Effective from Session 2015-2016

BABU BANARASI DAS UNIVERSITY, LUCKNOW
School of Engineering
Department of Electrical Engineering
Bachelor of Technology

Credit Summary Chart:

Credit Summary Chart										
Course Category	**Semester**								**Total Credits**	**%age**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
F	16/10	10/16	0	0	0	0	0	0	25/26	12.38
C	10/17	17/10	25	25	21	21	12	16	148/147	70.48
GE	0	0	0	0	4	4	8	4	20	9.52
OE	0	0	0	0	0	0	4	4	8	3.81
GP	1	1	1	1	1	1	1	1	8	3.81
Total	**27/28**	**28/27**	**26**	**26**	**26**	**26**	**25**	**25**	**209**	**100**
Discipline wise Credit Summary Chart										
Course Category	**Semester**								**Total Credits**	**%age**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
Basic Sciences	10/11	11	4	3					**28/29**	14.29
Humanities andSocials Sciences		5	2	2	3	3			**15**	7.15
Engg. Sciences	16	11/10							**27/26**	12.38
Professional Subject Core			19	20	18	17	9	8	**91**	43.34
Professional Subject -General Elective					4	4	8	4	**20**	9.53
Professional Subject -Open Elective							4	4	**8**	3.81
GP + Project Work, Seminar and / or Internship in Industry or elsewhere.	1	1	1	1	1	2	4	9	**20**	9.52
Total	**27/28**	**28/27**	**26**	**26**	**26**	**26**	**25**	**25**	**209**	**100**

SEMESTER I									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	BAS2101	Matrices and Calculus	3	1	0	40	60	**100**	**4**
C	BAS2102	Physics-I	2	1	0	40	60	**100**	**3**
Students need to select either GROUP 'A' or GROUP 'B'									
	GP2101	General Proficiency				100		**100**	**1**
Total			**5**	**2**	**0**	**180**	**120**	**300**	**8**

GROUP 'A'									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
F	BME2101	Engineering Mechanics	3	1	0	40	60	**100**	**4**
F	BCS2101	Foundation of Information Technology	3	1	0	40	60	**100**	**4**
F	BEC2101	Basic Electronics Engineering	3	1	0	40	60	**100**	**4**
C	BAS2104	Environmental Studies	2	0	0	40	60	**100**	**2**
F	BME2151	Engineering Mechanics Lab	0	0	2	40	60	**100**	**1**
F	BCS2151	Foundation of Information Technology Lab	0	0	2	40	60	**100**	**1**
F	BME2152	Workshop Practice	0	1	2	40	60	**100**	**2**
C	BAS2152	Physics-I Lab	0	0	2	40	60	**100**	**1**

Total	**11**	**4**	**8**	**320**	**480**	**800**	**19**

GROUP 'B'								
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
F	BEE2101	Basic Electrical Engineering	3	1	0	40	60	**100**	**4**
F	BME2102	Basic Mechanical Engineering	2	1	0	40	60	**100**	**3**
C	BAS2103	Chemistry	3	1	0	40	60	**100**	**4**
C	BHS2101	Professional Communication	3	1	0	40	60	**100**	**4**
F	BEE2151	Basic Electrical Engineering Lab	0	0	2	40	60	**100**	**1**
F	BME2153	Engineering Graphics Lab	0	1	2	40	60	**100**	**2**
C	BHS2151	Professional Communication Lab	0	0	2	40	60	**100**	**1**
C	BAS2153	Chemistry Lab	0	0	2	40	60	**100**	**1**
Total			**11**	**5**	**8**	**320**	**480**	**800**	**20**

SEMESTER II									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	BAS2201	Differential Equations and Fourier Analysis	3	1	0	40	60	**100**	**4**
C	BAS2202	Physics-II	2	1	0	40	60	**100**	**3**
Students need to select either GROUP 'A' or GROUP 'B'									
	GP2201	General Proficiency				100		**100**	**1**
Total			**5**	**2**	**0**	**180**	**120**	**300**	**8**

Note: Students who have selected GROUP 'A' in the first semester will select GROUP 'B' in the second semester and Vice-Versa

GROUP 'A'									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
F	BME2201	Engineering Mechanics	3	1	0	40	60	**100**	**4**
F	BCS2201	Foundation of Information Technology	3	1	0	40	60	**100**	**4**
F	BEC2201	Basic Electronics Engineering	3	1	0	40	60	**100**	**4**
C	BAS2204	Environmental Studies	2	0	0	40	60	**100**	**2**
F	BME2251	Engineering Mechanics Lab	0	0	2	40	60	**100**	**1**
F	BCS2251	Foundation of Information Technology Lab	0	0	2	40	60	**100**	**1**

F	BME2252	Workshop Practice	0	1	2	40	60	**100**	**2**
C	BAS2252	Physics-I Lab	0	0	2	40	60	**100**	**1**
Total			**11**	**4**	**8**	**320**	**480**	**800**	**19**

GROUP 'B'

Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
F	BEE2201	Basic Electrical Engineering	3	1	0	40	60	**100**	**4**
F	BME2202	Basic Mechanical Engineering	2	1	0	40	60	**100**	**3**
C	BAS2203	Chemistry	3	1	0	40	60	**100**	**4**
C	BHS2201	Professional Communication	3	1	0	40	60	**100**	**4**
F	BEE2251	Basic Electrical Engineering Lab	0	0	2	40	60	**100**	**1**
F	BME2253	Engineering Graphics	0	1	2	40	60	**100**	**2**
C	BHS2251	Professional Communication Lab	0	0	2	40	60	**100**	**1**
C	BAS2253	Chemistry Lab	0	0	2	40	60	**100**	**1**
Total			**11**	**5**	**8**	**320**	**480**	**800**	**20**

Evaluation Scheme:

2nd YEAR SEMESTER III									
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	BHS2301/ BHS2302	Industrial Psychology / Industrial Sociology	2	0	0	40	60	**100**	**2**
C	BAS2301	Complex Analysis and Integral Transforms	3	1	0	40	60	**100**	**4**
C	BEE2301	Fundamentals of Digital Electronics	2	1	0	40	60	**100**	**3**
C	BEE2302	Electronics Devices & Circuits	3	1	0	40	60	**100**	**4**
C	BEE2303	Electrical Measurement & Measuring Instruments	3	1	0	40	60	**100**	**4**
C	BCS2305	Programming in 'C'	3	1	0	40	60	**100**	**4**
C	BEE2351	Fundamentals of Digital Electronics Lab	0	0	2	40	60	**100**	**1**
C	BEE2352	Electronics Devices & Circuits Lab	0	0	2	40	60	**100**	**1**
C	BEE2353	Electrical Measurement & Measuring Instruments Lab	0	0	2	40	60	**100**	**1**
C	BCS2355	C' Programming Lab	0	0	2	40	60	**100**	**1**
	GP2301	General Proficiency				100		**100**	**1**
Total			**16**	**5**	**8**	**500**	**600**	**1100**	**26**

2nd YEAR SEMESTER IV									
\Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	BHS2402/ BHS2401	Industrial Sociology / Industrial Psychology	2	0	0	40	60	**100**	**2**
C	BAS2401	Statistical and Numerical Techniques	2	1	0	40	60	**100**	**3**
C	BEE2401	Electro-Mechanical Energy Conversion-I	3	1	0	40	60	**100**	**4**
C	BEE2402	Network and Synthesis	3	1	0	40	60	**100**	**4**
C	BEC2404	Microprocessor	3	1	0	40	60	**100**	**4**
C	BEE2403	Electrical and Electronics Engg. Materials	4	0	0	40	60	**100**	**4**
C	BEE2451	Electro-Mechanical Energy Conversion-I Lab	0	0	2	40	60	**100**	**1**
C	BEE2452	Network and Synthesis Lab	0	0	2	40	60	**100**	**1**
C	BEC2454	Microprocessor Lab	0	0	2	40	60	**100**	**1**
C	BEE2454	Electrical Simulation Lab	0	0	2	40	60	**100**	**1**
	GP2401	General Proficiency				100		**100**	**1**
Total			**17**	**4**	**8**	**500**	**600**	**1100**	**26**

3rdYEAR SEMESTER V									
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	BHS2501	Engineering & Managerial Economics	3	0	0	40	60	**100**	**3**
C	BEE2501	Electro-Mechanical Energy Conversion-II	3	1	0	40	60	**100**	**4**
C	BEE2502	Control System	3	1	0	40	60	**100**	**4**
C	BEE2503	Power System-I	3	1	0	40	60	**100**	**4**
C	BEC2504	Communication Engineering	3	0	0	40	60	**100**	**3**
GE		**Generic Elective-I**	3	1	0	40	60	**100**	**4**
C	BEE2551	Electro-Mechanical Energy Conversion-II Lab	0	0	2	40	60	**100**	**1**
C	BEE2552	Control System Lab	0	0	2	40	60	**100**	**1**
C	BEC2554	Communication Engineering Lab	0	0	2	40	60	**100**	**1**
	GP2501	General Proficiency				100		**100**	**1**
Total			**18**	**4**	**6**	**460**	**540**	**1000**	**26**

3rdYEAR SEMESTER VI									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	BHS2601	Industrial Management	3	0	0	40	60	**100**	**3**
C	BEE2601	Power Electronics	3	1	0	40	60	**100**	**4**
C	BEE2604 / BEE2504	Electromagnetic Field Theory	3	1	0	40	60	**100**	**4**
C	BEE2603	Power System-II	3	1	0	40	60	**100**	**4**
C	BEE2602	Electrical Instrumentation And Process Control	3	0	0	40	60	**100**	**3**
GE		**GenericElective-II**	3	1	0	40	60	**100**	**4**
C	BEE2651	Power Electronics Lab	0	0	2	40	60	**100**	**1**
C	BEE2652	Advanced Simulation lab	0	0	2	40	60	**100**	**1**
C	BEE2653	Seminar	0	0	2	100	0	**100**	**1**
	GP2601	General Proficiency				100		**100**	**1**
Total			**18**	**4**	**6**	**520**	**480**	**1000**	**26**

Note: The students need to undergo 4 to 6 weeks of Industrial Training after 6th semester that will be evaluated in the 7th semester.

4th YEAR SEMESTER VII									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	BEE2701	Electric Drives	3	1	0	40	60	**100**	**4**
C	BEE2702	Power System Protection	3	1	0	40	60	**100**	**4**
GE		**Generic Elective-III**	3	1	0	40	60	**100**	**4**
GE		**Generic Elective-IV**	3	1	0	40	60	**100**	**4**
OE		**Open Elective-I***	-	-	-	40	60	**100**	**4**
C	BEE2751	Electric Drives Lab	0	0	2	40	60	**100**	**1**
C	BEE2752	Power System Protection Lab	0	0	2	40	60	**100**	**1**
C	BEE2757	Industrial Training Evaluation	0	0	2	100	0	**100**	**1**
C	BEE2759	Project-I#	0	0	2	100	0	**100**	**1**
	GP2701	General Proficiency				100		**100**	**1**
Total			**12**	**4**	**8**	**580**	**420**	**1000**	**25**

*** Students will opt any one of the open elective from the list of open electives provided by the university.**

#Students need to submit an abstract for the project, required to complete at least 20% of the project work.

4th YEAR SEMESTER VIII									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	BEE2801	Computer Added Design of Electrical Machines	**3**	**0**	**0**	40	60	**100**	**3**
C	BEE2802	Utilization of Electrical Energy and Traction	**3**	**1**	**0**	40	60	**100**	**4**
GE		**Generic Elective-V**	**3**	**1**	**0**	40	60	**100**	**4**
OE		**Open Elective-II****	**-**	**-**	**-**	40	60	**100**	**4**
C	BEE2851	Computer Added Design of Electrical Machines Lab	**0**	**0**	**2**	40	60	**100**	**1**
C	BEE2859	Project-II##	**0**	**0**	**16**	160	240	**400**	**8**
	GP2801	General Proficiency				100		**100**	**1**
Total			**9**	**2**	**18**	**460**	**540**	**1000**	**25**

**** Students will opt any one of the open elective from the list of open electives provided by the university. The opted subject should be different from the one selected in 7th semester.**

##This is in continuation with the project work started in 7th semester. In this semester the student will complete the project.

