, PHI.
7. Power Electronics : Principles and applications, J.M. Jacob, Thomson

Course Outcome:

After completion of this course, the learners will be able to

1. differentiate between signal level and power level devices.
2. construct triggering and commutation circuits of SCR.
3. explain the principle of operation of AC-DC, DC-DC and DC-AC converters.
4. analysethe performance of AC-DC, DC-DC and DC-AC converters.
5. apply methods of voltage control and harmonic reduction to inverters.
6. solve numerical problems of switching devices, AC-DC, DC-DC and DC-AC converters.

Special Remarks (if any)
The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**ELECTRIC MACHINE-IILABORATORY**
Course Code: PC-EE 591	**Semester: 5th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 0 hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Different methods of starting of a 3 phase Cage Induction Motor & their comparison [DOL, Auto transformer &Star-Delta]
2.	Study of equivalent circuit of three phase Induction motor by no load and blocked rotor test.
3.	Study of performance of wound rotor Induction motor under load.
4.	Study of performance of three phase squirrel- cage Induction motor –determination of iron-loss, friction &windage loss.
5.	Speed control of 3 phase squirrel cage induction motor by different methods & their comparison [voltagecontrol & frequency control].
6.	Speed control of 3 phase slip ring Induction motor by rotor resistance control
7.	Determination of regulation of Synchronous machine by a. Potier reactance method. b. Synchronous Impedance method.
8.	Determination of equivalent circuit parameters of a single phase Induction motor.
9.	Load test on single phase Induction motor to obtain the performance characteristics.
10.	To determine the direct axis resistance [Xd] & quadrature reactance [Xq] of a 3 phase synchronous machine byslip test.
11.	Load test on wound rotor Induction motor to obtain the performance characteristics.
12.	To make connection diagram to full pitch & fractional slot winding of 18 slot squirrel cage Induction motor for6 poles & 4 pole operation
13.	To study the performance of Induction generator
14.	Parallel operation of 3 phase Synchronous generators
15.	V-curve of Synchronous motor

Institute may develop experiments based on the theory taught in addition to experiments mentioned.

Reference book:

1. Laboratory experiments on Electrical Machines, C.K. Chanda, A. Chakrabarti, Dhanpat Rai & Co.
2. Laboratory manual for Electrical Machines, D.P. Kothari, B.S.Umre, I K International Publishing House Pvt. Ltd.

Course outcome: After completion of this course, the learners will be able to

1. identify appropriate equipment and instruments for the experiment.
2. test the instrument for application to the experiment.
3. construct circuits with appropriate instruments and safety precautions.
4. validate different characteristics of single phase Induction motor, three phase Induction motor, Induction generator and synchronous motor , methods of speed control of Induction motors and parallel operation of the 3 phase Synchronous generator.
5. work effectively in a team

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**POWER SYSTEM-I LABORATORY**
Course Code: PC-EE 592	**Semester: 5th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 0 hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Determination of the generalized constants A.B, C, D of long transmission line and regulation of a 3-Φ transmission line model
2.	Study of distribution system by network analyzer.
3.	Measurement of earth resistance by earth tester.
4.	Determination of dielectric strength of insulating oil.
5.	Determination of breakdown strength of solid insulating material
6.	Determination of parameter of 3-Φ transmission line model by power circle diagram
7.	Study of different types of insulator.
8.	Study of active and reactive power control of alternator.
9.	Study and analysis of an electrical transmission line circuit with the help of software
10.	Determination of dielectric constant, tan delta, resistivity of transformer oil.

Institute may develop experiments based on the theory taught in addition to experiments mentioned.

Course outcome: After completion of this course, the learners will be able to

1. identify appropriate equipment and instruments for the experiment.
2. test the instrument for application to the experiment.
3. construct circuits with appropriate instruments and safety precautions.
4. validate different characteristics oftransmission line.
5. determine earth resistance, dielectric strength of insulating oil, breakdown strength of solid insulating material and dielectric constant of transformer oil.
6. analyze an electrical transmission line circuit with the help of software
7. work effectively in a team

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**CONTROL SYSTEMLABORATORY**
Course Code: PC-EE 593	**Semester: 5th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 0 hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Familiarization with MAT-Lab control system tool box, MAT-Lab- simulink tool box & PSPICE
2.	Determination of Step response for first order & Second order system with unity feedback with the help of CRO &calculation of control system specification , Time constant, % peak overshoot, settling time etc. from theresponse.
3.	Simulation of Step response & Impulse response for type-0, type-1 & Type-2 system with unity feedback usingMATLAB & PSPICE.
4.	Determination of Root locus, Bode plot, Nyquist plot using MATLAB control system tool box for a givensystem &stability by determining control system specification from the plot.
5.	Determination of PI, PD and PID controller action of first order simulated process.
6.	Determination of approximate transfer functions experimentally from Bode plot.
7.	Evaluation of steady state error, setting time , percentage peak overshoot, gain margin, phase margin withaddition of Lead, Lag, Lead-lag compensator.
8.	Study of a practical position control system obtaining closed step responses for gain setting corresponding toover-damped and under-damped responses. Determination of rise time and peak time using individualizedcomponents by simulation. Determination of un-damped natural frequency and damping ratio fromexperimental data.
9.	Analysis of performance of Lead, Lag and Lead-Lag compensation circuits for a given system using simulation.
10.	Determination of Transfer Function of a given system from State Variable model and vice versa.
11.	Analysis of performance of a physical system using State variable technique by simulation.Study ofstep response and initial condition response for asingle input, two-output system in SV form by simulation.

Institute may develop experiments based on the theory taught in addition to experiments mentioned.

Course outcome: After completion of this course, the learners will be able to

1. identify appropriate equipment and instruments for the experiment.
2. test the instrument for application to the experiment.
3. construct circuits with appropriate instruments and safety precautions.
4. use MAT-Lab control system tool box, MAT-Lab- simulink tool box & PSPICE for simulation of systems.
5. determinecontrol system specifications of first and second order systems.

6. validate step response & impulse response for type-0, type-1 & Type-2 system with unity feedback using MATLAB & PSPICE.
7. work effectively in a team

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**POWER ELECTRONICSLABORATORY**
Course Code: PC-EE 594	**Semester: 5th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 0 hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Study of the characteristics of an SCR.
2.	Study of the characteristics of a Triac
3.	Study of different triggering circuits of an SCR
4.	Study of firing circuits suitable for triggering SCR in a single phase full controlled bridge.
5.	Study of the operation of a single phase full controlled bridge converter with R and R-L load.
6.	Study of performance of single phase half controlled symmetrical and asymmetrical bridge converters.
7.	Study of performance of step down chopper with R and R-L load.
8.	Study of performance of single phase controlled converter with and without source inductance (simulation)
9.	Study of performance of step up and step down chopper with MOSFET, IGBT and GTO as switch (simulation)
10.	Study of performance of single phase half controlled symmetrical and asymmetrical bridge converter.(simulation)
11.	Study of performance of three phase controlled converter with R & R-L load. (simulation)
12.	Study of performance of PWM bridge inverter using MOSFET as switch with R and R-L load.
13.	Study of Zero Voltage Switching Resonant converter and Zero Current Switching Resonant Converter andto plot its output waveforms.
14.	Study the speed control of universal motor to plot speed v/s α

Institute may develop experiments based on the theory taught in addition to experiments mentioned.

Reference book:

1. Power Electronics Laboratory: Theory, Practice and Organization, O.P.Arora, Om Prakash Arora, Alpha science International.

Course outcome: After completion of this course, the learners will be able to

1. identify appropriate equipment and instruments for the experiment.
2. test the instrument for application to the experiment.
3. construct circuits with appropriate instruments and safety precautions.

4. validatecharacteristics of SCR, Triac, and performance of phase controlled converter, DC-DC converter, inverters and resonant pulse converters.
5. demonstrate the relation between the speed and firing angle of Universal motor.
6. work effectively in a team

Special Remarks:

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**DATA STRUCTURE & ALGORITHM**
Course Code: OE-EE-501A	**Semester: 5th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs./week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:	
1.	To understand the basics of abstract data types.
2.	To understand the principles of linear and nonlinear data structures.
3.	To build an application using sorting and searching

Pre-Requisite	
1.	Programing for problem solving (ES-CS 201)
2.	Mathematics (BS-M-102)
3.	Mathematics (BS-M-202)

Unit	**Content**	**Hrs**	**Marks**
1	Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Technique sand their complexity analysis.	10	
2	Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.	10	
3	Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms andthe complexity analysis. Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis	10	
4	Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing. Graph: BasicTerminologies and Representations, Graph search and traversal algorithms and complexity analysis.	10	

Text books:

1. Data Structures and Program Design In C, 2/E by Robert L. Kruse, Bruce P. Leung. PHI
2. Data Structure & Algorithms Using C, R.S. Salaria, 5th Ed., Khanna Publishing House
3. Data Structures in C, Aaron M. Tenenbaum. Pearson.
4. Data Structure, S. Lipschutz.. Mc Graw Hill.

Reference books

1. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, MIT press
2. Expert Data Structures with C++, R.B Patel, Khanna Publishing House
3. Fundamentals of Data Structures of C, Ellis Horowitz, SartajSahni, Susan Andersonfreed, MIT press
4. Data Structures Using C, ReemaThareja. Oxford University press
5. Data Structure Using C, 2/e by A.K. Rath, A. K. Jagadev. SCITECH
6. Data Structures through C, YashwantKanetkar, BPB Publications.

Course Outcome:

After completion of this course, the learners will be able to

1. differentiate how the choices of data structure & algorithm methods enhance the performance of the program.
2. solve problems based upon different data structure & also write programs.
3. write programs based on different data structure
4. identify appropriate data structure & algorithmic methods in solving problem.
5. discuss the computational efficiency of the principal algorithms for sorting, searching, and hashing
6. comparethe benefits of dynamic and static data structures implementations.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course		**OBJECT ORIENTED PROGRAMMING**	
Course Code: OE-EE-501B		**Semester: 5th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs./week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Practical: hrs./week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand simple abstract data types		
2.	To understand features of object-oriented design such as encapsulation, polymorphism, inheritance		
3.	To understand common object-oriented design patterns		
4.	To design applications with an event-driven graphical user interface.		
Pre-Requisite			
1.	Programing for problem solving (ES-CS 201)		
Unit	**Content**	**Hrs**	**Marks**
1	Abstract data types and their specification. How to implement an ADT. Concrete state space, concrete invariant, abstraction function. Implementing operations, illustrated by the Text example.	08	
2	Features of object-oriented programming. Encapsulation, object identity, polymorphism – but not inheritance.	08	
3	Inheritance in OO design. Design patterns. Introduction and classification. The iterator pattern.	08	
4	Model-view-controller pattern. Commands as methods and as objects. Implementing OO language features. Memory management.	08	
5	Generic types and collections GUIs. Graphical programming with Scale and Swing . The software development process	08	

Text books:

1. Mastering Object-Oriented Programming Using C++, R.S. Salaria, Khanna Publishing House.
2. Object Oriented Modelling and Design,Rambaugh, James Michael, Blaha Prentice Hall India.
3. The complete reference-Java2, Patrick Naughton, Herbert Schildt, TMH
4. Core Java For Beginners, R.K. Das, VIKAS PUBLISHING
5. Java How to Program, Deitel and Deitel, 6th ED, Pearson

Reference books

1. Object Oriented System Development, Ali Bahrami, McGraw Hill.
2. Ivor Horton's Beginning Java 2 SDK – Wrox
3. Programming With Java: A Primer, E. Balagurusamy 3rd Ed., TMH

Course Outcome:

After completion of this course, the learners will be able to

1. specify simple abstract data types.
2. recognise features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on object identity.
3. apply common object-oriented design patterns
4. specify uses of common object oriented design patterns with examples.
5. design applications with an event-driven graphical user interface.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course		**COMPUTER ORGANISATION**	
Course Code: OE-EE-501C		**Semester: 5th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs./week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Practical: hrs./week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the analysis and design of various digital electronic circuits.		
2.	To understand how Computer Systems work & its basic principles		
3.	To understand how I/O devices are being accessed and its principles etc.		
Pre-Requisite			
1.	Programing for problem solving (ES-CS 201)		
2.	Digital Electronics (PC-EE 402)		
Unit	**Content**	**Hrs**	**Marks**
1	Basic organization of the stored program computer and operation sequence for execution of a program. Role of operating systems and compiler/assembler. Fetch, decode and execute cycle, Concept of operator, operand, registers and storage, Instruction format. Instruction sets and addressing modes. Commonly used number systems. Fixed and floating point representation of numbers.	08	
2	Overflow and underflow. Design of adders - ripple carry and carry look ahead principles. Design of ALU. Fixed point multiplication - Booth's algorithm. Fixed point division - Restoring and non-restoring algorithms. Floating point - IEEE 754 standard.	08	
3	Memory unit design with special emphasis onimplementation of CPU-memory interfacing. Memory organization, static and dynamic memory, memory hierarchy, associative memory. Cache memory, Virtual memory. Data path design for read/write access.	10	
4	Design of control unit - hardwired and microprogrammed control. Introduction to instruction pipelining. Introduction to RISC architectures. RISC vs CISC architectures. I/O operations - Concept of handshaking, Polled I/O, interrupt and DMA.	10	

Text books:

1. Computer System Architecture, Mano, M.M. PHI.
2. Computer Architecture & Organisation, Hayes J. P, McGraw Hill,
3. Computer Organisation & Design, Chaudhuri P. Pal, PHI,
4. Computer Organization & Architecture, Rajaraman , PHI

Reference books

1. Computer Architecture, BehroozParhami , Oxford University Press

2. Microprocessors and Microcontrollers, N. senthil Kumar, M. Saravanan, S. Jeevananthan ,OUP
3. Computer Organization & Architecture , P N BasuVikas Pub
4. Computer Organization & Architecture, B.Ram, Newage Publications
5. Computer Organisation, Hamacher, McGraw Hill,

Course Outcome:

After completion of this course, the learners will be able to

1. explain basic structure of digital computer, stored program concept, different arithmetic and control unit operations, operating systems and compiler/assembler, memory and I/O operations.
2. differentiate between RISC vs CISC architectures, cache memory, virtual memory.
3. performfixed point multiplication and division.
4. applyrestoring and non-restoring algorithms, floating point - IEEE 754 standard.
5. design adder, memory unit and control unit, data path for read/write access.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**HIGH VOLTAGE ENGINEERING**
Course Code: PE-EE-501A	**Semester: 5th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs./week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To understand the breakdown phenomenon of solid, liquid and gases.
2.	To understand the method of generation of high voltage AC and DC.
3.	To understand measurement techniques of high voltage and current
4.	To understand the over voltage phenomenon and insulation coordination in Electric power systems
5.	To understand different methods of high voltage testing.
6.	To solve numerical problems of breakdown phenomena, generation and measurement of high voltage and currents, over voltage phenomena and high voltage testing.

Pre-Requisite

1.	Electric Circuit Theory (PC-EE-301)
2.	Electromagnetic field theory (PC-EE-303)
3.	Electric Machine-I (PC-EE-401)
4.	Electrical and Electronics measurement (PC-EE-403)

Unit	Content	Hrs	Marks
1	**Breakdown phenomena:** Breakdown of Gases: Mechanism of Breakdown of gases, Charge multiplication, Secondaryemission, Townsend Theory, Streamer Theory, Paschen's Law, Determination of Minimumbreakdown voltage, Breakdown in non-uniform field, Effect of polarity on corona inceptionand break down voltage. Partial Discharge: definition and development in solid dielectric. Break Down of Solids: Intrinsic breakdown, Electromechanical break down, Thermalbreakdown, Streamer Breakdown. Breakdown of Liquid: Intrinsic Break down, Cavitation Theory, Suspended particle Theory. Breakdown in Vacuum: Non-metallic electron emission mechanism, Clump mechanism, Effect of pressure on breakdown voltage.	10	
2	**Generation of High Voltage and Currents** Generation of highDC and AC voltages: half wave rectifier circuit, Cockroft-Walton voltage multiplier circuit, Electrostatic generator, Cascaded transformers, Series resonant circuit. Generation of Impulse voltages and currents: standard impulse wave shapes, Multistage impulse generators, generation of switching surges, generation of impulse currents, tripping and control of impulse generators.	08	
	Measurement of High Voltage and Currents		

3	Sphere gap, Uniform field spark gap, Rod gap, Electrostatic voltmeter, Generating voltmeter, Impulse voltage measurements using voltage dividers, Measurement of High DC and Impulse currents. Cathode ray oscillographs for impulse voltage and current measurements.	08	
4	**Over voltage phenomenon and insulation coordination in Electric power systems:** Lightning Phenomena, Electrification of cloud, Development of Lightning Stroke, lightning induced over voltage, direct stroke, indirect stroke. Protection of Electrical Apparatus against over voltage, Lightning Arrestors, Valve Type, Metal Oxide arresters, Expulsion type. Effect of location of lightning arresters on protection of transformer. Protection of substation, Ground wires. Insulation Co-ordination, Basic Insulation level. Basic Impulse level, Switching Impulse level. Volt time characteristics of protective devices, Determination of Basic Impulse level of substation equipment.	08	
5	**High Voltage Testing:** Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators andbushings, testing of isolators and circuit breakers, testing of cables, power transformers. High voltage laboratory layout, indoor and outdoor laboratories, testingfacility requirements, safety precautions in H. V. Labs.	06	

Text books:

1. High Voltage Engineering, C.L. Wadhawa, New Age International Publishers.
2. High Voltage Engineering, M.S. Naidu & V. Kamraju, Tata MC Graw Hill publication.

Reference books

1. High-Voltage Engineering : theory and practice, Mazen Abdel-Salam; Hussein Anis; Ahdab El-Morshedy; RoshdyRadwan, New York, N.Y. : Marcel Dekker, ©2000.
2. High Voltage Engineering, E. Kuffel, W.S. Zaengl, J. Kuffel, 2nd edition, Butterworth-Heinemann.

Course Outcome:

After completion of this course, the learners will be able to

1. explain breakdown phenomenon of gas, liquid and solid and vacuum
2. suggest methods for generation and measurement of high voltage and currents.
3. determine the basic insulation level of substation equipment.
4. apply methods for protection of electrical apparatus against over voltage
5. test insulators,bushings, isolators, circuit breakers, cables and power transformers.
6. solve numerical problems of breakdown phenomena, generation and measurement of high voltage and currents, over voltage phenomena and high voltage testing.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course		**POWER PLANT ENGINEERING**	
Course Code: PE-EE-501B		**Semester: 5th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs./week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Practical: hrs./week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand methods of selection of power plant and its economic.		
2.	To understand the principle of operation different types of power plants.		
3.	Tounderstand methods of site selection of different power plants.		
4.	To understand the cause of pollution and its remedy for power plants.		
5.	To understand methods of cooling of generators and transformers.		
6.	To solve numerical problems of load estimation, economics of power plants.		
Pre-Requisite			
1.	Electric Circuit Theory (PC-EE-301)		
2.	Electromagnetic field theory (PC-EE-303)		
3.	Electric Machine-I (PC-EE-401)		
4.	Electrical and Electronics measurement (PC-EE-403)		
Unit	**Content**	**Hrs**	**Marks**
1	**Introduction:** Power and energy, sources of energy, review of thermodynamic cycles related to powerplants, fuels and combustion calculations.Load estimation, load curves, various terms and factors involved in power plantcalculations. Effect of variable load on power plant operation, Selection of power plant. **Power plant economics and selection**: Effect of plant type on costs, rates, fixed elements, energy elements, customer elements andinvestor's profit; depreciation and replacement, theory of rates. Economics of plantselection, other considerations in plant selection.	08	
2	**Steam power plant:** General layout of steam power plant, Power plant boilers including critical and supercritical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systemssuch as coal handling system, pulverizers and coal burners, combustionsystem, draft, ash handling system, Dust collection system, Feed water treatment andcondenser and cooling towers and cooling ponds, Turbine auxiliary systems such asgoverning, feed heating, reheating, flange heating and gland leakage. Operation andmaintenance of steam power plant, heat balance and efficiency, Site selection of a steampower plant.	08	
	Diesel power plant:		

3	General layout, Components of Diesel power plant, Performance of diesel power plant, fuelsystem, lubrication system, air intake and admission system, supercharging system, exhaustsystem, diesel plant operation and efficiency, heat balance, Site selection of diesel powerplant, Comparative study of diesel power plant with steampower plant. **Gas turbine power plant:** Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels,cogeneration, auxiliary systems such as fuel, controls and lubrication, operation andmaintenance, Combined cycle power plants, Site selection of gas turbine power plant .	08	
4	**Nuclear power plant:** Principles of nuclear energy, Lay out of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants. **Hydro electric station:** Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, run off size of plant and choice of units, operation and maintenance, hydro systems, interconnected systems. **Non Conventional Power Plants:** Introduction to non-conventional power plants (Solar, wind, geothermal, tidal)etc.	10	
5	**Electrical system:** Generators and their cooling, transformers and their cooling.Instrumentation Purpose, classification, selection and application, recorders and their use,listing of various control rooms.Pollution due to power generation and its remedy	06	

Text books:

1. Power Plant Engineering, P.K. Nag, McGraw Hill.
2. Power Plant Engineering, F.T. Morse, Affiliated East-West Press Pvt. Ltd.
3. Power Plant Technology El-Vakil, McGraw Hill.

Reference books

1. Steam & Gas Turbines & Power Plant Engineering by R.Yadav, Central Pub.House.
2. An introduction to thermal power plant engineering and operation, P.K.Das and A.K. Das, Notion press.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the principle of operational of Steam, Hydroelectric, Diesel, Gas turbine, Nuclear power and non-conventional power plant.
2. identifythe cause of pollution for power generation and its remedy.
3. suggest location to set up Steam, Hydroelectric, Diesel, Gas turbine and Nuclear power plant.
4. compare Steam, Hydroelectric, Diesel, Gas turbine, Nuclear power and non-conventional power plant.
5. suggest methods of maintenance of Steam, Gas and Hydroelectric power plants
6. solve numerical problems of load estimation and economics of power plants.

Special Remarks (if any)
The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course		**RENEWABLE & NON CONVENTIONAL ENERGY**	
Course Code: PE-EE-501C		**Semester: 5th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs./week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Practical: hrs./week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the difference between Renewable and non-renewable energy sources		
2.	To understand methods of conversion of solar energy and wind energy to other form of energy.		
3.	Tounderstand methods harnessing energy from Biomass, Geothermal and ocean		
4.	To understand the principle of operation of Magneto Hydrodynamic power generation:		
5.	To understand the principle and operation of fuel cell.		
6.	To solve numerical problems of Renewable and non-renewable energy sources		
Pre-Requisite			
1.	Electric Circuit Theory (PC-EE-301)		
2.	Electromagnetic field theory (PC-EE-303)		
3.	Electric Machine-I (PC-EE-401)		
4.	Electrical and Electronics measurement (PC-EE-403)		
Unit	**Content**	**Hrs**	**Marks**
1	**Introduction to Energy sources:** Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy formeeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. Impact of renewable energy generation on environment, Kyoto Protocol.	03	
2	**Solar Energy:** Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solarradiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentratingcollectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters,solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaic - solar cells, different typesof PV Cells, Mono-poly Crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PVsystems & its applications. PV hybrid systems	08	
3	**Wind Energy:** Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, varioustypes and their constructional features; design considerations of horizontal and	05	

	vertical axis wind machines: analysis ofaerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations		
4	**Energy from Biomass:** Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas	05	
5	**Geothermal Energy:** Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dryrock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.	05	
6	**Energy from Ocean:** Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC inIndia. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages,limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages anddisadvantages of wave energy.	05	
7	**Magneto Hydrodynamic power generation:** Principle of MHD power generation, MHD system, Design problems and developments, gas conductivity, materials forMHD generators and future prospects.	05	
8	**Hydrogen Energy:** Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas,hydrogen as alternative fuel for vehicles.	03	
9	**Fuel cell:** Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, applicationof fuel cells	03	

Text books:

1. Renewable energy sources and conversion technology, Bansal Keemann, Meliss, Tata Mc Graw Hill.
2. Energy Technology, O.P. Gupta, Khanna Publishing House.
3. Renewable energy resources and emerging technologies, D.P. Kothari, PHI.
4. Non-conventional Energy sources, G.D. Rai, Khanna Publishers.
5. Non Conventional Energy Resources, Chandra, Khanna Publishing House.

Reference books

1. Non-conventional Energy, Ashok V. Desai, New Age International Publishers Ltd.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the principle of conversion of solar energy, wind energy , biomass, Geothermal energy, Ocean energy and Hydrogen energy to other form of energy.
2. explain the principle of operation of magneto hydrodynamic power generation:
3. useSolar energy, Wind energy , Biomass, Geothermal energy, Ocean energy, Hydrogen energy and fuel cell for different applications.
4. suggest location to set up wind mill and biogas generation plant
5. estimate conversion efficiency of fuel cell.
6. solve numerical problems relating to conversion of Solar energy, Wind energy , Biomass, Ocean energy and Hydrogen energy to heat and electric energy.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Semester-VI

Name of the course	**POWER SYSTEM-II**
Course Code: PC-EE-601	**Semester: 6th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:	
1.	To understand the method of representation of power system components
2.	To know about loacation and components of a distribution substation.
3.	To understand different methods of load flow studies.
4.	To determine faults in Electrical systems.
5.	To understand the principle of power system stability.
6.	To understand the principle of relays and methods of protection of power system
7.	To solve numerical problems on the topics studied.
Pre-Requisite	
1.	Electric Circuit Theory (PC-EE-301)
2.	Electromagnetic field theory (PC-EE-303)
3.	Power system-I (PC-EE-502)

Unit	Content	Hrs	Marks
1	**Representation of Power system components:** Single-phase representation of balanced three phase networks, the one-line diagram and the impedance or reactance diagram, per unit (PU) system.	02	
2	**Distribution substation:** Types of substations, location of substations, substation equipments and accessories, earthling (system & equipment), feeder and distributors, radial and loop systems.	05	
3	**Load flow studies:** Network model formulation, formation of Ybus, load flow problem, Gauss-Siedel method, Newton-Raphson method, Decoupled load flow studies, comparison of load flow methods.	05	
4	**Faults in Electrical systems:** Transient on a transmission line, short circuit of a synchronous machine under no load & loaded condition. Symmetrical component transformation, sequence impedance and sequence network of power system, synchronous machine, transmission lines and transformers. Symmetrical component analysis of unsymmetrical faults, single line-to –ground fault, lineto-line fault, double line-to- ground fault	08	
	Power system stability: Steady state stability, transient stability,		

5	equal area criteria, swing equation, multi machine stability concept	04	
6	**Power system protection:** Protective zones, Relaying elements and quantities. Protective relays, basic requirements and type of protection, phase and amplitude comparator, grading (time & current), classification of Electromagnetic relays, Directional relay, Distant relay, Differential relay, basic aspects of static and digital relays, relay protection scheme for transformer, feeder, generators and motors. Circuit breakers, circuit breaking transients, transient recovery voltage, current chopping and resistance switching, circuit breaker rating, arc and arc extinction, circuit breaker types, oil circuit breaker, vacuum circuit breaker, air blast circuit breaker, SF6 circuit breaker and operating mechanism, advantages and disadvantages of different types	12	

Text book:

1. Modern Power System Analysis, D.P. Kothari & I.J. Nagrath, 4th Edition, Tata McGraw Hill.
2. Electrical Power Systems, Subir Ray, PHI
3. Switchgear protection and power systems, Sunil S Rao, Khanna Publications.
4. A text book on Power System Engineering, M.L.Soni, P.V.Gupta, U.S. Bhatnagar & A. Chakrabarti, Dhanpat Rai & CO.

Reference Books:

1. Protection & Switchgear, B. Bhalja, R.P. Maheshwari, N.G.Chothani, Oxford.
2. Power system protection & switchgear, B.Ram & D.N. Vishwakarma, Tata McGraw Hill.
3. Handbook of Electrical Power Distribution, G. Ramamurthy, University Press
4. Electric Power Transmission and Distribution, S. Sivanagaraju, S.Satyanarayana, Pearson Education.
5. Power Systems Stability, Vol. I,II & II, E.W. Kimbark, Wiley.
6. Power Engineering, D.P Kothari & I.J. Nagrath, Tata McGraw Hill.
7. Power Systems Analysis, A. R. Bergen & V. Vittal, Pearson Education. 8. Computer Aided Power systems analysis, Dr. G. Kusic, CEC press.

Course Outcome:

After completion of this course, the learners will be able to

1. Represent power system components in line diagrams.
2. Determine the location of distribution substation.
3. Determine the performance of power system with the help of load flowv studies.
4. Analyse faults in Electrical systems.
5. Determine the stabilty of Power system.
6. Explain principle of operation of different power system protection equipments.
7. Solve numerical problems related to representation, load flow, faults, stabilty and protection of power system.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course		**MICROPROCESSOR & MICRO CONTROLLER**	
Course Code: PC-EE-602		**Semester: 6th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Credit Points: 3		Attendance: 05 Marks	
		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the architecture of 8086 microprocessor.		
2.	To understand the design aspects of I/O and Memory Interfacing circuits.		
3.	To interface microprocessors with supporting chips.		
4.	To understand the architecture of 8051 microcontroller.		
5.	To design a microcontroller based system		
Pre-Requisite			
1.	Analog Electronics (PC-EE-302)		
2.	Digital Electronics (PC-EE-402)		
Unit	Content	Hrs	Marks
1	**The 8086 Microprocessor:** Introduction to 8086- Microprocessor architecture – Addressing modes – Instruction set and assembler directives – Assembly language programming – Modular Programming – Linking and Relocation – Stacks – Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.	08	
2	**8086 System bus structure:** 8086 signals – Basic configurations – System bus timing –System design using 8086 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.	08	
3	**I/O INTERFACING**: Memory Interfacing and I/O interfacing – Parallel communication interface – Serial communication interface – D/A and A/D Interface – Timer – Keyboard /display controller – Interrupt controller –DMA controller – Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.	08	
4	**Microcontroller:** Architecture of 8051 – Special Function Registers(SFRs) – I/O Pins Ports and Circuits – Instruction set – Addressing modes – Assembly language programming.	08	
5	**Interfacing Microcontroller:** Programming 8051 Timers – Serial Port Programming – Interrupts Programming – LCD & Keyboard Interfacing – ADC, DAC & Sensor Interfacing – External Memory Interface- Stepper Motor and Waveform generation – Comparison	06	

	of Microprocessor, Microcontroller, PIC and ARM processors		

Text books:

1. Advanced Microprocessors and Peripheral, Koshor M Bhurchandi, Ajay Kumar Ray, 3rd Edition, MC Graw hill education.
2. Microprocessor & Interfacing, D.V. Hall, Mc Graw Hill.
3. The 8051 microcontroller, Ayala, Thomson.