Generic Elective:

Course Code	GenericElective-I
BEE2011	Basic of Signal and System
BEE2012	Power Station Practices
BEE2013	Special Electrical machines
Course Code	**Generic Elective-II**
BEE2021	Introduction toDigital Signal Processing& its Application
BEE2022	Introduction toDeregulation of Power System
BEE2023	Introduction toHigh Voltage D.C. Transmission System
Course Code	**Generic Elective-III**
BEE2031	Power System Transient
BEE2032	Introduction to Power Quality
BEE2033	Reliability of Power System
Course Code	**Generic Elective-IV**
BEE2041	Signal Conditioning and Data Acquisition
BEE2042	Satellite Communication Engineering
BEE2043	Introduction to Flexible AC transmission System (FACTS) Controllers
Course Code	**Generic Elective-V**
BEE2051	SCADA And Energy management System
BEE2052	Introduction to Robust And Adaptive Control
BEE2053	Introduction to Intelligent Instrumentation

List of open elective offered by Electrical engineering department:

S.No.	Course Code	Open Elective	Contact Hours		
			L	T	P
1	OEE2001	Energy Management	3	1	0
2	OEE2002	Non-Conventional Energy Resources	3	1	0

Legends:

L Number of Lecture Hours per week
T Number of Tutorial Hours per week
P Number of Practical Hours per week
CIA Continuous Internal Assessment
ESE End Semester Examination

Category of Courses:

F Foundation Course
C Core Course
GE Generic Elective
OE Open Elective

SEMESTER – I / II

BEE2101/BEE2201BASIC ELECTRICAL ENGINEERING

Course Objective:

1. This course provides comprehensive idea about circuit analysis.
2. The subject gives the knowledge about combinational circuits.
3. Subject gives the knowledge about the analysis and design of new electrical circuits.
4. Other logical working principles of machines and common Measuring instruments.

Learning Outcome:

At the end of the course students will be able.

1. Understand basic electrical engineering.
2. To understand the basic concepts of magnetic, AC & DC circuits.
3. To explain the working principle, construction, applications of DC & AC machines & measuring instruments.
4. To gain knowledge about the fundamentals of electric components, devices.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Electric Circuit:** Introduction to linear and nonlinear circuits, circuit elements, various sources and source transformation, Star delta transformation, solution of D.C. circuits using Kirchhoff's laws- Mesh Analysis and Nodal Analysis.Signal wave forms, Passive elements specifications. **Basic theorems:** Thevenin, Norton, Maximum Power, Superposition, Millman's Theorem, Tellegen's Theorem applied to DC networks.	30 Hours	1
II	**A. C. Circuits:** A.C. voltage and currents, average and r.m.s. values, Form factor and peak factor, Phasor representation of sinusoidal quantities, phasor in polar, rectangular and exponential forms. Analysis of single phase series, parallel and series-parallel circuits, Active & reactive and apparent power, p.f., Volt-amperes, frequency response and Q-factor. Analysis of balanced three phase a.c. circuits, Introductory concept, voltage, current and power in	30 Hours	1

	three phase balanced circuits. Star-delta connections. Measurement of three phase power by Wattmeter Method.		
III	**Measuring Instruments & Electromagnetic and Transformer:** Types of instruments, construction, working principles & applications, PMMC, MI, Single phase dynamometer, Ammeter, Voltmeter, Wattmeter, Induction type Energy meter, Use of shunt and multiplier. Magnetic circuit concept, B-H curves characteristics of magnetic materials, Practical magnetic circuits. Magnetic circuits with D.C. and A.C. excitation, Hysteresis and eddy current losses, Magnetic force. Self and mutual inductances, Faraday`s laws, Lenz`s Law, Statically and dynamically induced emfs, Energy stored in magnetic fields. Principle of Transformer operation, emf equation, Equivalent circuit of transformer, Losses and efficiency, Introduction of Auto Transformer and its applications.	30 Hours	1
IV	**Electrical Machines:** Basic concepts of rotating electric machines, DC machines (motor and generator), working principle, types, EMF and torque equations characteristics and application of DC motor. Three phase induction motors, types, principle of operation, applications. Single phase induction motors, principle of operation, starting methods, applications. Synchronous machines (motor and generator), principle of operation and applications.	30 Hours	1

Text &Reference books:

1. 'Fundamental of Electric Circuits' by Charles K Alexander and Matthew N. O. Sadiku, Tata McGraw Hill Publication.
2. 'Electrical Engineering Fundamentals' by Vincent Del Toro, PHI Publication.
3. 'Electric Technology' by H Cotton, CBS Publishers and Distributors.
4. 'Basic Electrical Technology' by A.E. Fitzgerald, McGraw Hill Publication.
5. 'Basic Electrical Engineering' by Kothari and I.J. Nagrath, Tata McGraw Hill.

6. ‘Basic Electrical Engineering’by S. N. Singh, PHI Publication.

BEE2151/BEE2251BASIC ELECTRICAL ENGINEERING LAB

(Any 10 experiments)

1. Verification of KCL & KVL.
2. Verification of Thevenin’s theorem and Norton’s theorem.
3. Verification of Superposition theorem.
4. Measurement of active and reactive power in 1-phase and Power Factor Improvement.
5. Measurement of active power in 3 -phase circuit using TWO wattmeter methods.
6. Study of transformer through assembling and polarity check.
7. Determination of equivalent circuit parameters of a single phase transformer by O.C. and S.C. tests and estimation of voltage regulation and efficiency at various loading conditions and verification by load test.
8. Study of dc shunt motor speed control using (1) Armature control (2) Field Control.
9. Determination of efficiency of DC shunts motor by load test.
10. Study of Electrical Equipment used in daily life.
11. Study of DC Machine.
12. Full wave rectifier circuit using diodes.
13. Transistor input-output characteristics.

SEMESTER – III

BEE2301FUNDAMENTALS OF DIGITAL ELECTRONICS

Course Objective:

1. To develop a strong foundation in the field of Digital Electronics.
2. The subject gives the deep knowledge about Digital logic families, Combinational circuits.
3. Subject gives the knowledge about the analysis and design of any sequential circuits.
4. Other logical problems.

Learning Outcome:

At the end of the course, student should be able:

1. Understand Digital concepts.
2. Logically explain the concepts of combinational and sequential circuits.
3. Logically analyses any synchronous sequential circuit.
4. May able to apply digital concepts.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Number Systems**: Binary, Octal, Decimal, Hexadecimal, Number base conversions, Complements, Signed Binary numbers, Binary Arithmetic, Binary codes: (Weighted , BCD, 2421, Gray code, Excess-3 code) A conversion from one code to another and laws, De-Morgan's Theorem, Principle of Duality, Boolean expression, Boolean function, Minimization of Boolean expressions, Sum of Products (SOP) & Product of Sums (POS), Minterm&Maxterm, Canonical forms, Conversion between canonical forms, Karnaugh map Minimization & Don't care conditions.	30 Hours	1
II	**Logic Gates**: AND, OR, NOT, NAND, NOR, Exclusive-OR and Exclusive-NOR, Implementations of Logic Functions using gates, NAND-NOR implementations, Multi-level gate implementations, Multi output gate implementations. **Combinational Circuits:** Design procedure, Adders/Subtractor, Serial & Parallel Adder/Subtractor Carry look ahead adder, BCD adder, Magnitude	30 Hours	1

	Comparator, Multiplexer/ Demultiplexer, Encoder/decoder, Paritychecker, Code converters, Implementation of combinational logic using MUX.**Sequential Circuit:**Latches, Flip flops: **(**SR, JK, T, D and Master slave), Characteristic excitation table and equation, Edge triggering, Level Triggering , Realization of one flip-flop using other flip flops		
III	**Sequential Circuit Design:**Classification of sequential circuits, Asynchronous / Ripple counters, Synchronous counters, Modulo-n counter, Synchronous counters**,** State diagram, State table**,** State minimization, State assignment, Register - Shift registers, Universal shift register, Ring counters, Sequential circuit designing.**OP-AMP applications:**MultivibratorsAstable, Monostable, Bistable**,** Schmitt trigger, IC-555 Timer.**,** A/D and D/A converters **Memory Devices:**Classification of memories, RAM organization, Memory decoding, Memory expansion, RAM Cell - Static, Bipolar, MOSFET, Dynamic, ROM organization - PROM, EPROM, EEPROM, EAPROM, Programmable Logic Devices (PLD), Programmable Logic Array (PLA), Programmable Array Logic (PAL).	30 Hours	1

Text &Reference Books:

1. 'Digital Electronics' by Taub& Schilling, Tata McGraw HillPublication.
2. 'Digital Design'by M. Morris Mano, Prentice Hall of India Pvt, PearsonEducation (Singapore) Pvt. Ltd.
3. 'Digital Circuits and Design' by S. Salivahanan and S. Arivazhagan, Vikas Publishing HousePvt. Ltd, New Delhi.
4. 'Digital Principles and Applications' by Donald P. Leach and Albert Paul Malvino, Tata McGrawHill Publication.
5. 'Modern Digital Electronics' byR.P.Jain, Tata McGraw–Hill publishing company limited, NewDelhi.

BEE2302 ELECTRONICS DEVICES & CIRCUITS

Course Objective:

1. To develop a strong foundation in the field of Electronics Devices & Circuits.
2. The subject gives the deep knowledge about Electronics Devices & circuits.
3. Subject gives the knowledge about the analysis and design of Electronics circuits.

4. We can generate other electronics circuits; learn many more about electronics devices.

Learning Outcome:

1. At the end of the course, student should be able.
2. Understand basic concepts about semiconductor, PN junction diode.
3. Understand basic concepts about rectifiers and transistors.
4. Can explain the concepts of FET and MOSFET.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Semiconductors:**Intrinsic and extrinsic semiconductors, P-type and N-Type semiconductors, Theory of P-N junction diode, formation of space charge region, Forward and reverse biasing of diodes, Energy band diagram of a diode, V-I Characteristics of diodes, equivalent circuit of diode, junction capacitances of diode.	30 Hours	1
II	**Rectifiers & Transistors:**Half wave and full wave bridge rectifier circuits, C filter, L filter, LC filter, CLC/II filter, Various parameters of power supply, Zener diode and regulated power supply using Zener diodes, PNP and NPN transistors, Construction and current components, transistor as an amplifier, CE, CB and CC amplifier circuit, input and output characteristics of transistor circuits, Various parameters of transistor, DC load line, Biasing of transistor amplifier, biasing stability, Transistor as a switch.	30 Hours	1
III	**Field Effect Transistor:** Construction, principle of working and V-I characteristics, MOSFET: Construction, principle of working and V-I characteristics, Depletion and enhancement type MOSFET, CMOS, FET biasing, parameters of a FET.	30 Hours	1
IV	**Feedback amplifiers and oscillators:**General feedback theory, Current and voltage feedback, Effect of negative feedback, condition for oscillation, RC phase oscillator, Hartley and Colpitt's oscillator, Crystal oscillator, Tunnel Diode Oscillator.	30 Hours	1

Text &Reference Books:

1. ‘Integrated Electronics’ by Millman and Halkias, Tata McGraw HillPublication.
2. ‘Electronic devices and circuits’ by Boylestad&Nashelsky Pearson Publication.
3. ‘Semiconductor Devices and circuits’ by AlokDutta, Oxford University Press.
4. ‘Microelectronic Circuits’ by Sedra Smith, Oxford Publication.