Ref erence books:

1. Advanced Microprocessors, Y. Rajasree, New Age international Publishers.
2. An introduction to the Intel family of Microprocessors, James L. Antonakos, Pearson Education,
3. The 8051 Microcontroller and Embedded systems, Muhammad Ali Mazidi & J. G. Mazidi, Pearson Education.
4. The 8086 Microprocessors: Programming & Interfacing the PC, K.J.Ayala, Thomson.
5. Microprocessor & Peripherals, S.P. Chowdhury & S. Chowdhury, Scitech.
6. Microchip technology data sheet, www.microchip.comerence books

Course Outcome:

After completion of this course, the learners will be able to

1. explain the architecture of 8086 and 8051.
2. do assembly language programming of 8086, 8051
3. interface different peripheral with 8086 and 8051
4. develop micro processor/ microcontroller based systems.
5. compare microprocessor, microcontroller, PIC and ARM processors

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course		**DIGITAL CONTROL SYSTEM**	
Course Code: PE-EE-601A		**Semester: 6th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Credit Points: 3		Attendance: 05 Marks	
		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the principle of sampling and reconstruction of signals.		
2.	To find Z-tranaform and inverse Z-transform of systems.		
3.	To carry out the analysis and design of digital control systems		
4.	To design compensators for digital control system to achieve desired specifications.		
5.	To represent digital control systems using state space models.		
6.	To analyze the effect sampling on stability, controllability and observability.		
7.	To design digital controllers for industrial applications.		
8.	To solve numerical problems on the topics studied.		
Pre-Requisite			
1.	Control system (PC-EE-503)		
Unit	Content	Hrs	Marks
1	**Sampling and reconstruction:** Introduction, Examples of Data control systems – Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.	03	
2	**Z-transform:** Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z – transforms, Modified Z- Transforms	05	
3	**Z- Plane analysis of discrete-time control system:** Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane.	05	
4	**State space analysis:** State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations.	06	
5	**Controllability and observability:** Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function	04	
6	**Stabilty analysis:** Mapping between the S-Plane and the Z-Plane – Primary strips and Complementary Strips – Constant frequency loci, Constant damping ratio loci, Stability Analysis of	05	

	closed loop systems in the Z-Plane. Jury stablility test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion.		
7.	**Design of discrete time control system by conventional methods:** Transient and steady – State response Analysis – Design based on the frequency response method – Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers.	06	
8.	**State feedback controllers and observers:** Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula. State Observers – Full order and Reduced order observers.	05	

Text book:

1. Digital Control and State Variable Methods , M. Gopal, TMH Publishers
2. Discrete-time Control Systems, K. Ogata, Pearson Education,
3. Digital Control Systems, B.C. Kuo, Wiley Publications.
4. Control System Engineering, I.J. Nagrath, M. Gopal, New age International.

Reference books

1. Digital control of dynamic systems, Gene F. Franklin, J. David Powell, and Michael Workman 3rd ed, 1998, Addison-Wesley.
2. Digital Control Systems, design, identification and implementation, Landau**,** Ioan Doré**,** Zito**,** Gianluca, Springer-Verlag London.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the principle of sampling and reconstrction of analog signal.
2. perform Z-transformation and inverse Z-tranaformation of systems.
3. analyse and design digital control systems.
4. design compensators for digital control system to achieve desired specifications.
5. represent digital control systems using state space models.
6. analyze the effect sampling on stability, controllability and observability.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**HVDC TRANSMISSION**
Course Code: PE-EE-601B	**Semester: 6th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:	
1.	To understand the basics of DC power transmssion system
2.	To analyse HVDC converters.
3.	To understand methods of control of HVDC system
4.	To understand causes of fault and protection against fault of converters.
5.	To understand function of smooting reactor and transient over voltage of DC line
6.	To understand methods of reactive power control.
7.	To solve numerical problems on the topics studied.
Pre-Requisite	
1.	Electric Circuit Theory (PC-EE-301)
2.	Power system-1 (PC-EE-502)
3.	Control system (PC-EE-503)
4.	Power Electronics (PC-EE-504)

Unit	Content	Hrs	Marks
1	**DC power transmission technology:** Introduction, Comparison of HVAC and HVDC transmission system, Applications of DC transmission, Description of DC transmission system, Configurations, Modern trends in DC transmission.	04	
2	**Analysis of HVDC converters:** Pulse number, Choice of converter configuration, Simplified analysis of Graetz circuit, Converter bridge characteristics, Characteristics of a twelve-pulse converter, Detailed analysis of converters with and without overlap	06	
3	**Converter and HVDC system control:** General, Principles of DC link control, Converter control characteristics, System control hierarchy, Firing angle control, Current and extinction angle control, Starting and stopping of DC link, Power control, Higher level controllers.	06	
4	**Converter faults and protection:** Converter faults, Protection against over-currents, Overvoltages in a converter station, Surge arresters, Protection against over-voltages.	05	
5	**Smoothing reactor and DC line:** Introduction, Smoothing reactors, DC line, Transient over voltages in DC line, Protection of DC line, DC breakers, Monopolar operation, Effects of proximity of AC and DC transmission lines.	06	
6	**Reactive power control:** Reactive power requirements in steady state, Sources of reactive power, Static VAR systems, Reactive	06	

	power control during transients, Harmonics and filters, Generation of harmonics, Design of AC filters and DC filters.		
7.	**Component models for the analysis of ac/dc systems:** General, Converter model, Converter control, Modelling of DC network, Modelling of AC networks. **Power flow analysis in AC/DC systems:** General, Modelling of DC links, Solution of DC load flow, Discussion, Per unit system for DC quantities.	06	

Text book:

1. HVDC Power transmission systems , K.R. Padiyar , Third Edition, New Age International Publishers

Reference books

1. Power Transmission by Direct Current, Erich Uhlmann, Fourth Indian Reprint, Springer International Edition, 2012.
2. HVDC Transmission, S Kamakshaiah, V Kamaraju , 2nd Edition, Mcgraw Hill Education, 2020.
3. Direct Current Transmission, E.W.Kimbark, Wiley–Blackwell; Volume 1 edition (1 January 1971)
4. H.V.D.C Transmission , J Arrillaga , 1st Edition, The Institution of Engineering and Technology, 1998

Course Outcome:

After completion of this course, the learners will be able to

1. choose intelligently AC and DC transmission systems for the dedicated application(s).
2. identify the suitable two-level/multilevel configuration for high power converters.
3. select the suitable protection method for various converter faults.
4. identify suitable reactive power compensation method.
5. decide the configuration for harmonic mitigation on both AC and DC sides..
6. solve numerical problems related to converters, power flow analysis, reactive power control.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course		**ELECTRICAL MACHINE DESIGN**	
Course Code: PE-EE-601C		**Semester: 6th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Credit Points: 3		Attendance: 05 Marks	
		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the baisc principle of design of Electric machines.		
2.	To understand basics of design of Transformer, Induction machine and Synchronous machines.		
3.	To understand different factors that influence design of Electric machines.		
4.	To undertand the need and use software tools for design of Electric machines		
5.	To solve numerical problems on the topics studied		
Pre-Requisite			
1.	Electric Machine-I (PC-EE-401)		
2.	Electric Machine-II (PC-EE-501)		
Unit	Content	Hrs	Marks
1	**Introduction:** Major considerations in Electrical Machine Design - Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loadings - Thermal considerations - Heat flow – Temperature rise and Insulating Materials - Rating of machines – Standard specifications.	04	
2	**Transformer:** Output Equations – Main Dimensions - kVA output for single and three phase transformers – Window space factor – Design of core and winding – Overall dimensions – Operating characteristics – No load current – Temperature rise in Transformers – Design of Tank - Methods of cooling of Transformers.	10	
3	**Induction motors:** Output equation of Induction motor – Main dimensions – Choice of Average flux density – Length of air gap- Rules for selecting rotor slots of squirrel cage machines – Design of rotor bars & slots – Design of end rings – Design of wound rotor – Magnetic leakage calculations – Leakage reactance of polyphase machines- Magnetizing current - Short circuit current – Operating characteristics- Losses and Efficiency.	10	
4	**Synchronous machines:** Output equations – choice of Electrical and Magnetic Loading – Design of salient pole machines – Short circuit ratio – shape of pole face – Armature design – Armature parameters – Estimation of air gap length – Design of rotor –Design of damper winding – Determination of full load field mmf – Design of field winding – Design of turbo alternators – Rotor design.	10	
	Computer aided Design (CAD): Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid	05	

	methods, design optimization methods, variables, constraints and objective function, problem formulation.		

Text book:

1. A Course in Electrical Machine Design, A.K. Sawhney, Dhanpat rai and sons.
2. Electrical machine design, V. rajini, V.S. Nagarajan, Pearson India education services Pvt. Ltd.
3. Computer Aided Design of Electrical Machine, K. M. V. Murthy, B.S. Publications.

Reference books

1. Design and Testing of Electrical Machines, M.V.Deshpande, PHI
2. Principles of Electrical Machine Design, 3rd Edition, S.K. sen, Oxf-Ibh
3. Computer Aided Design of Electrical Equipment, M. Ramamoorthy, East-West Press.

Course Outcome:

After completion of this course, the learners will be able to

1. specify the rating of electrical machines with standard specifications.
2. explain the principles of electrical machine design and carry out basic design of an ac machine
3. determine the various factors which influence the design of electrical, magnetic and thermal loading of electrical machines
4. explain the construction and performance characteristics of electrical machines.
5. use software tools to do design calculations.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**ELECTRICAL AND HYBRID VEHICLE**
Course Code: PE-EE-602A	**Semester: 6th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:	
1.	To understand the basic difference between conventional and Hybrid vehicles.
2.	To understand different configuration and control of Electric drives.
3.	To understand energy storage system in Hybrid vehicles.
4.	To understand different energy management strategies of Hybrid vehicles.
5.	To solve numerical problems on the topics studied
Pre-Requisite	
1.	Electric Machine-I (PC-EE-401)
2.	Electric Machine-II (PC-EE-501)

Unit	Content	Hrs	Marks
1	**Introduction:** Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	09	
2	**Electric Trains:** Electric Drive-trains: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	10	
3	**Energy Storage:** Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching	09	

	the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems		
4	**Energy Management Strategies:** Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.	06	
5	**Case Studies:** Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	05	

Text book:

1. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press.
2. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons.
3. Electric and Hybrid Vehicles: Khanna Publishing House.
4. Hybrid Electric Vehicles: Energy Management Strategies, Onori Simona, Serrao Lorenzo and Rizzoni Giorgio, Springer.
5. Electric and Hybrid Vehicles, T. Denton, Routledge.

Reference books

1. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi CRC Press, 2004.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the principle of Electric traction.
2. choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
3. design and develop basic schemes of electric vehicles and hybrid electric vehicles.
4. choose proper energy storage systems for vehicle applications
5. implement different energy management strategies for hybrid vehicle.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**POWER QUALITY AND FACTS**
Course Code: PE-EE-602B	**Semester: 6th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:	
1.	To understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.
2.	To understand the working principles of FACTS devices and their operating characteristics.
3.	To understand the basic concepts of power quality.
4.	To understand the working principles of devices to improve power quality.
5.	To solve numerical problems on the topics studied

Pre-Requisite	
1.	Power system-I (PC-EE-502)
2.	Control system (PC-EE-503)
3.	Power Electronics (PC-EE-504)

Unit	Content	Hrs	Marks
1	**Transmission Lines and Series/Shunt Reactive Power Compensation:** Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.	04	
2	**Thyristor-based Flexible AC Transmission Controllers (FACTS):** Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC. Fault Current Limiter.	06	
3	**Voltage Source Converter based (FACTS) controllers:** Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator. Fault Current Limiter.	08	

4	**Application of FACTS** : Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single-machine infinite bus system using a TCSC. Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM.	04	
5	**Power Quality Problems in Distribution Systems** : Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve.	04	
6.	**DSTATCOM**: Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters. Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques for DSTATCOM.	06	
7.	**Dynamic Voltage Restorer and Unified Power Quality Conditioner:** Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.	06	

Text book:

1. FACTS Controllers in Power Transmission and Distribution, N K. R. Padiyar, New Age International (P) Ltd. 2007.

Reference books

1. Understanding FACTS: Concepts and Technology of FACTS Systems, N. G. Hingorani and L. Gyugyi Wiley-IEEE Press, 1999.
2. Reactive Power Control in Electric Systems, T. J. E. Miller, John Wiley and Sons, New York, 1983.
3. Electrical Power Systems Quality", R. C. Dugan, McGraw Hill Education, 2012.
4. Electric Power Quality, G. T. Heydt , Stars in a Circle Publications, 1991

Course Outcome:

After completion of this course, the learners will be able to

1. analyse uncompensated AC transmission line.
2. explain the working principles of FACTS devices and their operating characteristics.
3. apply FACTS devices for power flow control and stabilty.
4. identify different issues of power quality in distribution system.
5. apply different compensation and control techniques for DSTATCOM
6. explain working principle of dynamic voltage restorer and UPQC

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Name of the course		**INDUSTRIAL ELECTRICAL SYSTEMS**	
Course Code: PE-EE-602C		**Semester: 6th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Credit Points: 3		Attendance: 05 Marks	
		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the electrical wiring systems with standard symbols , drawings and SLD for residential, commercial and industrial consumers		
2.	To understand various components of industrial electrical systems		
3.	To analyze and selec tthe proper size of various electrical system components		
4.	To understand methods of automation of Industrial Electrical Systems		
5.	To solve numerical problems on the topics studied		
Pre-Requisite			
1.	Power system-I (PC-EE-502)		
2.	Control system (PC-EE-503)		
3.	Power Electronics (PC-EE-504)		
Unit	Content	Hrs	Marks
1	**Electrical System Components:** LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices	06	
2	**Residential and Commercial Electrical Systems** :Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.	08	
3	**Illumination Systems** : Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.	06	
	Industrial Electrical Systems I: HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting		

4	of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.	06	
5	**Industrial Electrical Systems II:** DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.	06	
6.	**Industrial Electrical System Automation**: Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.	06	

Text book:

1. Electrical Wiring, Estimating & Costing, S. L. Uppal and G. C. Garg, Khanna publishers, 2008.
2. Electrical Design, Estimating & Costing, K. B. Raina, New age International, 2007.

Reference books

1. Electrical estimating and costing, S. Singh and R. D. Singh, Dhanpat Rai and Co., 1997.
2. Web site for IS Standards.
3. Residential Commercial and Industrial Systems, H. Joshi, McGraw Hill Education, 2008.