BEE2303ELECTRICAL MEASUREMENT & MEASURING INSTRUMENTS

Course Objective:

1. To develop a strong foundation in the field of measurement of different Electrical equipment (s).
2. The subject gives the knowledge about electrical equipment (s).
3. Subject gives the knowledge about the analysis and design of Electrical measurement circuits.
4. We learn many more about measuring devices.

Learning Outcome:

At the end of the course, student should be able:

1. Understand about measurement of different Electrical equipment (s).
2. Have sufficient knowledge about electrical measurement.
3. May able to apply measurement concepts.
4. Can explain the concepts of magnetic measurement &digital measurement of electrical quantities.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Classification of instrument system:** Classification of instrument system.Characteristics of instruments & measurement system.Errors in measurement and its analysis.Measuring Instruments- Principle of operation, constructional details of moving coil, moving iron, electrodynamics, electrostatic.Induction type of instruments; ammeters, voltmeters, wattmeter, energy meters & vibration galvanometer.	30 Hours	1

II	**Measurement of Parameters:**Measurement of Parameters.Different methods of measuring low, medium and high resistance.Price's Guard wire method, Loss of charge method,Measurement of inductance & capacitance with the help of AC bridges: Hay's bridge**,** Anderson bridge**,** Schering bridge**,** De-Sauty bridge and wein's bridge, Sources of errors in bridge measurements and their minimization.Poly phase metering Blondel's theorem for n- phase, p-wire system.Measurement of power, reactive KVA in 3 phases, balanced and unbalanced circuits.	30 Hours	1
III	**Instrument:**Instrument Transformers,Their application in the extension of instrument range.Theory and construction of current and potential transformer.Ratio and phase angle errors, effect of variation of power factor, secondary burden and frequency.Application of instrument transformers-measurement & protection, class of accuracy.A.C.Potentiometer:Polar type & Coordinate type AC potentiometer, Application of AC potentiometers in electrical measurement.	30 Hours	1
IV	**Magnetic Measurement & Digital Measurement of Electrical Quantities**:Ballistic Galvanometer, Grassotfluxmeter, determination of hysteresis loop, measuremet of iron losses. Concept of digital measurement. Block diagram study of digital voltmeter, frequency meter. Electronic multimeter. Cathode Ray Oscilloscope Basic CRO circuit (Block Diagram), Principle & working of CRO, Application of CRO to different measurements.	30 Hours	1

Text &Reference Books:

1. 'Electrical Measurement &Measuring Instrument' by E.W. Golding & F.C. Widdis, A.W.Wheeler& Co. Pvt. Ltd. India.
2. 'Electrical & Electronic Measurement & Instrument' by A.K. Sawhney, DhanpatRai& Sons,India.
3. 'Electrical Measurement' by Forest K. Harries Willey, Eastern Pvt. Ltd. India.
4. 'Electronic Instrument & Measurement Technique' by W.D.Cooper, PHI.
5. 'Electrical Measurement &Measuring Instrument'by Rajendra Prashad, Khanna Publisher.
6. 'Electrical Measurements and Measuring Instruments' by J.B. Gupta, S.K. Kataria& Sons.

BEE2351FUNDAMENTALS OF DIGITAL ELECTRONICS LAB

Note: Minimum eight experiments are to be performed from the following list:

1. To form basic logical OR gate having two or three inputs with two or three diodes.
2. To form basic logical OR, AND, NOR & NAND gates using transistor.
3. Verification of Boolean expansion.
4. To design a 4-bit parity generator /detector circuits.
5. To design a half adder circuit.
6. To design a full adder circuit.
7. To design a half subtractor circuit.
8. To design a full subtractor circuit.
9. To converters decimal to binary using 4-input NAND gates (Encoder)
10. To demonstrate the operation and application of 16:1 digital multiplexer using IC's.
11. To Design a R-S flip flop.
12. To Design a D flip flop.
13. To Design a J-K flip flop.
14. To design an up/down synchronous counter.
15. To study an 8-bit adder/sub tractor circuit.

BEE2352 ELECTRONICS DEVICES & CIRCUITS LAB

Note: Minimum eight experiments are to be performed from the following list:

1. To Plot V-I characteristics of junction diode and zener diode.
2. To draw wave shape of the electrical signal at input and output points of the half wave, full wave and bridge rectifiers.
3. To Plot input / output characteristics for common base transistor.
4. To Plot input /output characteristics of FET and determine FET parameters at a given operating point.
5. To determine voltage gain, current gain, input impedance and output impedance of common emitter amplifier.
6. To determine voltage gain, current gain, input impedance and output impedance and frequency response of R-C coupled common emitter amplifier.
7. To study transistor as a switch and determine load voltage and load current when the transistor is ON.

8. To study application of Operational Amplifier as summer integrator and voltage comparator
9. To study operation of Op-Amp based astable and mono-stablemultivibrators.
10. To study operation IC 555 based astable and mono-stablemultibrators.
11. To study operation of (a) multiplexer using IC 74150 (b) de-multiplexer using IC 74138.

BEE2353ELECTRICAL MEASUREMENT & MEASURING INSTRUMENTS LAB

Note: Minimum of eight experiments is to be performed from the following list:

1. Study of CRO.
2. Calibration of ac voltmeter and ac ammeter.
3. Measurement of form factor of a rectified sine wave and determine source of error if r.m.s. value is measured by a multi-meter.
4. Measurement of phase difference and frequency of a sinusoidal ac voltage using C.R.O.
5. Measurement of power and power factor of a single phase inductive load and to study effect of capacitance connected across the load on the power factor.
6. Measurement of low resistance by Kelvin's double bridge.
7. Measurement of voltage, current and resistance using dc potentiometer.
8. Measurement of inductance by Maxwell's bridge.
9. Measurement of inductance by Hay's bridge.
10. Measurement of inductance by Anderson's bridge.
11. Measurement of capacitance by Owen's bridge.
12. Measurement of capacitance by De-Sauty Bridge.
13. Measurement of capacitance by Schering Bridge.
14. Study of Frequency and differential time counter.
15. Measurement of energy and error determination of single phase energy meter.
16. Three phase power measurement using 2- wattmeter method.

SEMESTER - IV

BEE2401ELECTRO-MECHANICAL ENERGY CONVERSION-I

Course Objective:

1. To give the students a fair knowledge on the working of various DC machines.
2. To give the students a fair knowledge on the working of various Transformers.
3. The subject gives the knowledge about electrical energy conversion.
4. We can examine about electro-mechanical energy conversion.

Learning Outcome:

At the end of the course, student should be able:

1. To analyze the basic concept of rotating machines.
2. To analyze the performance of different types of DC machines & Transformers.
3. To appreciate the applications of them.
4. To understand the numerical aspect of various DC machine.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Principles of Electro-mechanical Energy Conversion:** Introduction, Flow of Energy in Electromechanical Devices, Energy in magnetic systems (defining energy & Co-energy).Singly Excited Systems, determination of mechanical force, mechanical energy, torque equation.Doubly excited Systems, Energy stored in magnetic field, electromagnetic torque.Generated emf in machines.Torque in machines with cylindrical air gap.	30 Hours	1
II	**Basic concepts of Rotating Electrical Machines:** Constructional details of various rotating machines**,** Introduction to Lap and wave windings, EMF generation, Effect of chording and distribution of winding on EMF**,** Harmonics in generated emf, MMF of distributed winding DC Machines: Construction, Action of commutator, E.M.F. generated in armature, Torque in DC machines, Methods of excitation, armature reaction, MMF and flux density wave from the DC Machines, Commutation process, inter-poles and compensating windings. Basic performance equations of DC machine. Magnetization and operating	30 Hours	1

	characteristics of DC generators and DC motors		
III	**D.C. Machines:** Performance Characteristics of D.C. motors, Starting of D.C. motors, 3 point and 4 point starters, Speed control of D.C. motors: Field Control, armature control**,** Voltage Control (Ward Lenonard method),Efficiency and Testing of D.C. machines (Hopkinson's and Swinburn's Test).	25 Hours	1
IV	**Single phase and three phase transformers:**Construction, Theory and operation, EMF equation. Single Phase Transformer Phasor diagram, Equivalent circuit, Efficiency and Voltage regulation**.** All day efficiency Testing of Transformers: O.C. and S.C. tests, Sumpner's test, Polarity test. Auto Transformer**.** Single phase and three phase auto transformers, volt-amp relation, efficiency, merits & demerits and applications.Construction of three phase transformer phasor groups and their connections, open delta connection, three phase to 2 phase, 6 phase or 12 phase connections, and their applications,Parallel operation and load sharing of single phase and three phase transformers, excitation phenomenon and harmonics in transformers, three winding transformers.	35 Hours	1

Text & Reference books:

1. 'Electrical Machinery' by P.S. Bhimbra, *Khanna Publishers.*
2. 'Electric Machinery' by Fitzerald, Kingsley and Umans.
3. 'Electrical Machines' by I.J. Nagrath&D.P.Kothari,Tata McGraw Hill.
4. 'The Performance and Design of AC machines' by M.G. Say, Pit man & Sons.

BEE2402 NETWORK AND SYNTHESIS

Course Objective:

1. To give the students a fair knowledge on the working of networks analysis.
2. To give the students a strong concept regarding synthesis.
3. The subject gives the knowledge about different electrical networks.
4. Can examine about different networks and synthesis.

Learning Outcome:

At the end of the course, student should be able:

1. To analyze the basic concept of electrical networks.
2. Introduction to different networks theorem.

3. Concepts of coupled circuits and transient analysis.
4. Introduction to two port and different types of network realization function.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Network Theorems (Applications to AC networks) & Graph Theory:**Super-position theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Millman's theorem, Compensation theorem &Tellegen's theorem, Graph of a Network, Definitions, tree, co tree, link, basic loop, Basic cut set, Incidence matrix, cut set matrix, Tie set matrix, Duality.	30 Hours	1
II	**Analysis of coupled circuits:**Introduction, Self Inductance, Mutual Inductance, Coefficient of coupling, Series connection of coupled coils,Dot convention in coupled circuits, AC networks based on coupled circuits,Review of Laplace Transform & its applications to electrical networks.	30 Hours	1
III	**Transient analysis:**DC Transient response of R-L, R-C, R-L-C circuits (Series and parallel combination) for DC excitation- Initial conditions- solution method using differential equation and Laplace transforms. AC Transient response of RL, RC, RLC circuits (Series and parallel combination) for Sinusoidal excitations- Initial conditions- solution method using differential equation and Laplace transforms.	30 Hours	1
IV	**Two Port Networks:**Network Synthesis Two port network parameters- Z, Y, ABCD, hybrid parameters and their relations. Reciprocity and Symmetry, Inter-connections of two port networks, Ladder and Lattice networks. T & Π Transformation, Driving point and Transfer Functions. Positive Real Functions, Definition and properties. Synthesis of LC, RL& RC circuits using Cauer and Fosters first and second form.	30 Hours	1

Text &Reference Books:

1. 'Network Analysis' byM.E. Van Valkenburg, Prentice Hall of India.
2. 'Circuit Theory' by A. Chakrabarti, DhanpatRai& Co.

3. 'Network Analysis and Synthesis' by C.L Wadhwa, New Age International Publishers.
4. 'Networks and Systems' by D.RoyChoudhary, Wiley Eastern Ltd.
5. 'An Introduction to Modern Network Synthesis' by M.E. Van Valkenburg, Wiley Eastern Ltd.

BEE2403 ELECTRICAL & ELECTRONICS ENGINEERING MATERIALS

Course Objective:

1. To give the students a fair knowledge on the working of different materials used in electrical and electronics engineering.
2. To give the students a strong concept regarding materials and their properties.
3. The subject gives the knowledge about different curves.
4. Can examine about different properties with the help of curves and to familiarize the students with the different types of materials used in engineering.