Course Outcome:

After completion of this course, the learners will be able to

1. Represent electrical wiring system for residential, commercial and industrial consumers.
2. Determine the rating of components of residential and commercial electrical systems.
3. Design lighting scheme for a residential and commercial premises.
4. Select transformer, switchgear, protection equipments for industrial electrical systems.
5. explain methods of automation of Industrial Electrical Systems
6. Solve numerical problems related to earthing system, lighting scheme, power factor correction.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course		**DIGITAL SIGNAL PROCESSING**	
Course Code: OE-EE-601A		**Semester: 6th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Credit Points: 3		Attendance: 05 Marks	
		End Semester Exam: 70 Marks	
Objective:			
1.	To understand sampling and reconstruction of signal		
2.	To understand the method of Z-transform and inverse Z- transform of signal and its properties		
3.	To understand Discrete Fourier Transform		
4.	To understand methods of design of Digital filters		
5.	To understand applications of Digital signal processing		
6.	To solve numerical problems on the topics studied		
Pre-Requisite			
1.	Electric circuit theory (PC-EE-301)		
2.	Control system (PC-EE-503)		
Unit	Content	Hrs	Marks
1	**Discrete-time signals and systems:** Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.	06	
2	**Z-transform:** z-Transform, Region of convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z- transforms.	06	
3	**Discrete Fourier Transform :** Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.	08	
4	**Design of Digital filters:** Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Bandstop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing	12	
	Applications of Digital Signal Processing: Correlation		

5	Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.	06	

Text book:

1. Digital Signal Processing-A computer based approach, S. Mitra, TMH
2. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis & M.G. Manslakis, PHI
3. Fundamental of Digital Signal Processing using MATLAB , Robert J. Schilling, S.L. Harris, Cengage Learning.

Reference books

1. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Learning
2. Digital Signal Processing, Chen, OUP
3. Digital Signal Processing, Johnson, PHI
4. Digital Signal Processing using MATLAB, Ingle, Vikas.
5. Digital Signal Processing, Ifeachor, Pearson Education.
6. Digital Signal Processing, A.V. Oppenhein & R.W. Shaffer, PHI
7. Theory and application of Digital Signal Processing, L.R. Rabiner & B. Gold, PHI
8. Digital Signal Processing, Ashok Ambarder, Cengage Learning.
9. Digital Signal Processing, S. Salivahanan, A. Vallavaris & C. Gnanpruja, TMH.
10. Xilinx FPGA user manual and application notes.

Course Outcome:

After completion of this course, the learners will be able to

1. represent signals mathematically in continuous and discrete-time and in the frequency domain.
2. analyse discrete-time systems using z-transform.
3. explain the Discrete-Fourier Transform (DFT) and the FFT algorithms.
4. design digital filters for various applications.
5. apply digital signal processing for the analysis of real-life signals.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**COMMUNICATION ENGINEERING**
Course Code: OE-EE-601B	**Semester: 6th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:	
1.	To understand the AM, FM and PM schemes with reference to SNR
2.	To understand the performance of ASK, FSK, PSK, BPSK, QPSK in a digital communication system
3.	To understand the source coding and channel coding schemes for a given communication link
4.	To understand the band width requirement and probability of error in various digital modulation systems
5.	To understand various digital modulation methods
6.	To solve numerical problems on the topics studied
Pre-Requisite	
1.	Analog Electronics (PC-EE 302)
2.	Digital Electronics (PC-EE 402)

Unit	Content	Hrs	Marks
1	**Elements of communication system:** The elements of a communication system, origin of noise and its effect, importance of SNR in system design. Basic principle of linear (AM) modulation, Generation of AM waves, Demodulation of AM wave. Basic principle of nonlinear (FM, PM) modulation. Generation of FM waves. Demodulation of FM waves. Sampling theorem, sampling rate, impulse sampling, reconstruction from samples, Aliasing. Analog pulse modulation-PAM (natural & flat topped sampling), PWM, PPM. Basic concept of Pulse code modulation, Block diagram of PCM, Multiplexing-TDM, FDM.	12	
2	**Digital transmission:** Concept of Quantization & Quantization error, Uniform quantizer, Non-uniform quantizer, A-law and μ -law. Encoding, coding efficiency. Line coding & properties, NRZ & RZ, AMI, Manchester coding, PCM, DPCM. Base band pulse transmission, Matched filter, error rate due to noise, ISI, Raised cosine function, Nyquist criterion for distortion-less base band binary transmission, Eye pattern, Signal power in binary digital signal.	08	
3	**Digital carrier modulation & demodulation technique:** Bit rate, Baud rate, Information capacity, Shanon's limit, M-ary encoding, Introduction to the different digital modulation techniques-ASK.FSK, PSK, BPSK, QPSK, mention of 8 BPSK, 16 BPSK.	10	

	Introduction to QAM, basic of 8 QAM, 16 QAM. Basic concept of Delta modulating, Adaptive delta modulation. Introduction to the concept DPCM. Basic concept of spread spectrum modulation.		
4	**Introduction to coding theory:** Introduction, News value & Information content, Entropy, Mutual information, Information rate, Shanon-Fano algorithm for encoding, Shanon's theorem-source coding theorem, Channel coding theorem, Information capacity theorem. Basic principle of Error control & coding.	08	

Text book:

1. An Introduction to Analog and Digital communication, Simon Haykin, Wiely India.
2. Analog communication system, P. Chakrabarti, Dhanpat Rai & Co.
3. Principle of digital communication, P. Chakrabarti, Dhanpat Rai & Co.
4. Modern Digital and Analog Communication systems, B.P. Lathi, Oxford university press

Reference books

1. Digital and Analog communication Systems, Leon W Couch II, Pearson Education Asia.
2. Communication Systems, A.B. Calson, Mc Graw Hill.
3. Communication Systems, R. Anand, Khanna Publications.

Course Outcome:

After completion of this course, the learners will be able to

1. compare the performance of AM, FM and PM schemes with reference to SNR
2. explain noise as a random process and its effect on communication receivers
3. evaluate the performance of ASK, FSK, PSK, BPSK, QPSK in a digital communication system
4. identify source coding and channel coding schemes for a given communication link
5. analyze various digital modulation methods
6. compute band width requirement and probability of error in various digital modulation systems

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**VLSI AND MICRO ELECTRONICS**
Course Code: OE-EE-603C	**Semester: 6th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:	
1.	To understand the concept of VLSI design
2.	To understand the basics of MOS structure
3.	To understand the process of VLSI fabrication
4.	To understand the principle of logic circuit design with hardware description language

Pre-Requisite	
1.	Analog Electronics (PC-EE 302)
2.	Digital Electronics (PC-EE 402)

Unit	Content	Hrs	Marks
1	**Introduction to VLSI Design**: VLSI Design Concepts, Moor's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI – basic idea only), Types of VLSI Chips (Analog & Digital VLSI chips, General purpose, ASIC, PLA, FPGA), Design principles (Digital VLSI – Concept of Regularity, Granularity etc), Design Domains (Behavioral, Structural, Physical), Y-Chart, Digital VLSI Design Steps.	08	
2	**MOS structure**: E-MOS & D-MOS, Charge inversion in E-MOS, Threshold voltage, Flat band voltage, Potential balance & Charge balance, Inversion, MOS capacitances. **Three Terminal MOS Structure:** Body effect **Four Terminal MOS Transistor**: Drain current, I-V characteristics. Current-voltage equations (simple derivation) **Scaling in MOSFET**: Short Channel Effects, General scaling, Constant Voltage & Field scaling **CMOS**: CMOS inverter, Simple Combinational Gates - NAND gate and NOR Gate using CMOS.	12	
3	**Micro-electronic Processes for VLSI Fabrication**: Silicon Semiconductor Technology- An Overview, Wafer processing, Oxidation, Epitaxial deposition, Ion-implantation & Diffusion, Cleaning, Etching, Photo-lithography – Positive & Negative photo-resist. **Basic CMOS Technology** – (Steps in fabricating CMOS), Basic n-well CMOS process, p-well CMOS process, Twin tub process, Silicon on insulator **Layout Design Rule**: Stick diagram with examples, Layout rules.	10	

4	**Hardware Description Language** – VHDL or Verilog Combinational & Sequential Logic circuit Design.	08	

Text book:

1. Digital Integrated Circuit, J.M.Rabaey, Chandrasan, Nicolic, Pearson Education.
2. CMOS Digital Integrated Circuit, S.M.Kang & Y.Leblebici, TMH.
3. Modern VLSI Design, Wayne Wolf, Pearson Education.
4. VHDL, Bhaskar, PHI.
5. Advance Digital Design Using Verilog , Michel D. Celliti, PHI

Reference books

1. Digital Integrated Circuits, Demassa & Ciccone, John Willey & Sons .
2. Modern VLSI Design: system on silicon, Wayne Wolf; Addison Wesley Longman Publisher
3. Basic VLSI Design, Douglas A. Pucknell & Kamran Eshranghian, PHI
4. CMOS Circuit Design, Layout & Simulation, R.J.Baker, H.W.Lee, D.E. Boyee, PHI
5. Digital System Design using VHDL, R. Anand, Khanna Publications.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the principle of design of VLSI circuits
2. explain different MOS structure with characteristics
3. apply different processes for VLSI fabrication
4. use programming language for the design of logic circuits
5. draw the stick diagram and layout for simple MOS circuits

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course		**ECONOMICS FOR ENGINEERS**	
Course Code: HM-EE-601		**Semester: 6th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Credit Points: 3		Attendance: 05 Marks	
		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the process of economic decision making		
2.	To understand th basic financial management aspects		
3.	To develop the skills to analyze financial statements		
4.	To understand the basic of accounting		
Pre-Requisite			
1.	Basic understanding of Engineering processes		
Unit	Content	Hrs	Marks
1	Economic Decisions Making – Overview, Problems, Role, Decision making process. Engineering Costs & Estimation – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - PerUnit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits.	06	
2	Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories & Computation, Time Value Of Money, Debt repayment, Nominal & Effective Interest. Present Worth Analysis : End-Of-Year Convention, Viewpoint Of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives. Cash Flow & Rate Of Return Analysis – Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate Of Return, Calculating Rate Of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Economic Analysis In The Public Sector - Quantifying And Valuing Benefits & drawbacks.	10	
3	Uncertainty In Future Events - Estimates And Their Use In Economic Analysis, Range Of Estimates, Probability, Joint Probability Distributions, Expected Value, Economic Decision Trees, Risk, Risk vs Return, Simulation, Real Options. Depreciation - Basic Aspects, Deterioration & Obsolescence, Depreciation And Expenses, Types Of Property, Depreciation	10	

	Calculation Fundamentals, Depreciation And Capital Allowance Methods, Straight-Line Depreciation Declining Balance Depreciation, Common Elements Of Tax Regulations For Depreciation And Capital Allowances.		
4	Replacement Analysis - Replacement Analysis Decision Map, Minimum Cost Life Of A New Asset, Marginal Cost, Minimum Cost Life Problems. Inflation And Price Change – Definition, Effects, Causes, Price Change With Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.	08	
5	Accounting – Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.	06	

Text book:

1. Sociology & Economics for Engineers, Premvir Kapoor, Khanna Publishing House.
2. Engineering Economics, James L.Riggs, David D. Bedworth, Sabah U. Randhawa 4e , McGraw-Hill Education.
3. Engineering Economics Analysis, Donald Newnan, Ted Eschembach, Jerome Lavelle , OUP
4. Principle of Engineering Economic Analysis, John A. White, Kenneth E.Case,David B.Pratt , Wiley

Reference books

1. Engineering Economy, Sullivan and Wicks, Koelling, Pearson
2. Engineering Economics, R.Paneer Seelvan, PHI
3. Engineering Economics Analysis, Michael R Lindeburg, ,Professional Pub

Course Outcome:

After completion of this course, the learners will be able to

1. evaluate the economic theories, cost concepts and pricing policies
2. explain the market structures and integration concepts
3. apply the concepts of financial management for project appraisal
4. explain accounting systems , the impact of inflation, taxation, depreciation
5. analyze financial statements using ratio analysis
6. explain financial planning, economic basis for replacement, project scheduling, legal and regulatory issues applied to economic investment and project-management problems

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**POWER SYSTEM-II LABORATORY**
Course Code: PC-EE 691	**Semester: 6th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 0 hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Study on the characteristics of on load time delay relay and off load time delay relay.
2.	Test to find out polarity, ratio and magnetization characteristics of CT and PT.
3.	Test to find out characteristics of (a) under voltage relay (b) earth fault relay.
4.	Study on DC load flow
5.	Study on AC load flow using Gauss-seidel method
6.	Study on AC load flow using Newton Raphson method.
7.	Study on Economic load dispatch.
8.	Study of different transformer protection schemes by simulation
9.	Study of different generator protection schemes by simulation
10.	Study of different motor protection schemes by simulation

11.	Study of different characteristics of over current relay.
12.	Study of different protection scheme for feeder.

Institute may develop experiments based on the theory taught in addition to experiments mentioned.

Course outcome: After completion of this course, the learners will be able to

1. Identify appropriate equipment and instruments for the experiment.
2. Test the instrument for application to the experiment.
3. Construct circuits with appropriate instruments and safety precautions.
4. Validate the characteristics of under voltage relay, over current relay, earth fault relay, on load time delay relay, off load time delay relay, CT and PT.
5. Validate protection schemes of transformer, generator, motor and feeder.
6. Apply software tools to find bus voltage, currents and power flows throughout the electrical system.
7. work effectively in a team

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**MICRO PROCESSOR AND MICRO CONTROLLER LABORATORY**
Course Code: PC-EE 692	**Semester: 6th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 0 hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Programs for 16 bit arithmetic operations for 8086 (using various addressing modes)
2.	Program for sorting an array for 8086
3.	Program for searching for a number or character in a string for 8086
4.	Program for String manipulations for 8086
5.	Program for digital clock design using 8086.
6.	Interfacing ADC and DAC to 8086.
7.	Parallel communication between two microprocessors using 8255.
8.	Serial communication between two microprocessor kits using 8251.
9.	Interfacing to 8086 and programming to control stepper motor.
10.	Programming using arithmetic, logical and bit manipulation instructions of 8051
11.	Program and verify Timer/Counter in 8051.

12.	Program and verify interrupt handling in 8051.
13.	UART operation in 8051.
14.	Interfacing LCD to 8051.
15.	Interfacing matrix or keyboard to 8051.
16.	Data transfer from peripheral to memory through DMA controller 8237/8257

Institute may develop experiments based on the theory taught in addition to experiments mentioned.