Learning Outcome:

At the end of the course, student should be able:

1. To review and compare different types crystal structures and materials
2. To understand in detail the use of – electric, dielectric and magnetic properties of materials.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Crystal Structure &Magnetic Properties of Material:** Bonds in solids and crystal structure, co-ordination number and atomic packing factor, Miller Indices, Bragg's law and x-ray diffraction. Structural Imperfections and crystal growth. Energy bands in solids and classification of materials using energy band. Origin of permanent magnetic dipoles in matters, Classification: Diamagnetism, Para-magnetism, Ferromagnetism, Anti-ferromagnetism and Ferrimagnetism, magnetostriction and properties of magnetic materials, Soft and hard magnetic materials and permanent magnetic materials.	30 Hours	1
II	**Dielectric Materials:** Static dielectric constant and Polarization, atomic interpretation of the dielectric constant of mono-atomic and poly atomic gases, internal fields in the solids and liquids & static dielectric	30 Hours	1

	constants of solids, ferroelectric materials and spontaneous polarization, piezo- electricity & Frequency dependence of electronics, ionic and orientational polarization, complex dielectric constant and dielectric losses.		
III	**Conductivity of Metals:** Electron theory of metals, factors affecting electrical resistance of materials & thermal conductivity of metals, heat developed in current carrying conductors & thermoelectric effect, superconductivity and super conducting materials, Properties & applications of electrical conducting and insulating material.	30 Hours	1
IV	**Semiconductor:** General concepts & types of semiconductors, Fermi Dirac distribution, intrinsic Semi-conductors & extrinsic Semi-conductors, hall effect, drift, mobility, diffusion in Semiconductors, Semi-conductors and their applications	30 Hours	1

Text & Reference books:

1. 'Electrical Engineering Materials' by A.J. Dekker, Prentice Hall of India.
2. 'Electrical Engg. Materials' by R.K. Rajput, Laxmi Publications.
3. 'An Introduction to Electrical Engg. Materials' by C.S. Indulkar& S. Triruvagdan, published by S.Chand& Co.
4. 'Electrical Properties of Materials' by Solymar, Oxford University Press.
5. 'Electrical Engineering Materials' byG.P. Chhalotra& B.K. Bhat, Khanna Publishers.

BEE2451 ELECTRO-MECHANICAL ENERGY CONVERSION-I LAB

Note: - At least eight experiments should be performed out of which 3 should be simulation based:

1. To obtain magnetization characteristics of a D.C. shunt generator.
2. To obtain load characteristics of a D.C. shunt generator and compound generator.
   (a) Cumulatively compounded.
   (b) Differentially compounded.
3. To obtain efficiency of a dc shunt machine using Swinburn's test.
4. To perform Hopkinson's test and determine losses and efficiency of DC machine.
5. To obtain speed-torque characteristics of a dc shunt motor.
6. To obtain speed control of dc shunt motor using.
   (a) Armature resistance control. (b) Field control.

7. To obtain speed control of dc separately excited motor using Conventional Ward-Leonard.

8. To study polarity and ratio test of single phase and 3-phase transformers.

9. To obtain equivalent circuit, efficiency and voltage regulation of a single phase Transformer using O.C. and S.C. tests.

10 To obtain efficiency and voltage regulation of a single phase transformer by Sumpner'stest.

11 To obtain 3-phase to 2-phase conversion by Scott connection.

12.To determine excitation phenomenon (B.H. loop) of single phase transformer using C.R.O.

BEE2452 NETWORKS AND SYSTEMS LAB

Note: Minimum eight experiments are to be performed from the following list.

1. Verification of principle of superposition with dc and ac sources.
2. Verification of Thevenin, Norton and Maximum power transfer theorems in ac circuits.
3. Verification of Tellegen's theorem for two networks of the same topology.
4. Determination of transient response of current in RL and RC circuits with step voltageinput.
5. Determination of transient response of current in RLC circuit with step voltage input forunderdamp, critically damp and overdamp cases.
6. Determination of frequency response of current in RLC circuit with sinusoidal ac input.
7. Determination of z and h parameters (dc only) for a network and computation of Y and ABCD parameters.
8. Determination of driving point and transfer functions of a two port ladder network andverify with theoretical values.
9. Determination of image impedance and characteristic impedance of T and Π networks, using O.C. and S.C. tests. Write Demo for the following in Ms-Power point.
10. Verification of parameter properties in inter-connected two port networks: Series, parallel and cascade also study loading effect in cascade.
11. Determination of frequency response of a Twin-T notch filter.
12. To determine attenuation characteristics of a low pass / high pass active filters.

BEE2454ELECTRICAL SIMULATION LAB

List of Experiments (PSPICE / MATLAB based minimum of two experiments)

Note: Minimum eight experiments are to be performed from the following list :

1. Study of various commands of PSPICE.
2. To determine node voltages and branch currents in a resistive network.
3. To obtain Thevenin's equivalent circuit of a resistive network.
4. To obtain transient response of a series R-L-C circuit for step voltage input.
5. To obtain transient response of a parallel R-L-C circuit for step current input.
6. To obtain transient response of a series R-L-C circuit for alternating square voltage waveform.
7. To obtain frequency response of a series R-L-C circuit for sinusoidal voltage input.
8. To determine line and load currents in a three phase delta circuit connected to a 3-phase balanced ac supply.
9. To plot magnitude, phase and step response of a network function.
10. To determine z,y,g,h and transmission parameters of a two part network.
11. To obtain transient response of output voltage in a single phase half wave rectifier circuit using capacitance filter.
12. To obtain output characteristics of CE NPN transistor.
13. To obtain frequency response of a R-C coupled CE amplifier.
14. To obtain frequency response of an op-Amp integrator circuit.
15. To verify truth tables of NOT, AND or OR gates implemented by NAND gates by plotting their digital input and output signals.

Reference Books:

1. Irvine, Calif, 'PSPICE Manual' Microsim Corporation.
2. Paul W. Tuinenga, 'SPICE: A guide to circuit Simulation and Analysis Using PSPICE', Prentice Hall.

SEMESTER – V

BEE2501 ELECTRO-MECHANICAL ENERGY CONVERSION - II

Course Objective:

1. To develop a strong foundation in the field of electro-mechanical energy conversion.
2. The subject gives the knowledge about electrical machines (s).
3. Subject gives the knowledge about the different characteristic related with the performance of electrical rotating machines (s).
4. To give the students a fair knowledge on the working of various AC machines & Fractional hp M/c.

Learning Outcome:

At the end of the course, student should be able:

1. To analyze the performance of different types of AC machines.
2. Understand about the working of different various AC machines(s).
3. Have sufficient knowledge about electrical machines.
4. To appreciate the applications of them.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Synchronous Machine-I:** Constructional features, Armature winding, EMF Equation, Winding coefficients, equivalent circuit and phasor diagram, Armature reaction.O.C. & S.C. tests, Voltage Regulation using Synchronous Impedance Method, MMF Method, Potier's Triangle Method, Parallel Operation of synchronous generators. Operations on infinite bus, synchronizing power and torque co-efficient.	30 Hours	1
II	**Synchronous Machine II:** Modified phasor diagram - analysis by two reaction theory - sudden short circuit - current waveforms - transient and sub transient reactance - slip test.Power angle characteristics of cylindrical rotor and salient pole machines - reactance power - active and reactive power control. **DC excitation: S**tatic excitation - brush less excitation and self-excitation - locus of generated voltage for	25 Hours	1

	constant real power and variable excitation - automatic voltage regulators. **Synchronous Motor:**Principle of operation - equivalent circuit - effect of load changes on synchronous motor - mechanical load diagram - armature current as function of power developed and excitation - V curves - inverted V curves – O curves - transition of a machine from generator mode to motor mode. **P**hasor diagram - torque and power relations - minimum excitation for given power - hunting - periodicity of hunting - suppression – different starting methods.		
III	**Three phase Induction Machine I:** Three phase induction motors - construction - principle of operation - rotor MMF and production of torque – slip and frequency of rotor current.Phasor diagram - equivalent circuit - mechanical power developed – maximum torque - torque slip characteristics - losses and power flow**,** Single phasing - no-load and blocked rotor tests - circle diagram, effect of deep bar and double cage rotors - effects of air gap flux harmonics - cogging and crawling**,** Induction generator & its applications.	30 Hours	1
IV	**Three phase Induction Machine- II:** Starting methods of three phase induction motors - direct on line starting - auto transformer starting - star delta starting - rotor resistance starting – starters. Contactors - basic methods for speed control of three phase induction motors - voltage control - frequency control - rotor resistance control - pole changing - static frequency conversion and slip power recovery scheme. Single phase Induction Motor: Double revolving field theory, Equivalent circuit, No load and blocked rotor tests. Starting methods, repulsion motor.AC Commutator Motors: Universal motor, Single phase a.c. series compensated motor, stepper motors.	35 Hours	1

Text & Reference books:

1. ‘Electrical Machinery’ byP.S.Bimbhra, Khanna Publication.
2. ‘Electric Machines’ by AshfaqHussain, DhanpatRai& Company.
3. ‘Electrical Machinery’ by Fitzgerald A.E. & Kingsley, Tata McGraw Hill.
4. ‘Electric Machines’ by D.P.Kothari&I.J.Nagrath, Tata McGraw Hill.

BEE2502 CONTROL SYSTEM

Course Objective:

1. To develop a strong foundation in the field of control system.
2. The subject gives the knowledge about different plots.
3. To acquire skills in the mathematical modelling of machines and use of components.
4. Function (s) to control a machine.

Learning Outcome:

At the end of the course, student should be able:

1. To find transfer function of DC Machines and compensating networks.
2. To understand the use of various control system components.
3. To analyze the performance of different types of machines.
4. Understand about the working of different machines(s) using control system.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**The Control System**: Open loop & closed control, servomechanisms, physical examples, Transfer functions, Block diagram algebra, Signal flow graph, Mason's gain formula, Reduction of parameter variation and effects of disturbance by using negative feedback **Control System Components:** Constructional and working concept of ac servomotor synchronous and stepper motor	30 Hours	1
II	**Time Response analysis:** Standard test signals, Time response**,** First and second order systems**,** Time response specifications**,** steady state errors and error constants **Design specifications of second order systems:** Derivative error, Derivative output, Integral error and PID compensations, Design considerations for higher order systems, Performance indices **Stability and Algebraic Criteria:** Concept of stability and necessary conditions**,** Routh-Hurwitz criteria and limitations **Root Locus Technique:** The root locus concepts**,** Construction of root loci	30 Hours	1

III	**Frequency response Analysis:** Frequency response**,** Correlation between time and frequency responses,Polar and inverse polar plots**,** Bode plots **Stability in Frequency Domain:** Nyquist stability criterion**,** Assessment of relative stability**,** Gain margin and Phase margin**,** Constant M&N circles **Introduction to Design:** The design problem and preliminary considerations lead, lag and lead-lag networks**,** Design of closed loop systems using compensation techniques in time domain and frequency domain	30 Hours	1
IV	**State – Variable Analysis :**Introduction State Space representation of linear systems**,** Transfer Function and state Variables**,** State Transition Matrix**,** Solution of state equations for homogeneous and non-homogeneous **s**ystems, Applications of State-Variable technique to the analysis of linear systemsConversion of state variable model to transfer function model and vice-versa**,** Diagonalization**,** Controllability and observability and their testing.	30 Hours	1

Text & Reference books:

1. 'Control System Engineering' by Nagrath&Gopal, New age International.
2. 'Modern Control Engineering'by K. Ogata, Prentice Hall of India.
3. 'Automatic Control System' byB.C. Kuo&FaridGolnaraghi, Wiley India Ltd.
4. 'Linear Control System with MATLAB Application' byB.S Manke,Khanna Publication.

BEE2503 POWER SYSTEM-I

Course Objective:

1. To develop a strong foundation in the field of Power system.
2. The subject gives the knowledge of power and power flow.
3. Subject gives the knowledge about the different technologies used in power system.
4. To give the students a fair knowledge on the working of various BUS bar systems.