Course outcome: After completion of this course, the learners will be able to

1. identify appropriate equipment and instruments for the experiment
2. test the instrument for application to the experiment
3. construct circuits with appropriate instruments and safety precautions
4. program 8086 for arithmatic operation, sorting of array, searching for a number in a string and string manipulation
5. interface ADC/DAC, 8255, 8251 to 8086 and LCD, keyboard to 8051
6. program 8051 using arithmatic, logical and bit manipulation instructions of 8051
7. work effectively in a team

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**ELECTRICAL AND ELECTRONICS DESIGN LABORATORY**
Course Code: PC-EE 681	**Semester: 6th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 1hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 4 hrs/week	
Credit Points:3	

	GROUP A
1.	Designing a heating element with specified wattage, voltage and ambient temperature.
2.	Designing an aircore grounding reactor with specified operating voltage, nominal current and fault current
3.	Designing the power distribution system for a small township
4.	Designing a double circuit transmission line for a given voltage level and power (MVA) transfer.
5.	Wiring and installation design of a multistoried residential building (G+4,not less than 16 dwelling flats with a lift and common pump)
	GROUP B
6.	Designing an ONAN distribution transformer.
7.	Designing a three phase squirrel cage induction motor.
8.	Designing a three phase wound rotor induction motor.
9.	Designing a split phase squirrel cage induction motor for a ceiling fan or a domestic pump.
10.	Designing a permanent magnet fractional hp servo motor .
	GROUP C

11.	Design the control circuit of a Lift mechanism
12.	Design a controller for speed control of DC machine.
13.	Design a controller for speed control of AC machine.
14.	Electronic system design employing electronic hardware (Analog, Digital, Mixed signal), microcontrollers, CPLDs, and FPGAs, PCB design and layout leading to implementation of an application

Topics to be covered in the Lecture class:

1.	Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits; Introduction to electronic instrumentation and PC based data acquisition; Electronic system design, Analog system design, Interfacing of analog and digital systems, Embedded systems,; System assembly considerations..	01

Evaluation Method:

1. The students would INDIVIDUALLY design the equipment and systems as per specifications provided by the class teacher following established procedures.
2. For each student, one item from each of the three groups would be chosen.
3. For unspecified items of specification and or specifications of wires, cables etc., data should be taken by students from handbooks and Indian standard.
4. Students should spend the allotted periods for carrying out design computations.
5. Their attendance shall be recorded.
6. Students should maintain a dedicated bound notebook for recording design activities like calculations, formulae used, sketches, flowcharts etc. The notebook should be regularly submitted to the class teacher for review and signature.
7. Evaluation would be based on (i) Class attendance (20%), (ii) Design Note Book (30%) (iii) Design Report (30%) (iv) End of semester viva (20%,)

Institute may develop experiments based on the theory taught in addition to experiments mentioned.

Course outcome: After completion of this course, the learners will be able to

1. explain basic concept of measurement, noise in electronic system, sensor and signal conditioning circuits
2. implement PC based data acquisition systems
3. construct circuits with appropriate instruments and safety precautions
4. design heating elements, air core grounding reactor, power distribution system for small township, double circuit transmission line and Electric machines
5. do wiring and installation design of a multistoried residential building with lift and pump
6. design electronic hardware for controller of lift, speed of AC/DC motor, and for an application with analog, digital, mixed signal, microcontroller and PCB

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Semester-VII

Name of the course		**ELECTRIC DRIVE**	
Course Code: PC-EE 701		**Semester: 7th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand basic concept, classification and principle of operation of Electric Drive.		
2.	To understand methods of starting and braking of Electric Drive.		
3.	To understand methods of control of speed of DC and AC Drives.		
4.	To solve problem related to Electric Drive.		
Pre-Requisite			
1.	Basic Electrical Engineering (ES-EE-101)		
2.	Electric Machine-I (PC-EE-401)		
3.	Electric Machine-II(PC-EE-501)		
Unit	Content	Hrs	Marks
1	**Electric Drive:** Concept, classification, parts and advantages of electrical dives. Types of Loads, Components of load toques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion. Determination of moment of inertia, Steady state stability, Transient stability. Multi-quadrant operation of drives. Load equalization.	5	
2	**Motor power rating:** Thermal model of motor for heating and cooling, classes of motor duty, determination of motor rating for continuous, short time and intermittent duty, equivalent current, torque and power methods of determination of rating for fluctuating and intermittent loads. Effect of load inertia & environmental factors.	5	
3	**Stating of Electric Drives:** Effect of starting on Power supply, motor and load. Methods of stating of electric motors. Acceleration time, Energy relation during stating. Methods to reduce the Energy loss during starting. **Braking of Electric Drives:** Types of braking, braking of DC motor, Induction motor and Synchronous motor, Energy loss during braking,	6	
4	**DC motor drives:** Modeling of DC motors**,** State space modeling, block diagram & Transfer function, Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. Power factor, supply harmonics and ripple in motor	8	

	current. Chopper controlled DC motor drives. Closed loop control of DC Drives.		
5	**Induction motor drives:** Stator voltage variation by three phase controllers, Speed control using chopper resistance in the rotor circuit, slip power recovery scheme. Pulse width modulated inverter fed and current source inverter fed induction motor drive. Volts/Hertz Control, Vector or Field oriented control.	6	
6	**Synchronous motor drives:** Variable frequency control, Self Control, Voltage source inverter fed synchronous motor drive, Vector control.	5	
7	Introduction to Solar and Battery Powered Drive, Stepper motor, Switched Reluctance motor drive **Industrial application:** Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.	5	

Text books:

1. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.
2. Electric Drives, Vedam Subrahmanyam, TMH
3. A first course on Electrical Drives, S.K. Pillai, , New Age International Publication.

Reference books:

1. Electric motor drives, R. Krishnan, PHI
2. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education.
3. Electric Motor & Drives. Austin Hughes, Newnes.

Course Outcome: After completion of this course, the learners will be able to

1. explain the principle of operation of Electric Drive.
2. describe different methods of starting and braking of Electric Drive.
3. model and control DC Drive
4. control speed of Induction and Synchronous motors.
5. recommend drives for different applications.
6. estimate ratings, variables and parameters of Electric Drives.

Special Remarks (if any)

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course		**CONTROL SYSTEM DESIGN**	
Course Code: PE-EE 701 A		**Semester: 7th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand basic design specifications.		
2.	To understand design of control system in time domain, frequency domain and in State space.		
3.	To understand design of PID controllers		
4.	To solve problem related to design of control system.		
Pre-Requisite			
1.	Basic Electrical Engineering (ES-EE-101)		
2.	Control system (PC-EE-503)		
Unit	Content	Hrs	Marks
1	**Design Specifications:** Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response.	6	
2	**Design of Classical Control System in the time domain:** Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.	8	
3	**Design of Classical Control System in frequency domain:** Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.	8	
4	**Design of PID controllers:** Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.	6	
5	**Control System Design in state space:** Review of state space representation. Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.	8	
6	**Nonlinearities and its effect on system performance:** Various types of non-linearities. Effect of various non-linearities on system	4	

	performance. Singular points. Phase plot analysis.		

Text books:

1. Control System Engineering, N. Nise, 8th Edition, John Wiley, 2019.
2. Control System Engineering, , I. J. Nagrath and M. Gopal, New Age International Publishers, 2018.
3. Design of Feedback Control Systems, R.T. Stefani and G.H. Hostetter , Saunders College Pub, 1994.
4. Linear control system analysis and design (conventional and modern), John J .D'azzo, C.H. Houpis, McGraw Hill, 1995.

Reference books:

1. Digital Control Engineering, M. Gopal , New Age International Publishers, 2014.
2. Automatic Control system, B. C. Kuo, F. Golnaraghi, Wiley, 2014.
3. Modern Control Engineering, K. Ogata, 5th Edition, Prentice Hall, 2010.

Course Outcome: After completion of this course, the learners will be able to

1. explain the effect of gain, addition of pole and zeros on system's performance.
2. describe time domain and frequency domain design specifications.
3. demonstrate the effect of nonlinearity on system performance.
4. design control system in time domain , in frequency domain and in state space.
5. design PID controllers.
6. select appropriate method for design of control system.

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Special Remarks (if any)

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course		**ELECTRICAL ENERGY CONSERVATION & AUDITING**	
Course Code: PE-EE 701B		**Semester: 7th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the basic of energy resources, energy security, energy conservation and pollution.		
2.	To understand the energy management concepts.		
3.	To understand energy conservation principles and measures		
4.	To learn the methods of energy audit and usage of instruments		
Pre-Requisite			
1.	Basic Electrical Engineering (ES-EE-101)		
2.	Electric Machine (PC-EE-401, PC-EE-501)		
3.	Electric Power system (PC-EE-502, PC-EE-601)		
4.	Control System (PC-EE-503)		
Unit	Content	Hrs	Marks
1	**Energy Scenario:** Commercial and Non-commercial energy, Primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.	5	
2	**Basics of Thermal Energy management :** Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.	5	
3	**Energy Management & Audit:** Definition, energy audit, need, types of energy audit. Energy management (audit) approach, understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.	6	
4	**Energy Efficiency in Electrical Systems:** Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Performance	8	

	assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.		
5	**Energy Efficiency in Industrial Systems:** Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.	10	
6	**Energy Efficient Technologies in Electrical Systems:** Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.	6	

Text books:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)
3. Electric Energy Utilization and Conservation, S. C. Tripathy, Tata McGraw Hill, 1991.

Reference books:

1. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

Course Outcome: After completion of this course, the learners will be able to

1. explain the basic of energy resources, energy security, energy conservation and pollution.
2. quantify the energy conservation opportunities in different thermal systems
3. quantify the energy conservation opportunities in different electrical systems
4. identify the common energy conservation opportunities in different energy intensive industrial equipments
5. explain the methods of energy management and audit.
6. analyse and report the outcome of energy audit.

Special Remarks (if any) The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Name of the course		**POWER GENERATION ECONOMICS**	
Course Code: PE-EE 701C		**Semester: 7th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the basics of economics of Power generation.		
2.	To understand different methods of Tariff.		
3.	To understand the optimization with unit commitment in power system.		
4.	To understand the principle of economic load dispatch.		
5.	To understand the method of state estimation and load forecasting in a power system.		
Pre-Requisite			
1.	Electric Power system-I (PC-EE-502)		
2.	Electric Power system-II (PC-EE-601)		
Unit	Content	Hrs	Marks
1	**Economics of Generation:** Cost of power generation- Thermal, Hydro and Nuclear. Types of Consumers in a distribution system- Domestic, Commercial, Industrial etc. Concept of load factor, plant capacity factor, plant use factor, diversity factor, demand factor. Choice of size and number of generation units.	07	
2	**Tariff:** Block rate, flat rate, two part, maximum demand, Power factor and three part tariffs. Subsidization and Cross subsidization. Availability tariff of generation companies. Pool tariff of transmission companies. Availability based tariff (ABT).	08	
3	**Unit Commitment:** Constraints in Unit Commitment, Spinning reserve, Thermal unit constraints, Hydro constraints, Must run, Fuel constraints. Unit commitment solution methods,	07	
4	**Economic Dispatch**: Transmission loss formulae and its application in economic load scheduling. Computational methods in economic load scheduling. Active and reactive power optimization	08	
5	**State Estimation and load forecasting in power system:** Introduction, state estimation methods, concept of load forecasting, load forecasting technique and application in power system.	08	

Text books:

1. Economic operation of Power System, L.K. Kirchmayar Wiely India Pvt. Ltd, 2009
2. Power system Analysis, operation & control, A. Chakrabarty & S. Haldar, PHI, 2010.
3. Modern power system analysis, D.P. Kothari & I.J. Nagtrath, Tata McGraw Hill, 2007.

Reference books:

1. Power generation operation & control, A.J. Wood & B.F. Wollenberg, G.B. Sheble, Wiley, 2013
2. Operation and control in power system, P.S.R. Murthy, BSP Publication. 2009

Course Outcome: After completion of this course, the learners will be able to

1. explain the different terms e.g. load factor etc for economics of generation.
2. apply different types of tariff for electricity pricing.
3. optimize the operation of power system with unit commitment.
4. determine generation levels such that the total cost of generation becomes minimum for a defined level of load.
5. determine the state of the system given by the voltage magnitudes and phase angles at all buses,
6. predict the power or energy needed to balance the supply and load demand at all the times.

Special Remarks (if any)

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**ARTIFICIAL INTELLIGENCE**
Course Code: OE-EE-701A	**Semester: 7th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:	
1.	To understand the basic concepts, theories and state-of-the-art techniques of artificial intelligence.
2.	To understand basic concepts and applications of machine learning.
3.	To learn the application of machine learning /A.I algorithms in the different fields of science, medicine, finance etc.
Pre-Requisite	
1.	Programming for problem solving (ES-CS201)
2.	Mathematics (BS-M301)
3.	Data structure and algorithm(OE-EE-501A)

Unit	Content	Hrs	Marks
1	**Introduction:** Overview of Artificial intelligence- Problems of AI, AI technique, Tic - Tac - Toe problem. **Intelligent Agents**: Agents & environment, nature of environment, structure of agents, goal based agents, utility based agents, learning agents. **Problem Solving:** Problems, Problem Space & search: Defining the problem as state space search, production system, problem characteristics, issues in the design of search programs.	06	
2	**Search techniques**: Solving problems by Searching: problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies. **Heuristic search strategies:** Greedy best-first search, A* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search, genetic algorithms; constraint satisfaction problems, local search for constraint satisfaction problems. **Adversarial search :** Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening	12	
3	**Knowledge & reasoning:** Knowledge representation issues, representation & mapping, approaches to knowledge representation, issues in knowledge representation	05	

4.	**Using predicate logic:** Representing simple fact in logic, representing instant & ISA relationship, computable functions & predicates, resolution, natural deduction. Probabilistic reasoning [4] Representing knowledge in an uncertain domain, the semantics of Bayesian networks, Dempster-Shafer theory, Fuzzy sets & fuzzy logic	06	
5.	**Natural Language processing:** Introduction, Syntactic processing, semantic analysis, discourse & pragmatic processing. **Learning:** Forms of learning, inductive learning, learning decision trees, explanation based learning, learning using relevance information, neural net learning & genetic learning. **Expert Systems:** Representing and using domain knowledge, expert system shells, knowledge acquisition	08	

Text book:

1. Artificial Intelligence, K, Knight, E. Rich, S.B. Nair, 3rd Edition TMH
2. A classical approach to Artificial Intelligence, M.C. Trivedi, 2nd Edition, Khanna Publishing House, New Delhi
3. Introduction to Artificial Intelligence & Expert Systems, D.W. Patterson, PHI
4. Artificial Intelligence A Modern Approach, Stuart Russel, Peter Norvig, Pearson

Reference books

1. Computational Intelligence, D. Poole, Alan Mackworth, and Randy Goebe, lOUP
2. Logic & Prolog Programming, Saroj Kaushik, New Age International
3. Expert Systems principle and programming, J.C. Giarranto, Cengage Learing.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the concept of knowledge representation and predicate logic and transform the real life information in different representation
2. describe state space and its searching strategies
3. demonstrate profciency in applying scientifc method to models of machine learning
4. apply the machine learning concepts in real life problems
5. demonstrate an ability to share in discussions of AI, its current scope and limitations, and societal implications

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course	**INTERNET OF THINGS**
Course Code: OE-EE-701B	**Semester: 7th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:	
1.	To understand the terminology, technology and its applications
2.	To understand the concept of M2M (machine to machine) with necessary protocols
3.	To learn the Python Scripting Language which is used in many IoT devices.
4.	To understand the Raspberry PI platform, that is widely used in IoT applications.
5.	To understand the implementation of web based services on IoT devices.
Pre-Requisite	
1.	Programming for problem solving (ES-CS201)

Unit	Content	Hrs	Marks
1	**Introduction to Internet of Things:** Definition and characteristics of IoT, Physical design of IoT – IoT Protocols, IoT communication models, Iot Communication APIs, IoT enabled technologies – Wireless sensor networks, Cloud computing, Big data analytics, Communication protocols, Embedded systems, IoT levels and templates, Domain specific IoTs – Home, City, Environment, Energy, Retail, Logistics, Agriculture, Industry, health and Lifestyle.	08	
2	**IoT and M2M:** Software defined networks, network function virtualization, difference between SDN and NFV for IoT. Basics of IoT System Management with NETCOZF, YANG- NETCONF, YANG, SNMP NETOPEER	06	
3	**Introduction to Python:** Language features of Python, Data types, data structures, Control of flow, functions, modules, packaging, file handling, data/time operations, classes, Exception handling. Python packages - JSON, XML, HTTP Lib, URL Lib, SMTP Lib.	08	
4.	**IoT Physical Devices and Endpoints:** Introduction to Raspberry PI - Interfaces (serial, SPI, I2C). Programming – Python program with Raspberry PI with focus of interfacing external gadgets, controlling output, reading input from pins.	08	
5.	**IoT Physical Servers and Cloud Offerings:** Introduction to Cloud Storage models and communication APIs. Webserver – Web server for IoT, Cloud for IoT, Python web application framework. Designing a RESTful web API	08	

Text book:

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015.
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2016.
3. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things**,** David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, Pearson Education, 2017.
4. Internet of Things, K.G. Srinivasa , G.M. Siddesh, R.R. Hanumantha, CENGAGE Leaning India, 2018

Reference books:

1. Internet of Things (A Hands-on-Approach), Arshdeep Bahga and Vijay Madisetti, VPT, 2014.
2. Internet of Things: Architecture and Design Principles, Raj Kamal , McGraw Hill Education, 2017.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the definition and usage of the term “Internet of Things” in different contexts
2. explain the key components that make up an IoT system.
3. differentiate between the levels of the IoT stack and be familiar with the key technologies and protocols employed at each layer of the stack
4. build and test a IoT system involving prototyping, programming and data analysis
5. apply cloud computing and data analytics in a typical IoT system

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

Maulana Abul Kalam Azad University of Technology, West Bengal

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(Applicable from the academic session 2018-2019)

Name of the course		**COMPUTER GRAPHICS**	
Course Code: OE-EE-701C		**Semester: 7th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Credit Points: 3		Attendance: 05 Marks	
		End Semester Exam: 70 Marks	
Objective:			
1.	To understand fundamental concepts and theory of computer graphics		
2.	To understand the concept of graphics systems, input devices, geometric representations, 2D/3D transformations, viewing and projections and visible surface detection.		
Pre-Requisite			
1.	Programming for problem solving (ES-CS201)		
2.	Mathematics (BS-M301)		
3.	Data structure and algorithm(OE-EE-501A)		
Unit	Content	Hrs	Marks
1	**Introduction to Computer graphics & graphic systems:** Overview of computer graphics, representing pictures, preparing, presenting & interacting with pictures for presentations; Visualization & image processing; RGB color model, direct coding, lookup table; storage tube graphics display, Raster scan display, 3D viewing devices, Plotters, printers, digitizers, Light pens etc.; Active & Passive graphics devices; Computer graphics software.	06	
2	**Scan conversion:** Points & lines, Line drawing algorithms; DDA algorithm, Bresenham's line algorithm, Circle generation algorithm; Ellipse generating algorithm; scan line polygon, fill algorithm, boundary fill algorithm, flood fill algorithm.	05	
3	**2D Transformations and viewing:** Basic transformations: translation, rotation, scaling; Matrix representations & homogeneous coordinates, transformations between coordinate systems; reflection shear; Transformation of points, lines, parallel lines, intersecting lines. Viewing pipeline, Window to view port co-ordinate transformation, clipping operations, point clipping, line clipping, clipping circles, polygons & ellipse. Cohen and Sutherland line clipping, Sutherland-Hodgeman Polygon clipping, Cyrus-beck clipping method **3D transformation & viewing:** 3D transformations: translation, rotation, scaling & other transformations. Rotation about an arbitrary axis in space, reflection through an arbitrary plane; general parallel projection transformation; clipping, view port clipping, 3D viewing	12	
4	**Plane Curves and Surfaces:** Curve Representation, Nonparametric Curves, Parametric Curves, Parametric Representation of a Circle, Parametric Representation of an Ellipse, Parametric Representation	06	

	of a Parabola, Parametric Representation of a Hyperbola, A Procedure for using Conic Sections, The General Conic Equation; Representation of Space Curves, Cubic Splines, , Bezier Curves, B-spline Curves, B-spline Curve Fit, B-spline Curve Subdivision, Parametric Cubic Curves, Quadric Surfaces. Bezier Surfaces		
5	**Visible-Surface Determination:** Techniques for efficient Visible-Surface Algorithms, Categories of algorithms, Back face removal, The z-Buffer Algorithm, Scan-line method, Painter's algorithms (depth sorting), Area sub-division method, BSP trees, Visible-Surface Ray Tracing, comparison of the methods.	06	
6	**Color & shading models :** Light & color model; interpolative shading model; Texture. **Introduction to Ray-tracing:** Human vision and color, Lighting, Reflection and transmission models	05	

Text book:

1. Computer Graphics (C version), Hearn, Baker, Pearson Education, 2002
2. Schaum's outlines Computer Graphics , Z. Xiang, R. Plastock , McGraw Hill Education, 2000.
3. Mathematical Elements for Computer Graphics, D. F. Rogers, J. A. Adams, McGraw Hill Education, 2017.

Reference books:

1. Computer Graphics, Multimedia and Animation, M.K. Pakhira, PHI, 2010.

Course Outcome:

After completion of this course, the learners will be able to

1. explain Computer graphics and graphic systems.
2. test and implement line drawing algorithm, circle and ellipse drawing algorithm, area filling algorithms.
3. Perform 2D and 3D transformation and viewing.
4. apply algorithms for visible surface determination.
5. explain colors and shading models and ray tracing.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**EMBEDDED SYSTEM**
Course Code: OE-EE 702A	**Semester: 7th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:	
1.	To understand fundamental concepts of design principles of embedded system.
2.	To understand the role of firmware, operating systems in correlation with hardware systems.
Pre-Requisite	
1.	Programming for problem solving (ES-CS 201)
2.	Micro processor & Micro controller (PC-EE 602)

Unit	Content	Hrs	Marks
1	**Introduction to Embedded Systems:** Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.	05	
2	**Typical Embedded System:** Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Interfacing techniques, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.	07	
3	**Advanced Embedded Microcontrollers:** PIC Microcontrollers: Overview and features; PIC 16C6X/7X - File Selection Register (FSR), PIC Reset Actions, PIC Oscillator connections, PIC Memory Organization, PIC 16C6X/7X instructions, Addressing Modes, I/O Ports, Interrupts in PIC 16C61/71, Timers. PIC 16F8XX Flash Microcontroller – Introduction, Pin diagram, Registers, Memory organization, Interrupts, I/O Ports, Timers. Introduction to AVR microcontroller: Introduction to AVR (ATmega 328p-pu) microcontroller, pin layout, architecture, program memory, Data Direction register, Port Registers (PORTx), PWM registers (8-bit), ADC registers. Introduction to ARM microcontroller: Architecture of ARM Embedded microcontroller, ARM instruction sets.	12	
4	**Embedded Firmware:** Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.	06	
5	**RTOS Based Embedded System Design:** Operating System	10	

	Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.		

Text book:

1. Introduction to Embedded Systems, Shibu K.V, Mc Graw Hill. 2017

Reference books:

1. Embedded Systems – Architecture, Programming and design, Raj Kamal, McGraw Hill Education, 2017
2. Embedded System Design: A unified Hardware/ Software introduction, Tony Givargis and Frank Vahid, Wiley 2006
3. Design with PIC Microcontrollers , J. B. Peatman, Pearson India,2008
4. Microcontrollers (Theory and Applications) – A. V. Deshmukh, TMH Education Private Limited, 2017
5. Programming and Customizing the AVR Microcontroller, Dhananjay Gadre, McGraw Hill Education, 2014.

Course Outcome:

After completion of this course, the learners will be able to

1. discuss the definition, purpose, application, classification , quality characteristics and attributes of Embedded Systems
2. explain the internal structure of the Embedded system.
3. interface IO devices and other peripherals with micro controllers in Embedded systems.
4. write programs for Micro controllers in Embedded systems.
5. apply the concept of Embedded firmware in design of Embedded systems.
6. design RTOS based Embedded systems.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Name of the course	**DIGITAL IMAGE PROCESSING**
Course Code: OE-EE 702B	**Semester: 7th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:	
1.	To understand fundamentals and mathematical transforms necessary for image processing.
2.	To understand the image enhancement techniques.
3.	To understand the image restoration procedures.
4.	To understand the image compression procedures.
Pre-Requisite	
1.	Digital Signal Processing (OE-EE 601A)

Unit	Content	Hrs	Marks
1	**Introduction:** Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Sampling and Quantization, Representing Digital Images (Data structure), Some Basic Relationships Between Pixels- Neighbors and Connectivity of pixels in image, Applications of Image Processing: Medical imaging, Robot vision, Character recognition, Remote Sensing.	08	
2	**Image Enhancement In The Spatial Domain**: Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.	08	
3	**Image Enhancement In Frequency Domain:** Introduction, Fourier Transform, Discrete Fourier Transform (DFT), properties of DFT, Discrete Cosine Transform (DCT), Image filtering in frequency domain.	08	
4	**Image Segmentation:** Introduction, Detection of isolated points, line detection, Edge detection, Edge linking, Region based segmentation- Region growing, split and merge technique, local processing, regional processing, Hough transform, Segmentation using Threshold.	08	
5	**Image Compression:** Introduction, coding Redundancy , Inter-pixel redundancy, image compression model, Lossy and Lossless compression, Huffman Coding, Arithmetic Coding, LZW coding, Transform Coding, Sub-image size selection, blocking, DCT implementation using FFT, Run length coding.	08	

Text book:

1. Digital Image Processing, R.C Gonzalez and R. Woods, Pearson publication, 2017
2. Digital Image Processing, Anil K. Jain, Prentice-Hall, India, 1988.

Reference books:

1. Digital Image Processing, W.K. Pratt , John Wiley & Sons, 1991.
2. Digital Image Processing and Analysis, B. Chanda & D. Dutta Majumder Prentice-Hall India, 2011
3. Image Processing- Theory, Algorithms & Architecture, M. A. Sid-Ahmed, McGraw-Hill, 1994.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the fundamental concepts of a digital image processing system.
2. enhance images in the spatial and frequency domain using various transforms.
3. apply different image segmentation techniques.
4. categorize various compression techniques.
5. implement image process and analysis algorithms.
6. apply image processing algorithms in practical applications.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**COMPUTER NETWORK**
Course Code: OE-EE 702C	**Semester: 7th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:	
1.	To understand the fundamental concepts of data communication and computer networking.
2.	To understand different layers of OSI, TCP/IP model in networking.
Pre-Requisite	
1.	Data Structure and Algorithm (OE-EE 501A)
2.	Operating System

Unit	Content	Hrs	Marks
1	**Overview of Data Communication and Networking:** Introduction, Data communications: components, data representation (ASCII, ISO etc.), direction of data flow (simplex, half duplex, full duplex); network criteria, physical structure (type of connection, topology), categories of network (LAN, MAN,WAN); Internet: brief history, Protocols and standards; Reference models: OSI reference model, TCP/IP reference model, their comparative study.	06	
2	**Physical Level:** Overview of data (analog & digital), signal (analog & digital), transmission (analog & digital) & transmission media (guided & unguided); Circuit Switching: time division & space division switch, TDM bus; Telephone Network.	04	
3	**Data link Layer:** Types of errors, framing (character and bit stuffing), error detection & correction methods; Flow control; Protocols: Stop & wait ARQ, Go-Back-N ARQ, Selective repeat ARQ, HDLC. **Medium Access sub layer:** Point to Point Protocol, LCP, NCP, Token Ring; Reservation, Polling, Multiple access protocols: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA Traditional Ethernet, fast Ethernet (in brief).	10	
4	**Network layer:** Internetworking & devices: Repeaters, Hubs, Bridges, Switches, Router, Gateway; Addressing : IP addressing, sub netting; Routing : techniques, static vs. dynamic routing , Unicast Routing Protocols: RIP, OSPF, BGP; Other Protocols: ARP, IP, ICMP, IPV6. **Transport layer:** Process to Process delivery; UDP; TCP; Congestion Control: Open Loop, Closed Loop choke packets; Quality of service: techniques to improve QoS: Leaky bucket algorithm, Token bucket algorithm	12	

5	**Application Layer:** Introduction to DNS, SMTP, SNMP, FTP, HTTP & WWW; Security: Cryptography (Public, Private Key based), Digital Signature, Firewalls. **Modern topics:** ISDN services & ATM, DSL technology, Cable Modem: Architecture and operation in brief. Wireless LAN: IEEE 802.11, Introduction to blue-tooth.**:**	08	

Text book:

1. Data Communications and Networking , A. Forouzan , TMH, 2004
2. Computer Networks , A. S. Tanenbaum, Pearson Education, 2003.
3. Data and Computer Communications (5th Ed.), W. Stallings, Pearson Education, 2017.

Reference books:

1. Communication Networks, Leon, Garica, Widjaja, McGraw Hill, 2017.
2. High performance Communication Networks, Walrand, Elsvier India, 2004.
3. Internetworking with TCP/IP, vol. 1, 2, 3, Comer, Pearson Education, 2000.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the concepts of data communication and networking.
2. identify the different types of network topologies and protocols.
3. describe the function of a network system with OSI and TCP/IP model.
4. differentiate different types of routing protocol.
5. apply principles of congestion control .
6. implement different schemes for security of the networks.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course		**PRINCIPLE OF MANAGEMEENT**	
Course Code: HM-EE 701		**Semester: 7th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand basic concept and approaches to management.		
2.	To understand planning and decision making processes. .		
3.	To understand organizational design and structure.		
4.	To understand various aspects of leadership.		
Pre-Requisite			
1.	English (HM- HU 201)		
Unit	Content	Hrs	Marks
1	**Concept & approaches to management:** Meaning & Definition of the term Management, Management as a Science or an Art, Management as a Profession, Management as a Process, Difference between Management & Administration; Levels of Management, Roles of a Manager, Quality of a good Manager, Significance of Management, Limitations of Management, Business Environment and its interaction with Management. Approaches to Management – Classical, Neo-classical and Modern Contributors to Management Thought – Taylor and Scientific Theory, Fayol's and Administrative Theory, Peter Drucker and Management Thought. Various Approaches to Management (i.e. Schools of Management Thought) Indian Management Thought	8	
2	**Planning & decision making:** Planning: Meaning, Definition, Process, Types, Principles, Significance & Limitations of Planning; Strategic Planning – Meaning & Process, MBO – Meaning, Process and Requirements for Implementation, Planning Premises – Meaning & Types, Forecasting – Meaning & Techniques. Decision Making – Meaning, Types, Process, Significance & Limitations	8	
3	**Organization design & Structure:** Organization – Meaning, Process, Principles, Organization Structure – Determinants and Forms: Line, Functional, Line & Staff, Project, Matrix and Committees; Formal and Informal Organization; Departmentation – Meaning and Bases; Span of Control – Meaning and Factors Influencing; Authority, Responsibility and Accountability; Delegation – Meaning, Process; Principles; Centralization and Decentralization – Meaning; Degree	8	

	of Decentralization; Difference between Delegation and Decentralization.		
4	**Directing:** Motivation – Meaning , Definition, Significance & Limitations; Financial and non-financial incentives of Motivation Leadership - Meaning, Definition, Significance of Leadership, Leadership styles Type, Process and Barriers of Communication, Strategies to overcome the Barriers.	8	
5	**Customer Management** – Market Planning & Research, Marketing Mix, Advertising & Brand Management. **Operations & Technology Management** – Production & Operations Management, Logistics & Supply Chain Management, TQM, Kaizen & Six Sigma, MIS.	8	

Text books:

1. Essentials of Management. H. Koontz and H. Weihrich , 7th Edition, Tata McGraw Hill
2. Principles of Management, Premvir Kapoor, Khanna Publishing House, 2019
3. Principles of Management - Text and Cases, Dipak Kumar Bhattacharyya. Pearson Education India, 2011.