Learning Outcome:

At the end of the course, student should be able:

1. To analyze the performance of different types of bus bar circuits.
2. Have sufficient knowledge about the different items used in power system.
3. Understand about the working oftransmission system.
4. To appreciate the applications of them.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction to Power system:**Structure of Power System**.** **Generation**:Conventional sources of electrical energy - thermal, hydroelectric, diesel and nuclear power plants.Renewable energy sources.Power plant economics - operating costs, load factor, demand factor, diversity factor, plant factor, tariffs.Distributed generation-micro grid and smart grid. **Distribution systems**: Classification and arrangement of distribution systems. Distribution substation layout and arrangement. Economic loading of distribution transformers. Considerations in primary and secondary distribution system design. Current distribution and voltage drop calculation. Design of feeders and distributors	30 Hours	1
II	**Transmission- Overhead transmission systems:** Arrangement of conductors.Types of conductors - copper, aluminum and ACSR conductors.Volume of conductor required for various systems of transmission. Choice of transmission voltage. Conductor size - Kelvin's law. Resistance, inductance and capacitance of three phase transmission lines. Symmetrical and unsymmetrical spacing. Double circuit lines. Bundled conductors. Effect of earth on transmission line capacitance. Performance of transmission lines. **Representation of lines**:Short and medium lines.Equivalent Pi and T networks. Long lines - equivalent circuit of a long line.	30 Hours	1

III	**Corona:** Disruptive critical voltage, Visual critical voltage.Power loss due to corona.Factors affecting corona interference on communication lines. **Insulators**: Different types of insulators. Voltage distribution. Grading and string efficiency of suspension insulators.	30 Hours	1
IV	**Mechanical features of transmission lines**: Sag, Sag template. Catenary curve. Calculation of sag & tension. Effects of wind and ice loading, Sag template, Vibration Dampers **Cables:** Types of cables. Insulation resistance. Voltage stress. Grading of cables. Capacitance of single core and 3 - core cables,Current rating.		

Text &Reference books

1. 'Power System Engineering' by I.J.Nagarath & D.P. Kothari, TMH Publication.
2. 'Modern Power System Analysis' by Kothari &Nagrath, Tata Mc. Graw Hill.
3. 'Power system Analysis and Design' byB.R. Gupta, Wheeler publishers.
4. 'Electrical Power Systems' by C. L. Wadhwa,New age international Ltd.
5. 'Power System' by AsfaqHussain, CBS Publishers and Distributors.
6. 'Electric Power' by S.L. Uppal,Khanna Publishers.

BEE2551 ELECTRO-MECHANICAL ENERGY CONVERSION – II LAB

Note: - At least eight experiments should be performed out of which 3 should be simulation based.

1. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and arrive equivalent circuit.
2. To perform load test on a three phase induction motor and draw:a). Torque -speed characteristics b) Power factor-line current characteristics.
3. To perform no load and blocked rotor tests on a single phase induction motor and arrive equivalent circuit.
4. To study speed control of three phase induction motor by keeping V/f ratio constant.
5. To study speed control of three phase induction motor by varying supply voltage.
6. To perform open circuit and short circuit tests on a three phase alternator and determine voltage regulation at full load and at unity, 0.8 lagging and leading power factors by (i) EMF method (ii) MMF method.

7. To determine V-curves and inverted V-curves of a three phase synchronous motor.
8. To determine X_d and $X_q$of a three phase salient pole synchronous machine using the slip test and draw the power-angle curve.
9. To study synchronization of an alternator with the infinite bus by using: (i) dark lamp method (ii) two bright and one dark lamp method

Software based experiments (Develop Computer Program in 'C' language or use MATLAB or other commercial software)

10. To determine speed-torque characteristics of three phase slip ring induction motor and study the effect of including resistance, or capacitance in the rotor circuit.
11. To determine speed-torque characteristics of single phase induction motor and study the effect of voltage variation.
12. To determine speed-torque characteristics of a three phase induction motor by (i) keeping v/f ratio constant (ii) increasing frequency at the rated voltage.
13. To determine steady state performance of a three phase induction motor using equivalent circuit.
14. Draw O.C. and S.C. characteristics of a three phase alternator from the experimental data and determine voltage regulation at full load, and unity, 0.8 lagging and leading power factors.

BEE2552CONTROL SYSTEM LAB

Note: The minimum of ten experiments are to be performed from the following, out of which at-least three should be software based.

1. To determine response of first order and second order systems for step input for various values of constant 'K' using linear simulator unit and compare theoretical and practical results.
2. To study P, PI and PID temperature controller for an oven and compare their performance.
3. To study and calibrate temperature using resistance temperature detector (RTD)
4. To design Lag, Lead and Lag-Lead compensators using Bode plot.
5. To study DC position control system
6. To study synchro-transmitter and receiver and obtain output V/S input characteristics.
7. To determine speed-torque characteristics of an ac servomotor.
8. To study performance of servo voltage stabilizer at various loads using load bank.
9. To study behavior of separately excited dc motor in open loop and closed loop conditions at variousloads.

10. To study PID Controller for simulation proves like transportation lag.

Software based experiments (Use MATLAB, LABVIEW software etc.)

11. To determine time domain response of a second order system for step input and obtains performanceparameters.
12. To convert transfer function of a system into state space form and vice-versa.
13. To plot root locus diagram of an open loop transfer function and determine range of gain ‘k’ for stability.
14. To plot a Bode diagram of an open loop transfer function.
15. To draw a Nyquist plot of an open loop transfer functions and examines the stability of the closed loop system.

SEMESTER - VI

BEE2601 POWER ELECTRONICS

Course Objective:

1. To learn the characteristics of different types of semiconductor devices.
2. To develop a strong foundation in the field of Power Electronics.
3. To understand the operation of controlled rectifiers.
4. The subject gives the knowledge of power semiconductor switches & power electronics devices.
5. To understand the operation of choppers, inverters, AC Voltage Controllers and DC – DC Converters.

Learning Outcome:

At the end of the course, student should be able:

1. To apply advanced knowledge to Engineering problems.
2. To improve their ability in solving power circuits andtheir wave forms.
3. To familiarize with the applications of power electronics.
4. To expose to the concept of power electronics.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Power Semiconductor Switches:**Power diodes - Basic structure and V-I characteristics - various types - DIACs – Basic structure and V-I characteristics – TRIACs**,** Basic structure and V-I characteristics -IGBTs - Basic structure and V-I characteristics. MOSFETs - Basic structure and V-I characteristic. 1.3 Thyristor - basic structure - static and dynamic characteristics - device specifications and ratings - methods of turning on - gate triggering circuit using UJT –Rectifiers. **Thyristor:** series and parallel operation, methods of turning off - commutation circuits. Line frequency phase controlled rectifiers using SCR Single Phase – Half wave rectifier with R and RL loads. Full wave half controlled and fully controlled converters with continuous and constant currents - Input side harmonics and power factor - Effect of source inductance Three Phase - Half wave rectifier with R and RL loads - Full wave fully controlled converters with continuous and constant currents	30 Hours	1

II	**Inverters &Cyclo-converters:**Inverters – Single phase inverters – series, parallel and bridge inverters, Single Phase Pulse Width Modulated (PWM) inverters – Basic circuit and operation, Single phase series resonant inverter, Single phase bridge inverters, Three phase bridge inverters, Voltage control of inverters, Harmonics reduction techniques, Single phase and three phase current source inverters.	30 Hours	1
III	**AC Voltage Controllers:**Principle of On-Off and phase controls, Single phase ac voltage controller with resistive and inductive loads.Three phase ac voltage controllers (various configurations and comparison only), Single phase transformer taps changer.Cyclo Converters-Basic principle of operation, single phase to single phase.Three phase to single phase and three phase to three phase cyclo converters.Output voltage equation combination for sinusoidal.	30 Hours	1
IV	**DC – DC Converters:**Choppers - principle of operation.Step-up and step-down choppers. Switching regulators.Buck regulators - Boost regulators - Buck-boost regulators.Switched mode power supply.Principle of operation and analysis.	30 Hours	1

Text &Reference Books:

1. 'Power Electronics' byNed Mohan, John Wiley and Sons.
2. 'Power Electronics Circuits Devices and Applications' by M.H.Rashid, Pearson Education.
3. 'Thyristorised Power Controllers' byG.K.Dubey, Wiley Eastern Ltd.
4. 'Power Electronics' by P.S Bhimbhra, Khanna Publishers.
5. 'Principles of Electric Machines and Power Electronics' by P.C Sen, John Wiley & Sons.

BEE2604/BEE2504

ELECTRO MAGNETIC FIELD THEORY

Course Objective:

1. To learn the Coordinate systems.
2. To develop a strong foundation in the field of EMFT.
3. To understand the principle of operation in electric and magnetic fields.

4. To understand the operation and applications of Electromagnetic Waves & Transmission line.

Learning Outcome:

At the end of the course, student should be able:

1. To apply advanced matrix knowledge to Engineering problems.
2. To improve their ability in solving geometrical applications problems.
3. To equip themselves familiar with the functions of several variables in the field of EMT.
4. To familiarize with the applications of Electromagnetic Waves & Transmission line and to expose to the concept of three dimensional analytical geometry.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Coordinate systems and transformation**: Coordinate systems. Cartesian coordinates, Cylindrical coordinates. Spherical coordinates system. Line, Surface and Volume integrals, Del operator, Gradient of a scalar, Divergence of a vector, Curl of a vector with their physical Explanation, Divergence theorem, Stoke's theorem &Laplacian of a scalar.	30 Hours	1
II	**Electrostatics:**Electrostatic fields, Coulombs law and field intensity, Electric field due to continuous charge distributions. Electric flux density, Gauss's Law – Maxwell's equation, Application of Gauss's Law, Electric Potential-Maxwell's equation Electric dipole and flux lines, energy density in electrostatic fields. Convection and conduction currents, conductors, polarization in dielectrics, dielectric constants, continuity equation. Electrostatic boundary condition, Poission's and Laplace's equations, general procedures for solving Poission's or Laplace's equations, resistance and capacitance.	30 Hours	1
III	**Magneto-statics**:Magneto-static fields, Biot-Savart's Law, Ampere's circuit law. Maxwell's equation, application of ampere's law, magnetic flux density-Maxwell's equation, Maxwell's equation for static fields. Forces due to magnetic field, magnetic torque and moment, a magnetic dipole, magnetization in materials. Magnetic boundary conditions. Inductors and	30 Hours	1

	inductances, magnetic energy.		
IV	**Electromagnetic Wave**s:Maxwell's equation in Time varying Field. Faraday's Law. Displacement current, Electromagnetic wave propagation, Wave propagation in lossy dielectrics, Plane waves in lossless dielectrics, Plane wave in free space, Plain waves in good conductors, Power and the pointing vector, reflection of a plain wave in a normal incidence and oblique incidence. **Transmission line:** Transmission line parameters, Transmission line equations, input impedance, characteristic impedance.Lossless Transmission line open circuit and short circuit Transmission line Reflection in Transmission Line and standing wave ratio and power, applications of transmission lines.	30 Hours	1

Text & Reference books

1. 'Elements of Electromagnetics' by M. N. O. Sadiku, Oxford University Press.
2. 'Electromagnetic field theory' by W. H. Hayt and J. A. Buck, TMH.
3. 'Principle and applications of Electromagnetic fields' by Ptonsey R and Collin R.P.
4. 'Electromagnetic Fields' byJean G Van Bladel, Wily and sons,inc, publication.
5. 'The Electromagnetic Field' byShadowitz A. Mc. Graw Hill Publication.

BEE2603POWER SYSTEM-II

Course Objective:

1. To construct that circuit &mathematical models of a given power system.
2. To study about symmetrical &Unsymmetricalfaults.
3. To perform load flow studies using numerical techniques.
4. To analyses the behavior of the power system under abnormal conditions.

Learning Outcome:

At the end of the course, student should be able:

1. To apply advanced matrix knowledge to Engineering problems in power system.
2. To improve their ability in solving symmetrical & Unsymmetricalfaults problems.
3. To equip themselves familiar with the modern technology (Gauss Siedel and Newton-Raphson method).
4. To familiarize with the applications of Power system in real world.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Representation of Power System Components**: Synchronous machines, Transformers, Transmission lines, One line diagram, Impedance and reactance diagram, Per unit System. **Symmetrical components**: Symmetrical Components of unbalanced phasors, Power in terms of symmetrical components, Sequence impedances and sequence networks.	30 Hours	1
II	**Short circuit studies**: Faults on power systems, Short circuit capacity of a bus and circuit breaker ratings, Current limiting reactor. **Symmetrical fault analysis**: Transient in R-L series circuit, Calculation of 3-phase short circuit current and reactance of synchronous machine, Internal voltage of loaded machines under transient conditions. **Unsymmetrical faults**: Analysis of single line to ground fault, line-to-line fault and Double Line to ground fault on an unloaded generators and power system network with and without fault impedance. Formation of Z-bus using singular transformation and algorithm, Computer method for short circuit calculations.	30 Hours	1
III	**Power System Stability**: Stability and Stability limit, Steady state stability study, Derivation of Swing equation, Transient stability studies by equal area criterion and step-by-step method. Factors affecting steady state and transient stability,Methods of improvement.	30 Hours	1
IV	**Load Flow:** Introduction, Bus classifications, Nodal admittance matrix (*Y BUS*), Development of load flow equations, Load flow solution using Gauss Siedel and Newton-Raphson method, Approximation to N-R method, line flow equations and fast decoupled method.		1

Text & Reference books

1. 'Elements of Power System Analysis' by W.D. Stevenson, Jr, McGraw Hill.
2. 'Modern Power System Analysis' by Kothari &Nagrath, Tata Mc. Graw Hill.

3. ‘Power System Analysis’ by T.K Nagsarkar & M.S. Sukhija, Oxford University Press.
4. ‘Advanced Power System Analysis & Dynamics’ byL. P. Singh, New Age International.
5. ‘Power System Analysis’ by P.S.R. Murthy, B.S. Publications.

BEE2602ELECTRICAL INSTRUMENTATION AND PROCESS CONTROL

Course Objective:

1. To impart analytical ability in learning and solving of theoretical and mathematical problems as applied to the respective branches of Engineering.
2. To learn how to control electrical instruments andtheir control.
3. To check whether given circuit perform within its stability limits.
4. Analysis of a system by using electrical instruments andprocess control.

Learning Outcome:

At the end of the course, student should be able:

1. To learn electrical instruments in various modes.
2. To have an idea about Telemetry & Process Control and applicationsof Transducer.
3. To familiarize with the applications of electrical instruments.
4. To expose to the concept of advanced equipment(s).

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Transducer:** Definition, advantages of electrical transducers. Classification, characteristics, factors affecting the choice of transducers. Potentiometers, Strain gauges, Resistance thermometer. Thermistors, Thermocouples, LVDT, RVDT.Capacitive, Piezoelectric Hall effect. Electronic transducers. Measurement of Motion, Force pressure, temperature, flow and liquid level.	30 Hours	1

II	**Telemetry:** General telemetry system, land line & radio frequency telemetering system, transmission channels and media, receiver & transmitter, Data Acquisition System**,** Analog data acquisition system, Digital data acquisition system, Modern digital data acquisition system, Display Devices**,** Storage oscilloscope, Spectrum analyzer, Recorders, Strip chart & x-y recorders. Magnetic tape.Digital tape recorders.	30 Hours	1
III	**Process Control:** Recent Developments, Computer aided measurements, Fiber optic transducers, micro-sensors, smart sensors, smart transmitters, Principle, elements of process control system, Process characteristics, proportional (P), integral (I), Derivative (D), Other controllers PI, PD and PID, Controllers**,** Electronic controllers, Pneumatic controllers, Digital controllers.	30 Hours	1

Text / Reference Books:

1. 'Advanced Measurements & Instrumentation' by A.K.Sawhney, DhanpatRai& Sons.
2. 'Instrumentation, Measurement and Analysis' by B.C. Nakra&K.Chaudhry, Tata McGraw Hill 2nd Edition.
3. 'Process Control Instrumentation Technology' by Curtis Johns, Prentice Hall.
4. 'Measurement System – Application & design' by E.O. Decblin, McGraw Hill.
5. 'Electronic Measurement and Instrumentation' byRajendraPrasad,Khanna Publisher.

BEE2651 POWER ELECTRONICS LAB

Note: The minimum of eight experiments is to be performed.

1. To study V-I characteristics of SCR and measure latching and holding currents.
2. To study UJT trigger circuit for half wave and full wave control.
3. To study single-phase half wave controlled rectified with (i) resistive load (ii) inductive load with and without freewheeling diode.
4. To study single phase (i) fully controlled (ii) half controlled bridge rectifiers with resistive and inductive loads.
5. To study three-phase fully/half controlled bridge rectifier with resistive and inductive loads.
6. To study single-phase ac voltage regulator with resistive and inductive loads.
7. To study single phase cyclo-converters.

8. To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor.
9. To study operation of IGBT/MOSFET chopper circuit. 10. To study MOSFET/IGBT based single-phase series-resonant inverter.
10. To study MOSFET/IGBT based single-phase bridge inverter.

Software based experiments (PSPICE/MATLAB)

1. To obtain simulation of SCR and GTO thyristor.
2. To obtain simulation of Power Transistor and IGBT.
3. To obtain simulation of single phase fully controlled bridge rectifier and draw load voltage and load current waveform for inductive load.
4. To obtain simulation of single phase full wave ac voltage controller and draw load voltage and load current waveforms for inductive load.
5. To obtain simulation of step down dc chopper with L-C output filter for inductive load and determine steady-state values of output voltage ripples in output voltage and load current.

BEE2652 ADVANCED SIMULATION LAB

Note: The minimum of eightexperiments is to be performed.

1. Verification of sampling theorem.
2. Impulse response of a given system.
3. Linear convolution of two given sequences.
4. Circular convolution of two given sequences.
5. Autocorrelation of a given sequence and verification of its properties.
6. Cross correlation of given sequences and verification of its properties.
7. Solving a given difference equation.
8. Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum.
9. Linear convolution of two sequences using DFT and IDFT.
10. Circular convolution of two given sequences using DFT and IDFT.
11. Design and implementation of FIR filter to meet given specifications.
12. Design and implementation of IIR filter to meet given specification.

SEMESTER – VII

BEE2701ELECTRIC DRIVES

Course Objective:

1. To learn characteristics and control of solid state DC motors drives.
2. Induction motor drives &Synchronous motor drives.
3. To learn digital control of various drives.
4. To impart analytical ability in solving mathematical problems as applied to the respective branches of Engineering.

Learning Outcome:

At the end of the course, student should be able:

1. To learn Fundamentals of Electric Drive.
2. To have an idea about Dynamics of Electric Drive.
3. To familiarize with the applications ofElectric Braking.
4. To expose the concept of Power Electronic Control of DC Drives.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Fundamentals of Electric Drive:** Electric Drives and its parts, advantages of electric drives Classification of electric drives Speed-torque conventions and multi-quadrant operations Constant torque and constant power operation Types of load. **Load torque:** components, nature and classification.	30 Hours	1
II	**Dynamics of Electric Drive:** Dynamics of motor-load combination; Steady state stability of Electric Drive; Transient stability of electric Drive Selection of Motor Power rating: Thermal model of motor for heating and cooling, classes of motor duty, determination of motor power rating for continuous duty, short time duty and intermittent duty.Load equalization.	30 Hours	1

III	**Electric Braking:** Purpose and types of electric braking, braking of dc, three phase induction and synchronous motors Dynamics During Starting and Braking: Calculation of acceleration time and energy loss during starting of dc shunt and three phase induction motors, methods of reducing energy loss during starting. Energy relations during braking, dynamics during braking	30 Hours	1
IV	**Power Electronic Control of DC Drives:** Single phase and three phase controlled converter fed separately excited dc motor drives (continuous conduction only), dual converter fed separately excited dc motor drive, rectifier control of dc series motor. Supply harmonics, power factor and ripples in motor current Chopper control of separately excited dc motor and dc series motor. Power Electronic Control of AC Drives: Three Phase induction Motor Drive: Static Voltage control scheme, static frequency control scheme (VSI, CSI, and cyclo – converter based) static rotor resistance and slip power recovery control schemes. Three Phase Synchronous motor: Self-controlled scheme Special Drives: Switched Reluctance motor, Brushless dc motor. Selection of motor for particular applications	30 Hours	1

Text Books / Reference Books:

1. 'Fundamentals of Electric Drives' by G.K. Dubey,Narosa publishing House.
2. 'A First Course on Electric Drives' by S.K.Pillai, New Age International.
3. 'Fundamentals of Electric Drives' byMohammed A. El-Sharkawi, Thomson Asia, Pvt. Ltd.
4. 'Electric Drives' by N.K. De and PrashantK.Sen, Prentice Hall of India Ltd.

BEE2702 POWER SYSTEM PROTECTION

Course Objective:

1. To introduce the students to different types of circuit breakers.
2. Concept and working of different types of relays
3. Protection schemes for various power system components
4. Characteristics and use of fuse.
5. Protection from lightning.

Learning Outcome:

At the conclusion of this course, the students will be able to:

1. Describe what type of protection is needed in electrical system.
2. Describe the various protection systems for the different sections in electrical system.
3. Describe the methods of designing comparators and relays and circuit breakers.
4. Principle and working of different circuit breakers.
5. Power Protection System gives the concept of electrical protection. This will permit an engineer to expend their domain in the field of power system protection.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction to Protection System:**Introduction to protection system and its elements.Functions of protective relaying, protective zones.Primary and backup protection.Desirable qualities of protective relaying.Basic terminology, definitions, codes, standards.	30 Hours	1
II	**Protective Relays:**Functions of Protective relay.Constructional and operating principles of Electromagnetic induction**.** Thermal relays, Gas actuated relay, Earth fault relays, Directional relays, Differential relays and Distance relays.Basic principles of static relaying.Phase and amplitude comparator. Recent Trends in Relays, Numerical Relays.Microprocessor based relays.	30 Hours	1
III	**Switchgear principles:**Circuit breakers-principles of operation.Theory of arc formation and its extinction (AC and DC).Re-striking and recovery voltage, RRRV, Current chopping, Duties of switchgear.Constructional features and Selection of LT breakers (MCB/MCCB/ELCB) and HT Breakers (ABCB - OCB – SF6CB– VCB- HVDCCB).Circuit breaker ratings, Testing of circuit breakers.	30 Hours	1
IV	**Traveling Waves**:Wave equation for uniform Transmission lines. Velocity of propagation, surge impedance.Reflection and transmission of traveling waves under different line loadings. Lightning strokes, Protection against lightning, Earth wires, Lightning diverters, Surge absorbers, Arcing ground, Neutral	30 Hours	1

	earthing. Basic concepts of insulation levels and their selection, Protection of Transmission Line, Over current protection, distances protection, pilot wire protection, carrier current protection, protection of bus bar, auto re-closing. Protection of Transformer, generator and motor.		

Text & Reference Books:

1. 'Switchgear and Protection' by S. S. Rao, Khanna Publishers.
2. 'Power system Protection and Switchgear' by B. Ravindranath and M. Chander,Wiley Eastern Ltd.
3. 'Modern Power System Analysis' by Kothari &Nagrath, Tata Mc. Graw Hill.
4. 'Power System Protection and Switchgear' by B. Ram and D. N. Vishwakarma, Tata Mc. Graw Hill.
5. 'Power System Protection Static Relays with Microprocessor Applications' by T.S.M. Rao,Tata Macgraw Hill.

BEE2751 ELECTRIC DRIVES LAB

Note: - Minimum eight experiments are to be performed from the following out of which at least three should be simulation based.