Reference books:

1. Management-Text & Cases, V.S.P Rao & Hari V. Krishna, Excel Books, 2005
2. Principles of Management, T. Ramaswami, Himalaya Publishing House, 2014
3. Management of Technology and Operations, R. Ray Gehani, Wiley, 1998

Course Outcome: After completion of this course, the learners will be able to

1. explain the concepts and approaches of management.
2. demonstrate the roles, skills and functions of management.
3. diagnose and solve organizational problems.
4. identify the complexities associated with management of human resources in the organizations and integrate the learning in handling these complexities.
5. apply different methods of Customer, Operation and Technology management.
6. acquire skills of good leader in an organization.

Special Remarks (if any)

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course	**ELECTRIC DRIVE LABORATORY**
Course Code: PC-EE 791	**Semester: 7th**
Duration: 6 months	**Maximum marks:100**
Teaching Scheme	**Examination scheme:**
Theory: 0 hr/week	**Continuous Internal Assessment:40**
Tutorial: 0 hr/week	**External Assessment: 60**
Practical: 2 hrs/week	
Credit Points:1	

	Laboratory Experiments:
1.	Study of speed control of Thysistor controlled DC Drive.
2.	Study of speed control of Chopper fed DC Drive
3.	Study of speed control of single phase motor using TRIAC.
4.	Study of PWM Inverter fed 3 phase Induction Motor control using software.
5.	Study of VSI / CSI fed Induction motor Drive using software.
6.	Study of V/f control of 3phase Induction motor drive.
7.	Study of permanent magnet synchronous motor drive fed by PWM Inverter using Software.
8.	Study of Regenerative / Dynamic braking operation for DC Motor - Study using software.
9.	Study of Regenerative / Dynamic braking operation of AC motor - study using software.
10.	Study of PC/PLC based AC/DC motor control operation.

Institute may develop experiments based on the theory taught in addition to experiments mentioned.

Course outcome: After completion of this course, the learners will be able to

1. identify appropriate equipment and instruments for the experiment.
2. test the instrument for application to the experiment.
3. construct circuits with appropriate instruments and safety precautions.
4. apply different methods of control of Electric Drive in the laboratory.
5. analyse experimental data obtained in the laboratory.
6. work effectively in a team

Special Remarks: The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Semester-VIII

Name of the course		**UTILIZATION OF ELECTRIC POWER**	
Course Code: PC-EE 801		**Semester: 8th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand basic principle of illumination and good lighting practices		
2.	To understand the method of Electric heating, Welding and Electrolytic processes.		
3.	To understand the concepts of Electrical traction systems .		
4.	To solve numerical problems on the topics studied.		
Pre-Requisite			
1.	Electric Machine (PC-EE-401, PC-EE-501)		
2.	Control System (PC-EE-503)		
3.	Power Electronics (PC-EE-504)		
Unit	Content	Hrs	Marks
1	**Electric Traction :** Requirement of an ideal traction system, Supply system for electric traction, Train movement (speed time curve, simplified speed time curve, average speed and schedule speed), Mechanism of train movement (energy consumption, tractive effort during acceleration, tractive effort on a gradient, tractive effort for resistance, power & energy output for the driving axles, factors affecting specific energy consumption, coefficient of adhesion). Electric traction motor & their control: Parallel and series operation of Series and Shunt motor with equal and unequal wheel diameter, effect of sudden change of in supply voltage, Temporary interruption of supply, Tractive effort and horse power. Use of AC series motor and Induction motor for traction. Traction motor control: DC series motor control, Multiple unit control, Braking of electric motors, Electrolysis by current through earth, current collection in traction system, Power electronic controllers in traction system.	10	
2	**Electric Lighting:** Definition of terms; laws of illumination; Luminaries; Lighting requirements; Illumination levels; lamp selection and maintenance; Lighting schemes, calculations & design – Interior lighting – industrial, Factory, residential lighting; Exterior lighting - Flood, street lighting, lighting for displays and signaling - neon signs, LED-LCD displays beacons and lighting for surveillance; Energy Conservation codes for lighting; lighting controls – daylight sensors and occupancy sensors; controller design.	8	
3	**Electric Heating :** Advantages of electrical heating, Heating methods, Resistance heating – direct and indirect resistance heating, electric ovens, their temperature range, properties of resistance heating elements, domestic water heaters and other heating	08	

	appliances and thermostat control circuit ,Induction heating; principle of core type and coreless induction furnace , Electric arc heating, direct and indirect arc heating, construction, working and applications of arc furnace, Dielectric heating, applications in various industrial fields, Infra-red heating and its applications, Microwave heating, Simple design problems of resistance heating element.		
4	**Electric Welding:** Advantages of electric welding, Welding methods, Principles of resistance welding, types –spot, projection seam and butt, welding and welding equipment used , Principle of arc production, electric arc welding, characteristics of arc, carbon arc, metal arc, hydrogen arc welding and their applications, Power supply required ,Advantages of using coated electrodes, comparison between AC and DC arc welding, welding control circuits, welding of aluminum and copper, Introduction to TIG, MIG welding	08	
5	**Electrolytic processes:** Need of electro-deposition, Laws of electrolysis, process of electro-deposition - clearing, operation, deposition of metals, polishing, buffing, Equipment and accessories for electroplating, Factors affecting electro-deposition, Principle of galvanizing and its applications, Principle of anodising and its applications, Electroplating on non-conducting materials , Manufacture of chemicals by electrolytic process and electrolysis process.	06	

Text books:

1. Generation Distribution and Utilization of Electrical Energy, C.L. Wadhawa, New Age International Publishers, 2015
2. Art and Science of Utilization of Electrical Energy, H. Partab, Dhanpat Rai & co, 2017
3. Utilisation of Electric Energy, E.Openahaw Taylor, Universities press, 1981

Reference books:

1. Generation and Utilization of Electrical Energy by S. Sivanagaruju, Pearson, 2010.
2. Utilization of Electrical Energy by J. B. Gupta, Rajeev Manglik, Rohit Manglik, Kataria Publications, 2012.

Course Outcome: After completion of this course, the learners will be able to

1. explain the fundamentals of illumination and different lighting schemes.
2. explain the fundamental of Electrolytic processes, Electric heating and Welding.
3. able to select appropriate lighting, heating and welding techniques for specific applications.
4. apply different electrolysis process for different applications.
5. explain the principle of different aspect of Electric traction and control of traction motor.

Special Remarks (if any)

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Name of the course		**LINE COMMUTATED AND ACTIVE PWM RECTIFIERS**	
Course Code: PE-EE 801A		**Semester: 8th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the principle of operation of different converter circuits and filters		
2.	To understand the method of steady state analysis of converters.		
3.	To understand the different control techniques of the converters.		
4.	To understand the application of different converters. .		
Pre-Requisite			
1.	Control System (PC-EE-503)		
2.	Power Electronics (PC-EE-504)		
Unit	Content	Hrs	Marks
1	**Diode rectifiers with passive filtering:** Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current wave shape, effect of source inductance; commutation overlap.	5	
2	**Thyristor rectifiers with passive filtering:** Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3- phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape	5	
3	**Multi-Pulse converter:** Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.	6	
4	**Single-phase ac-dc single-switch boost converter:** Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure.	6	
5	**Ac-dc bidirectional boost converter:** Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.	6	
6	**Isolated single-phase ac-dc fly back converter:** Dc-dc fly back converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc fly back	08	

	converter, steady state analysis, unity power factor operation, closed loop control structure		

Text books:

1. Power Electronics: Converters, Applications and Design, N. Mohan and T. M. Undeland, John Wiley & Sons, 2007.
2. Power Electronics: Essentials and Applications, L. Umanand, Wiley India, 2009
3. Principles of Power Electronics, J.G. Kassakian, M. F. Schlecht and G. C. Verghese, Addison-Wesley, 1991.

Reference books:

1. Fundamentals of Power Electronics, R. W. Erickson and D. Maksimovic, Springer Science & Business Media, 2001.

Course Outcome: After completion of this course, the learners will be able to

1. explain the principle of operation of different converters.
2. suggest the application of different filters.
3. apply converters for different applications.
4. analyze converter circuits.
5. develop appropriate scheme for control of different converters.
6. solve numerical problems relating to different converters.

Special Remarks (if any)

The above mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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Syllabus for B. Tech in Electrical Engineering

(Applicable from the academic session 2018-2019)

Name of the course		**POWER SYSTEM DYNAMICS AND CONTROL**	
Course Code: PE-EE 801B		**Semester: 8th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand power stability problems and the basic concepts of modeling and analysis of dynamical systems.		
2.	To understand the Modeling of power system components - generators, transmission lines, excitation and prime mover controllers.		
3.	To understand the Stability of single machine and multi-machine systems using digital simulation and small-signal analysis techniques.		
4.	To understand the impact of stability problems on power system planning, and operation.		
Pre-Requisite			
1.	Power System (PC-EE-502, PC-EE-601)		
2.	Control System (PC-EE-503)		
3.	Electric Machine(PC-EE-401, PC-EE501)		
Unit	Content	Hrs	Marks
1	**Introduction to Power System Operations:** Introduction to power system stability. Power System Operations and Control. Stability problems in Power System. Impact on Power System Operations and control.	3	
2	**Analysis of Linear Dynamical System and Numerical Methods :** Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability. Modal Analysis of Linear System. Analysis using Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System.	5	
3	**Modeling of Synchronous Machines and Associated Controllers:** Modeling of synchronous machine: Physical Characteristics. Rotor position dependent model. D-Q Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. Short Circuit Transient Analysis of a Synchronous Machine. Synchronization of Synchronous Machine to an Infinite Bus. Modeling of Excitation and Prime Mover Systems. Physical Characteristics and Models. Excitation System Control. Automatic Voltage Regulator. Prime Mover Control Systems. Speed Governors.	10	
4	**Modeling of other Power System Components:** Modeling of Transmission Lines and Loads. Transmission Line Physical Characteristics. Transmission Line Modeling. Load Models - induction machine model. Frequency and Voltage Dependence of Loads. Other Subsystems – HVDC and FACTS	08	

	controllers, Wind Energy Systems.		
5	**Stability Analysis:** Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multi-machine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governor droop. Single Machine Load Bus System: Voltage Stability. Introduction to Tensional Oscillations and the SSR phenomenon. Stability Analysis Tools: Transient Stability Programs, Small Signal Analysis Programs	10	
6	**Enhancing System Stability:** Planning Measures. Stabilizing Controllers (Power System Stabilizers). Operational Measures- Preventive Control. Emergency Control.	4	

Text books:

1. Power System Dynamics, Stability and Control, K.R. Padiyar. B. S. Publications, 2002.
2. Power System Stability and Control, Prabha Kundur. McGraw Hill, 2006.
3. Power System Dynamics and Stability, P. W. Sauer and M. A. Pai . Pearson, 1997.

Reference books:

1. The Essentials of Power System Dynamics and Control, Hemanshu Roy Pota, Springer, 2018
2. Power System Dynamics and Control, H.G. Kwanty and K.M.Miller, Birkhauser. 2016

Course Outcome: After completion of this course, the learners will be able to

1. explain the model of power system components
2. select the appropriate model for required analysis.
3. analyze the performance of the system with small signal analysis.
4. evaluate the stability of the single and multi machine systems. .
5. develop measures for enhancing the stability of the system.
6. Solve numerical problems of linear dynamical system, modeling of different components and stability.

Special Remarks (if any)

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(Applicable from the academic session 2018-2019)

Name of the course	**ADVANCED ELECTRIC DRIVE**
Course Code: PE-EE 801C	**Semester: 8th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Practical: 0 hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:	
1.	To understand basic principle of operation of Power Converters used for AC drives
2.	To understand the method for modeling and control of Induction motor and Synchronous motor.
3.	To understand the method of control of Permanent magnet motor drive, Switched reluctance motor drive.
4.	To understand the principle of DSP based motion control.

Pre-Requisite	
1.	Electric Machine (PC-EE-401, PC-EE-501)
2.	Control System (PC-EE-503)
3.	Power Electronics (PC-EE-504)

Unit	Content	Hrs	Marks
1	**Power Converters for AC drives:** PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H bridge as a 4-Q drive.	8	
2	**Induction motor drives:** Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control(DTC).	8	
3	**Synchronous motor drives:** Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.	5	
4	**Permanent magnet motor drives:** Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.	5	
5	**Switched reluctance motor drives:** Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM.	5	
6	**DSP based motion control:** Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.	5	

Text books:

1. Modern Power Electronics and AC Drives, B. K. Bose, PHI, 2005
2. Permanent Magnet Synchronous and Brushless DC motor Drives, R. Krishnan, CRC Press, 2009
3. DSP based Electromechanical Motion Control, H. A. Taliyat and S. G. Campbell, CRC Press, 2003.

Reference books:

1. Analysis of Electric Machinery and Drive Systems, P.C. Krause, O. Wasynczuk and S.D. Sudhoff, Wiley, 2013.

Course Outcome: After completion of this course, the learners will be able to

1. explain the principle of operation of converters for AC drives.
2. model Induction and Synchronous motor by reference frame theory.
3. apply different control methods to control speed and torque of Induction and Synchronous motor.
4. explain the configurations and method of speed control of BLDC, PMSM and SRM.
5. realize basic blocks for DSP based motion control.
6. develop appropriate scheme for speed control of Induction and Synchronous motor.