(A) Hardware Based Experiments:

1. To study speed control of separately excited dc motor by varying armature voltage using single-phase fully controlled bridge converter.
2. To study speed control of separately excited dc motor by varying armature voltage using single phase half controlled bridge converter.
3. To study speed control of separately excited dc motor using single phase dual converter (Static Ward-Leonard Control).
4. To study speed control of separately excited dc motor using MOSFET/IGBT chopper.
5. To study closed loop control of separately excited dc motor.
6. To study speed control of single phase induction motor using single phase ac voltage controller.
7. To study speed control of three phase induction motor using three phase ac voltage controller.
8. To study speed control of three phase induction motor using three phase current source inverter.
9. To study speed control of three phase induction motor using three phase voltage source inverter.

10. To study speed control of three phase slip ring induction motor using static rotor resistance control using rectifier and chopper.
11. To study speed control of three phase slip ring induction motor using static slip power recovery control scheme.

(B)Simulation Based Experiments (using MATLAB or any other software)

12. To study starting transient response of separately excited dc motor.
13. To study speed control of separately excited dc motor using single phase fully / half controlled bridge converter in discontinuous and continuous current modes.
14. To study speed control of separately excited dc motor using chopper control in motoring and braking modes.
15. To study starting transient response of three phase induction motor.
16. To study speed control of three phase induction motor using (a) constant/V/F control (b) Constant Voltage and frequency control.

BEE2752 POWER SYSTEM PROTECTION LAB

Note: - At least eight experiments should be performed out of which 3 should be simulation based.

(A) Hardware Based:

1. To determine direct axis reactance (xd) and quadrature axis reactance (xq) of a salient pole alternator.
2. To determine negative and zero sequence reactances of an alternator.
3. To determine sub transient direct axis reactance (xd) and sub transient quadrature axis reactance (xq) of an alternator.
4. To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation.
5. To study the IDMT over current relay and determine the time current characteristics.
6. To study percentage differential relay.
7. To study Impedance, MHO and Reactance type distance relays.
8. To determine location of fault in a cable using cable fault locator.
9. To study *Ferranti effect*and voltage distribution in H.V. long transmission line using transmission line model.
10. To study operation of oil testing set.

(B)Simulation Based Experiments (using MATLAB or any other software)

11. To determine transmission line performance. To obtain steady state, transient and sub-transient short circuit currents in an alternator

12. To obtain formation of Y-bus and perform load flow analysis
13. To perform symmetrical fault analysis in a power system
14. To perform unsymmetrical fault analysis in a power system

SEMESTER VIII

BEE2801 COMPUTER ADDED DESIGN OF ELECTRICAL MACHINES

Course Objective:

1. Computer Added Design of Electrical Machines gives the concept of designing of electrical machines and their performance.
2. This will permit an engineer to expend their domain in the field of designing of electrical machines like transformer, ac/dc machines and other electrical materials.
3. To learn how to design a machine.
4. To learn how to reduce losses and hence the cost of electrical machines by proper selection of materials.

Learning Outcome:

At the conclusion of this course, the students will be able to:

1. Explain what type of considerations is needed in designing of electrical machines.
2. Describe the various factors affecting the performance of individual electrical machines.
3. Describe the methods to analyze the new technologies regarding designing and performance of electrical machines.
4. Describe the methods of programming for designing and comparing.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Classification of materials: Insulating. Ohm's law for electric and magnetic circuits Magnetic materials. Heating and cooling of electrical machines. Radial, Axial and Forced ventilation, Heat dissipation (Radiation, conduction and convection), Newton's law of cooling. Quantity of cooling medium, Temperature rise- time curve.	30 Hours	1
II	**Conventional Design of Electrical Machine:** Designing of Transformer.Designing of Induction motors.Designing of Alternator (3-phase synchronous machines).Designing of D.C. machine.Modern technology in the designing of electrical machines.	30 Hours	1
III	**Computer Aided Design of Electrical Machine:** Advantages of (CAD) Computer Aided Design.Disadvantages of (CAD) Computer Aided	30 Hours	1

	Design. Limitations of (CAD) Computer Aided Design.Optimization, Standardisation of design.Programming in java for the designing of different machines.Designing of Transformer.Designing of Induction motor.Designing of Alternator.		

Text & Reference Books:

1. 'Computer Aided Design of Electrical Machines' byV.K.Maurya and RiturajJalan, S.K.Kataria& Sons.
2. 'Electrical Machines' by A.K.Sawhney, DhanpatRai& Sons.

BEE2802 UTILIZATION OF ELECTRICAL ENERGY AND TRACTION

Course Objective:

1. To develop a strong foundation in the field of Traction.
2. The subject gives the knowledge about utilization of electrical energy and traction.
3. Subject gives the knowledge about Illumination and different types of heating.
4. Learn about Electric Traction I & II.

Learning Outcome:

At the end of the course, student should be able:

1. Understand about Illumination and different types of heating.
2. May able to apply concept of indoor lighting, outdoor lighting system.
3. Have sufficient knowledge about Refrigeration, Air Conditioningsystem, Domestic refrigerator, water cooler and other types of air conditioning, Window air conditioner.
4. Have sufficient knowledge about Electric Traction.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Heating**: Electric Heating**,** Advantages and methods of electric heating, Resistance heating, Electric arc heating, Induction heating, Dielectric heating **Welding**: Electric Welding**,** Electric Arc Welding, Electric Resistance welding, Electronic welding control**. Electrolyte Process:** Electrolyte Process, Principles of electro deposition, Laws of electrolysis, applications of	30 Hours	1

	electrolysis**.**		
II	**Illumination:** Illumination, Various definitions and Laws of illumination, Requirements of good lighting, Design of indoor lighting and outdoor lighting systems. Refrigeration and Air Conditioning**,** Refrigeration systems, Domestic refrigerator, water cooler and other types of air conditioning, Window air conditioner.	30 Hours	1
III	**Electric Traction – I:**Types of electric traction, Systems of track electrification, Traction mechanics-types of services, speed time curve and its simplification, Average and schedule speeds, Tractive effort, specific energy consumption, Mechanics of train movement, Coefficient of adhesion and its influence.	30 Hours	1
IV	**Electric Traction – II:** Salient features of traction drives, Series – parallel control of dc traction drives (bridge transition) and energy saving, Power Electronic control of dc and ac traction drives, Diesel electric traction.	30 Hours	1

Text & Reference Books:

1. 'Art and Science of Electrical Energy' by H.Partab, DhanpatRai& Sons.
2. 'Fundamentals of Electric Drives' by G.K.Dubey, Narosa Publishing House.

BEE2851 COMPUTER ADDED DESIGN OF ELECTRICAL MACHINES LAB

Note: Minimum of eight experiments is to be performed from the following list:

1. To study of 3 phase transformer.
2. To study of Induction motors.
3. To study of Alternator (3-phase synchronous machines).
4. To study of D.C. machines.
5. Develop a program for the overall design of 3 phase transformer.
6. Develop a program for the overall design of Induction motors.
7. Develop a program for the overall design of Alternator (3-phase synchronous machines).
8. Develop a program for the overall design of D.C. machines.
9. Develop a program for the heating and cooling of electrical machines.

GENERIC ELECTIVE-I

BEE2011 BASIC OF SIGNALS AND SYSTEMS

Course Objective:

1. To understand the signals and systems.
2. To grab the concept of Fourier and Laplace transform.
3. To understand the concept of z-transform and DTFT.
4. To understanding of various filters and signal distortion.

Learning Outcome:

1. Understands the signals and systems.
2. Concept of Fourier series, Fourier Transform and Laplace transform.
3. Concept of z-transform and DTFT.
4. Understanding of various filters and signal distortion.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Signals and System** **Signals:** Introduction**,** Types of signals and their representation: Continuous- time/discrete-time, periodic/non-periodic, even/odd, energy/power, deterministic/random**.,** Commonly used signals (Continuous and discrete): unit impulse, unit step, ramp and their inter relation, exponential, sinusoidal and rectangular pulses, Operation on continuous and discrete-time signals. **Systems:** Introduction to systems, Classification: linearity, time-invariance, causality, impulse response, LTI system characteristics, convolution summation, step response of discrete time systems, stability, convolution integral, co-relations, signal energy and energy spectral density, Signal power and power spectral density, properties of power spectral density.	30 Hours	1

II	**Laplace and Fourier Transform** **Laplace Transform:** Introduction to Laplace Transform**,** Laplace Transform of common signals, Region of Convergence (ROC), Properties of Laplace Transform, Inverse Laplace Transform, Initial and Final Value Theorem, Solution of differential equation using Laplace transforms. **Fourier Series:** Fourier series, Fourier series representation of Periodic and Aperiodic Signals. **Fourier Transform:** Introduction to Fourier Transform, Fourier Transform existence and its Properties, Parseval's Theorem, Fourier Transform of some common signals, Inverse Fourier Transform, Relation between Fourier and Laplace Transform.	30 Hours	1
III	**Z- Transform & Discrete Time Fourier Transform (DTFT)** **Z-Transform:** Introduction to Z-Transform and its properties. Z-transform of common signals, ROC, Inverse z-transform, Initial & Final value theorem, Solution of differential equation using z-transform, Pulse transfer function. **Discrete Time Fourier Transform (DTFT)**: Introduction to DTFT, Convergence of DTFT & DTFT Properties, DTFT of common signals, Inverse DTFT, Relationship of DTFT to z-transform and DFT.	30 Hours	1
IV	**Filtering and Signal Distortion:** Introduction, Time response, frequency response, Linear distortion and equalization, Ideal-low pass filter, Band-pass transmission, Phase delay and group delay, Nonlinear distortion.	30 Hours	1

Text &Reference Books:

1. 'Signals and Systems' by A. V. Oppenheim, A. S. Willsky and I. T. Young,Prentice-Hall India.
2. 'Signals, Systems and Transforms' by C. L. Philips, J. M. Parr and E. A. Riskin, PHI.
3. 'Signals and Systems' by Simon Haykins, John Wiley.

BEE2012POWER STATION PRACTICES

Course Objective:

1. To develop a strong foundation in the field of power station practices.
2. The subject gives the knowledge about different power plants.
3. Subject gives the knowledge about Economic Operation of Power Systems.
4. Learn about Non-Conventional Energy Sources.

Learning Outcome:

At the end of the course, student should be able:

1. Understand about power stations.
2. May able to apply concept of Non-Conventional Energy Sources over conventional.
3. Have sufficient knowledge about different power plants.
4. Have sufficient knowledge about Economic Operation.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction**: Electric energy demand and growth in India, electric energy sources. **Thermal Power Plant:** Site selection, general layout and operation of plant, detailed description and use of different parts. **Hydro Electric Plants:** Classifications, location and site selection, detailed description of various components, general layout andoperation of Plants, brief description of impulse, reaction, Kaplan and Francis turbines, advantages &disadvantages, hydro-potential in India.	30 Hours	1
II	**Gas Turbine Plant**:Operational principle of gas turbine plant & its efficiency, fuels, open and closed-cycle plants, regeneration, inter-cooling and reheating, role and applications. **Diesel Plants**: Diesel plant layout, components & their functions, its performance, role and applications **Economic Operation of Power Systems**:Characteristics of steam and hydro-plants,Constraints in operation, Economic load	30 Hours	1

	scheduling of thermal plants Neglecting and considering transmission Losses, Penalty factor, loss coefficients, Incremental transmission loss. Hydrothermal Scheduling.		
III	**Sub-stations Layout**: Types of substations, bus-bar arrangements, and typical layout of substation. **Power Plant Economics and Tariffs:**Load curve, load duration curve, different factors related to plants and consumers, Cost of electrical energy, depreciation, generation cost, effect of Load factor on unit cost. Fixed and operating cost of different plants, role of load diversity in power system economy. Tariff, power factor improvements.	30 Hours	1
IV	**Non-Conventional Energy Sources**:Power Crisis, future energy demand, role of Private sectors in energy management, **MHD generation:** Working principle, open and closed cycles, MHD systems, advantages, parameters governing power output. **Solar power plant:** Conversion of solar heat to electricity, Solar energy collectors, Photovoltaic cell, power generation, future prospects of solar energy use. **Wind Energy**: Windmills, power output with combined operation of wind turbine generation and isolated generating system, technical choices& economic size. **Geothermal Energy:** Earth energy, heat extraction, vapor turbine cycle, difficulties & disadvantages, Tidal energy: Tidal phenomenon, tidal barrage, tidal power Schemes. **Ocean Thermal Energy:** Introduction, energy conversion, problems.	30 Hours	1

Text & Reference Books:

1. 'Generation of Electrical Energy' by B.R. Gupta, S. Chand Publication.
2. 'A text book on Power System Engineering' by Soni Gupta & Bhatnagar, DhanpatRai& Co.
3. 'Operation and control of Power System' by P.S.R. Murthy, BS Publications.