Special Remarks (if any)

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(Applicable from the academic session 2018-2019)

Name of the course		**INDUSTRIAL AUTOMATION AND CONTROL**	
Course Code: PE-EE 801D		**Semester: 8th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0 hr/week		Assignment & Quiz: 10 Marks	
Practical: 0 hrs/week		Attendance: 05 Marks	
Credit Points: 3		End Semester Exam: 70 Marks	
Objective:			
1.	To understand Industrial automation and control.		
2.	To understand the different control modes.		
3.	To understand advance industrial control strategies.		
4.	To understand the Programmable Logic Controller and distributed control system.		
Pre-Requisite			
1.	Control System (PC-EEE-503)		
Unit	Content	Hrs	Marks
1	**Introduction to Industrial Automation and Control**: Architecture of Industrial Automation Systems. General review of process, Process control & automation, Servo and regulatory control, Characteristic parameter of a process: Process quality, Process potential, Process resistance, Process capacitance, Process lag, Self regulation.	08	
2	**Different control modes and Implementation:** On-off control, Multistep, Time proportional, Proportional, Proportional-integral, Proportional -derivative, Proportional-integral-derivative, integral windup, bump less transfer, Inverse derivative control, controller tuning techniques and selection guideline. Implementation of PID Controllers.	08	
3	**Advance Industrial control strategies (Brief analysis):** Feedforward control, Cascade control, Ratio control, Selective Control, Split Range Control, Adaptive control.	06	
4	**Actuators and final control elements:** Classification of Actuators: pneumatic, hydraulic, electro-pneumatic, and stepper motor operated actuators. Pumps and motors, proportional and servo valves.	06	
5	**Programmable Logic Controller:** Block diagram, Classification, Basic Architecture and Functions; Input-Output Modules, power supply. PLC Programming: Relay logic and ladder logic, PLC ladder diagram realization, PLC Timer, PLC Counter, advance instructions. PLC programming examples for Industrial maintenance and control.	06	
6	**Distributed Control System (DCS):** Basic concept and overview of DCS, DCS System Architecture, configuration, operation and features. HMI and SCADA, OSI Communication Standard and Fieldbus.	06	

Text books:

1. Industrial Instrumentation and Control, S. K. Singh, Tata-McGraw , 2010
2. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A. K. Deb, Jaico Publishing House, 2012.
3. Process Control, K. Krishnaswamy, New Age International Publishers, 2009
4. Programmable Logic Controllers with Control Logix, Jon Stenerson, Delmar Cengage learning, 2009

Reference books:

1. Automatic Process Control, D.P. Eckman, John Wiley and sons, 1958
2. Process control instrumentation technology, C.D. Johnson, PHI, 2005
3. Instrument Engineers Handbook, B.G. Liptak, CRC Press, 2003

Course Outcome: After completion of this course, the learners will be able to

1. explain the basic structure of industrial automation and control
2. classify different types of control actions of controllers.
3. analyze control strategies of different processes of industry.
4. illustrate the construction and use of different types of actuators and control valves.
5. use PLC, DCS and SCADA in advanced industrial control.

Special Remarks (if any)

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(Applicable from the academic session 2018-2019)

Name of the course		**SOFT COMPUTING TECHNIQUES**	
Course Code: OE-EE 801A		**Semester: 8th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Credit Points: 3		Attendance: 05 Marks	
		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the theory of Neural network, Fuzzy logic and Genetic Algorithm.		
2.	To Introduce neural networks, Genetic Algorithm and Fuzzy logic from an engineering perspective.		
Pre-Requisite			
1.	Programming for problem solving (ES-CS 201)		
Unit	Content	Hrs	Marks
1	**Introduction:** Introduction to soft computing; introduction to fuzzy sets and fuzzy logic systems; introduction to biological and artificial neural network; introduction to Genetic Algorithm.	05	
2	**Fuzzy sets and Fuzzy logic systems:** Classical Sets and Fuzzy Sets and Fuzzy relations: Operations on Classical sets, properties of classical sets, Fuzzy set operations, properties of fuzzy sets, cardinality, operations, and properties of fuzzy relations. Membership functions: Features of membership functions, standard forms and boundaries, different fuzzification methods. Fuzzy to Crisp conversions: Lambda Cuts for fuzzy sets, fuzzy Relations, Defuzzification methods. Classical Logic and Fuzzy Logic: Classical predicate logic, Fuzzy Logic, Approximate reasoning and Fuzzy Implication Fuzzy Rule based Systems: Linguistic Hedges, Fuzzy Rule based system – Aggregation of fuzzy Rules, Fuzzy Inference System- Mamdani Fuzzy Models – Sugeno Fuzzy Models. Applications of Fuzzy Logic: How Fuzzy Logic is applied in Home Appliances, General Fuzzy Logic controllers, Basic Medical Diagnostic systems and Weather forecasting Fuzzy Control, Convention control systems, Fuzzy logic control vs. PID control.	12	
3	**Neural Network**: Introduction to Neural Networks: Advent of Modern Neuroscience, Classical AI and Neural Networks, Biological Neurons and Artificial neural network; model of artificial neuron. Learning Methods : Hebbian, competitive, Boltzman etc., Neural Network models: Perceptron, Adaline and Madaline networks; single layer network; Back propagation and multi layer networks. Competitive learning networks: Kohonen self organizing networks, Hebbian learning; Hopfield Networks. Neuo-Fuzzy modelling:Applications of Neural Networks: Pattern Recognition and classification**:**	10	
4	**Genetic Algorithms:** Simple GA, crossover and mutation, Multi-		

	objective Genetic Algorithm (MOGA). Applications of Genetic Algorithm: genetic algorithms in search and optimization, GA based clustering Algorithm, Image processing and pattern Recognition.	08	
5	**Other Soft Computing techniques:** Simulated Annealing, Tabu search, Ant colony optimization (ACO), Particle Swarm Optimization (PSO).	05	

Text book:

1. Fuzzy logic with engineering applications, Timothy J. Ross, Wiley ,2011
2. Neural Networks Fuxxy Logic and Genetic Algorithm: Synthesis and Application, S. Rajashekharan and G.A. Vijaylakshmi Pai, PHI,2013
3. Principles of Soft Computing, S N Sivanandam, S.N. Deepa, Wiley , 2011.

Reference books:

1. Genetic Algorithms in search, Optimization & Machine Learning by David E. Goldberg, Addison Wesley, 1989.
2. Neuro-Fuzzy and Soft computing, Jang, Sun, Mizutani, Pearson, 1996.
3. Neural Networks: A Classroom Approach, Satish Kumar, McGraw Hill, 2017.
4. Genetic Algorithms in search, Optimization & Machine Learning by David E. Goldberg, Pearson/PHI
5. Introduction to Soft Computing-Neuro Fuzzy and Genetic Algorithm, Samir Roy & Udit Chakraborty, Pearson, 2013.

Course Outcome:

After completion of this course, the learners will be able to

1. explain soft computing techniques and their roles in building intelligent machines
2. anlyse the feasibility of application of soft computing techniques for a particular problem
3. effectively use existing software tools to solve real problems using a soft computing approach
4. evaluate solutions by various soft computing approaches for a given problem.
5. apply different soft computing techniques to solve Engineering problems.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.

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(Applicable from the academic session 2018-2019)

Name of the course		**BIOMEDICAL INSTRUMENTATION**	
Course Code: OE-EE 801B		**Semester: 8th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Credit Points: 3		Attendance: 05 Marks	
		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the fundamental of Medical Instruments		
2.	To understand Biomedical recorders, Medical Imaging equipments, Surgical , Therapeutic Instruments and Medical Laboratory equipments.		
Pre-Requisite			
1.	Analog Electronics (PC-EE-302)		
2.	Digital Electronics (PC-EE-402)		
Unit	Content	Hrs	Marks
1	**Fundamentals of Medical Instruments:** Fundamentals of medical instrumentation- Sources of biomedical signals, Generalized medical instrumentation block diagram. Medical electrodes - ECG, EEG, EMG, Defibrillator. Medical transducers: Body temperature, Blood pressure, respiration rate. Classification of Medical instruments based on application - (diagnostic, therapeutic, Imaging, analytical).	08	
2	**Biomedical Recorders:** Electrocardiograph (ECG) machine -ECG block diagram, Bipolar and unipolar leads, Phono-cardiograph. Electroencephalograph (EEG). 10-20 electrode placement system, EEG readout device, Electro-myograph (EMG) machine. Bio-feedback Instrumentation. Pulse Oximeter.	08	
3	**Medical Imaging Equipments:** X-ray machine, CT-Scan machine, MRI Scan machine, Properties of ultrasound, Ultrasonic foetal monitors. Echoencephalography. Echo-cardiograph. Colour Doppler ultrasound machine.	08	
4	**Surgical & Therapeutic Instruments:** Electro-surgery machine (cautery), Hemo-dialysis machine Muscle stimulators, Defibrilator Machine	06	
5	**Medical Laboratory Instruments:** Types of test- Blood cell, Bio chemistry, Blood Cell Counter, Bio chemistry analyze, Auto analyzer, Blood gas analyzer.	06	

Text book:

1. Handbook of Biomedical instrumentation, R. S. Khandpur, Tata McGraw Hill, New Delhi, 2003
2. Introduction to Biomedical equipment technology, Joseph J. Carr and J.M. Brown , Pearson education, New Delhi, 2000
3. Biomedical instrumentation measurements , Lesli P Cromwell, Fred J. Weibell, Erich A. Pfeiffer, PHI Learning, New Delhi, 2018

Reference books:

1. Medical instrumentation application & design, John G. Webster, Editor, John Wiley and Sons, New Delhi, 2009
2. Introduction to Biomedical Instrumentation, Mandeep Singh, PHI, 2010

Course Outcome:

After completion of this course, the learners will be able to

1. describe the principle of medical transducers for temperature, pressure and respiration rate.
2. explain the principle of operation of Biomedical recorders, Medical Imaging equipments Surgical & Therapeutic Instruments and Medical Laboratory Instruments.
3. use different Medical laboratory equipments for different tests .
4. analyze any measurement application and suggest suitable measurement methods.
5. suggest suitable imaging methodology for a specific ailment.

Special Remarks (if any)

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(Applicable from the academic session 2018-2019)

Name of the course		**INTRODUCTION TO MACHINE LEARNING**	
Course Code: OE-EE 801C		**Semester: 8th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Credit Points: 3		Attendance: 05 Marks	
		End Semester Exam: 70 Marks	
Objective:			
1.	To understand fundamental concepts of Machine Learning		
2.	To apply Machine Learning in real life applications.		
Pre-Requisite			
1.	Programming for problem solving (ES-CS 201)		
Unit	Content	Hrs	Marks
1	**Basics of Machine Learning and Python:** Review of Linear Algebra, Definition of learning systems; Designing a learning system, Goals and applications of machine learning; Classification of learning system, Basic concepts in Machine Learning. Python Basics – string, number, list, tuple, Dictionary, functions, conditional statement, Loop statements, Numpy, Matplotlib, simple programming exercises using python.	12	
2	**Supervised Learning:** Linear regression with one variable, Linear regression with multiple variables, Logistic regression; Linear Methods for Classification; Linear Methods for Regression; Decision trees, overfitting.	07	
3	**Support Vector Machines:** Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, non-linear SVM, Kernels for learning non-linear functions.	07	
4	**Unsupervised Learning:** Learning from unclassified data, Clustering - Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering; Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.	07	
5	**Applications of Machine Learning:** Strategies, guidelines for good design, performance measurement, Reading Data, PreProcessing Data, handwriting recognition, object detection, face detection.	07	

Text book:

1. Machine Learning, Dr. Rajjiv Chopra, Khanna Publishing, 2020
2. Introduction to Machine Learning, EthemAlpaydi, PHIl, 2015
3. Building Machine Learning Systems with Python, Richert& Coelho, Packt publishing, 2013

Reference books:

1. The Elements Of Statistical Learning: Data mining, Infarence and Prediction, Trevor Hastie, Robert Tibshirani, Jerome Friedman, 2017.
2. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, MIT Press 2012.

Course Outcome:

After completion of this course, the learners will be able to

1. explain the basics concepts and classification of Machine Learning .
2. write simple programs using python.
3. describe Supervised Learning concepts.
4. explain the concept of Support Vector Machine.
5. describe unsupervised learning concepts and dimensionality reduction techniques.
6. apply Machine Learning in a range of real-world applications .

Special Remarks (if any)

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(Applicable from the academic session 2018-2019)

Name of the course		**SENSORS AND TRANSDUCERS**	
Course Code: OE-EE 801D		**Semester: 8th**	
Duration: 6 months		**Maximum Marks: 100**	
Teaching Scheme		**Examination Scheme**	
Theory: 3 hrs/week		Mid Semester Exam: 15 Marks	
Tutorial: 0hr/week		Assignment & Quiz: 10 Marks	
Credit Points: 3		Attendance: 05 Marks	
		End Semester Exam: 70 Marks	
Objective:			
1.	To understand the principle of operation of Transducers and Sensors		
2.	To understand the application of Transducers and Sensors		
Pre-Requisite			
1.	Electric Circuit Theory (PC-EEE-301)		
2.	Electromagnetic Field Theory (PC-EEE-303)		
Unit	Content	Hrs	Marks
1	**Introduction**: Definition, significance of measurement and instruments. Principle of sensing & transduction, transducer classification, Transducer characteristics, emerging fields of sensor technologies.	05	
2	**Resistive transducers:** Potentiometers: types, loading error, metal and semiconductor strain gauges, types, resistance measuring methods, strain gauge applications: Load and torque measurement.	05	
3	**Inductive transducers:** Transformer type, synchros, eddy current transducers, LVDT: Construction, material, input-output characteristics. **Optical Sensors:** LDR, Photo Diode, Stroboscope, IR Sensor.	08	
4	**Capacitive transducers:** Variable distance-parallel plate type, variable area- parallel plate type, cylindrical type, differential type, variable dielectric constant type, calculation of sensitivity. Capacitive microphone, fluid level measurement. **Piezoelectric transducers:** piezoelectric effects, Materials, natural and synthetic types – their comparison, Charge and voltage co-efficient, Force and stress sensing, displacement measurement. **Magnetic Transducer:** Hall effect sensors, Magnetostrictive transducers: principle, positive and negative magnetostriction.	10	
5	**Thermal sensors:** Resistance temperature detector (RTD): principle, materials and types; Thermistor: principle, materials and types; Thermocouple, Thermoelectric effects, laws of thermocouple, thermocouple types, construction. IC temperature sensor, PTAT type sensor. **Radiation sensors:** types, characteristics and comparison. Pyroelectric type.	06	
6	**Micro-sensors and smart sensors:** Construction, characteristics and applications. Standards for smart sensor interface. **Recent Trends in Sensor Technologies:** Introduction; Film sensors (Thick film sensors, thin film sensor)	04	

Text book:

1. Transducers and Instrumentation , D.V.S. Murthy, Prentice Hall, 2008
2. Sensors and Transducers, D. Patranabis, Prentice Hall India, 2003
3. Measurement Systems - Application and Design, E.O. Doebelin, McGraw-Hill, 2008

Reference books:

1. Instrument Transducers - An Introduction to their Performance and Design", H.K.P. Neubert , Oxford University Press, 1999.
2. Measurement Systems and Sensors, WaldemarNawrocki Artech House, 2016.
3. Semiconductor sensors", S.M. Sze, Wiley - Interscience, 1994
4. Instrumentation Measurement and Analysis", B. C. Nakara&Chaudhry TATA McGraw-Hill, 2009
5. Smart Sensors and Sensing Technology, Daniel E. Suarez, Nova Science Publishers, 2011

Course Outcome:

After completion of this course, the learners will be able to

1. explain the basic principle of operation of Transducers and Sensors.
2. distinguish different sensors and transducers.
3. identify suitable transducer by comparing different industrial standards and procedures for measurement of physical parameters
4. estimate the performance of different transducers.
5. design real life electronics and instrumentation measurement systems.
6. apply smart sensors, bio-sensors, PLC and Internet of Things to different applications.

Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.