BEE2013 SPECIALELECTRICAL MACHINES

Course Objective:

1. The subject gives the knowledge about special machines.
2. To give the students a fair knowledge on the servo motors, stepper motors,**r**eluctance motors, universal motors and linear Machines.

Learning Outcome:

At the end of the course, student should be able:

1. To analyze the performance of different types of special machines.
2. To appreciate the applications of them.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Servo motors:** Requirement of a good servomotor, Types of servomotors: D. C. servomotor: Basic working principle and its classification, Field controlled and Armature controlled DC servomotor, Application: servo stabilizer and position control system, AC servo motor: construction, operating principle and Application, Symmetrical components applied to two - phase servo motors -equivalent circuit, Performance based on symmetrical components - servo motor torque - speed curves.	30 Hours	1
II	**Stepper motors**: Construction features - method of operation - drive - amplifiers and transistor logic – Drive, Circuits - half stepping and the required switching sequence, The reluctance type stepper motor – ratings, Characteristics of Stepper Motor- Stepper motor application.	25 Hours	1
III	**Reluctance motors:** General types of synchronous motors - Reluctance motors - definitions - construction – polyphase and split phase reluctance motors - capacitor type reluctance motors, Hysteresis motors - Construction – polyphase - capacitor type and shaded pole hysteresis motors –Methods of reversing direction of rotation in shaded pole motor, Advantage over reluctance motors, Torque develop and slip. **Universal motors:**Applications - torque characteristics	35 Hours	1

	- essential parts of universal motor, EMF due to main filed and cross field - Transformer and rotational emf - circuit model and Phasor Diagram.		
IV	**Linear Machines:**Basic difference between LEMS and rotating – machine, Classification of LEMS, linear motors and levitation machines, Linear induction motors - linear synchronous motors, DC linear motors – linear levitation machines, Edge Effect, MMF wave and its velocity, air gap flux density.	30 Hours	1

Text & Reference books:

1. 'Electrical Machinery' by P.S.Bimbhra, Khanna Publication.
2. 'Electric Machines' by AshfaqHussain, DhanpatRai& Company.
3. 'Electric Machines' by D.P.Kothari&I.J.Nagrath,Tata McGraw Hill.
4. 'Theory of AC Machinery' by Langsdorf A.S., McGraw Hill.

GENERIC ELECTIVE-II

BEE2021 INTRODUCTION TO DIGITAL SIGNAL PROCESSING & IT'S APPLICATION

Course Objective:

1. To understand digital representation of signals: sampling rate, band width.
2. Analyzing Discrete Fourier Transform of discrete signals.
3. To understand the application of Fast Fourier Transform (FFT), Gortezel and Chirp z-transform algorithm for reducing the complex calculations.
4. To design digital filters (IIR and FIR) using different techniques.

Learning Outcome:

1. Understand digital representation of signals: sampling rate, band width.
2. Discrete Fourier Transform of discrete signals.
3. Fast Fourier Transform (FFT), Gortezel and Chirp z-transform algorithm for reducing the complex calculations.
4. Design digital filters (IIR and FIR) using different techniques.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Discrete Fourier Transform:** Introduction, Sampling of Continuous Time Signals and Their Reconstruction, Discrete Fourier Transform (DFT), DFT as linear Transformation, Relationship of DFT to other transforms, Properties of DFT**:** Periodicity, Linearity & Symmetry, Multiplication of two DFTs and Circular Convolution, Additional DFT properties.	30 Hours	1
II	**EFFICIENT COMPUTATION OF DFT:** Introduction, Direct Computation of the DFT, FFT Algorithm, Radix-2 FFT Algorithm: DIT FFT Algorithm, DIF FFT Algorithm, Gortezel Algorithm, Chirp Z-transform Algorithm, Efficient Computation of the DFT of two real sequence computations, Efficient Computation of the DFT of 2N point real sequence..	30 Hours	1
III	**REALIZATION OF IIR & FIR FILTER STRUCTURE** **IIR FILTER STRUCTURE:** Introduction, Direct Form (I & II), Cascade and Parallel Realizations, Signal Flow	30 Hours	1

	Graph, Transposed Structure. **FIR FILTER STRUCTURE:** Introduction, Direct Form Structure, Frequency Sampling Structure, Lattice Structure, Linear Phase FIR Structure..		
IV	**DIGITAL FILTER DESIGN** **FIR FILTER DESIGN:** Introduction, Symmetric and anti-symmetric FIR Filter, FIR filters using Windows, Design of Linear-Phase FIR Filters by Frequency sampling Method, Equip ripple Filter Design, Differentiators, Design of Hilbert Transform. **IIR FILTER DESIGN FROM ANALOG FILTERS:** IIR Filter Design by Approximation of Derivatives, IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation, Matched-z transformation, Characteristics of Commonly used Analog Filters, Application of above technique to the Design of Butterworth and Chebyshev Filter.	30 Hours	1

Text & Reference Books:

1. 'Digital Signal Processing: Principles Algorithms and Applications' by J. G. Proakis and D. G. Manolakis, Pearson Education.
2. 'Digital Signal Processing' by A. V. Oppenheim, R. W. Schafer, Pearson Education.
3. 'Digital Signal Processing A computer based approach' by S. K. Mitra, TMH.
4. 'Theory and Application of Digital Signal Processing' by L. R. Rabiner and B. Gold,Pearson Education.

BEE2022INTRODUCTION TO DEREGULATIONOF POWER SYSTEM

Course Objective:

1. The subject gives the knowledge about introduction of deregulation of power system.
2. To give the students a fair knowledge in deregulation field.

Learning Outcome:

At the end of the course, student should be able:

1. To analyze the Restructuring Models and Trading Arrangements and System Operator (SO).
2. To analyze in detail and understand about Different Models of Deregulation, Operation and control.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction of Deregulation:**Deregulation,Motivations for Restructuring the Power Industry,Restructuring Process-Unbundling & Privatization.	30 Hours	1
II	**Restructuring Models and Trading Arrangements:** Components and Models ofRestructuredElectricity Markets, System Operator (SO), Functions and Responsibilities, TradingArrangements (Pool, Bilateral & Multilateral).	30 Hours	1
III	**Different Models of Deregulation:**UK Model,California Model**,** Australian and New Zeeland Models**,** Deregulation in Asia including India.	30 Hours	1
IV	**Operation and control:** Old vs New, Bidding strategies, Forward and future Market,Market Power, Available Transfer Capability.	30 Hours	1

Text & References Books:

1. 'Power System Restructuring: Engineering andEconomics' by M. Ilic, F. Galiana and L Fink, Kluwer Academic Publishers.
2. 'Restructured Electrical Power Systems' by M. Shahidehpour and M. Alomoush, Volatility, Marcel Dekker Inc.
3. L.L. Lie, Power System Restructuring and Deregulation, John Wiley & Sons, UK.
4. K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Operation of RestructuredPower Systems, Kluwer Academic Publishers, USA.
5. L. Philipson and H.L. Willis, "Understanding Electric Utilities and Deregulation", Marcel Dekker Inc.

BEE2023 INTRODUCTION TO HIGH VOLTAGE DC TRANSMISSION SYSTEM

Course Objective:

1. The subject gives the knowledge about introduction of high voltage DC.
2. To give the students a fair knowledge in the field of DC transmission.

Learning Outcome:

At the end of the course, student should be able:

1. To analyze the Phase controlled rectifiers &HVDC Control and Protection.

2. To analyze in detail and understand about harmonic analysis&recent Scenarios:

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction:** Review of power electronic components, comparison between HVAC and HVDC. **Transmission schemes:** Monopolar, bipolar, back to back.	30 Hours	1
II	**Phase controlled rectifiers:** Thyristorised phase controlled rectifiers and dual converters, Operating principle, Characteristics.	30 Hours	1
III	**HVDC Control and Protection**: Alpha minimum characteristics, Constant current characteristic at rectifier, Constant extinction angle characteristics at rectifier, Active power control, Current control amplifier (CCA), Commutation failure prevention control, Equidistant firing control.	30 Hours	1
IV	**Harmonic analysis**: Harmonic analyzer, Distortion factor (DF), Ripple factor. **Filtering:** Active and passive, AC-DC system interaction. **Recent Scenarios**: HVDC schemes in India and worldwide, Research topics related to HVDC controls	30 Hours	1

Text & References Books:

1. Direct current transmission, volume 1 Edward Wilson Kimbark.
2. High voltage direct current transmission J. Arrillaga.
3. 'HVDC power transmission system' by K.R. Padiyar.
4. 'HVDC and FACTS controller' by V.K.Sood.

GENERIC ELECTIVE-III

BEE2031POWER SYSTEM TRANSIENTS

Course Objective:

1. The subject gives the knowledge about transient's features of power system.
2. To give the students a fair knowledge in transient's field in power system.

Learning Outcome:

At the end of the course, student should be able:

1. To analyze the origin and nature of transients and surges.
2. To analyze in detail and understand about Line energization, de-energization transients, Lightning Phenomenon and Insulation Co-ordination.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Origin and nature of transients and surges:**Surge parameters of plant, Equivalent circuit representations, Lumped and distributed circuit transients.	30 Hours	1
II	**Line energization and de-energization transients:**Earth and earth wire effects, Current chopping in circuit breakers, Short line fault condition and its relation to circuit breaker duty, Trapped charge effects, Effect of source and source representation in short line faultStudies, Control of transients.	30 Hours	1
III	**Lightning Phenomenon:**Influence of tower footing resistance and earth resistance. Traveling waves in distributed parameter multi-conductor lines. Parameters as a function of frequency, Influence of pole opening and pole re-closing	30 Hours	1
IV	**Insulation Co-ordination:** Over voltage limiting devices, Dielectric properties, Breakdown of gaseous insulation, Tracking and erosion of insulation, High current arcs and metallic contacts, Simulation of surge diverters in transient analysis.	30 Hours	1

Text &Reference books

1. 'Transients in Power System' by V. A. Vanikov, Mir Publications, Moscow.
2. 'Traveling Waves on Transmission Lines Bewley' by L.V., Dover Publications Inc., New York.

3. ‘High Voltage Insulation Engineering’ byRavinderaArora, Wolfgang Mosch, New Age International Publishers Limited.
4. ‘Electrical Transients in Power Systems’ by Greenwood, A John Wiley & Sons.

BEE2032INTRODUCTION TOPOWER QUALITY

Course Objective:

1. To study the various issues affecting Power Quality.
2. To learn about production, monitoring and suppression.

Learning Outcome:

At the end of the course, student should be able

1. To study the production of voltages sags, interruptions and harmonics and methods of control.
2. To study various methods of power quality monitoring.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction**: Overview and definition of power quality (PQ), Sources of pollution, International power quality standards and regulations. **Power quality issues:**Rapid voltage fluctuations voltage unbalance, voltage dips and voltage swells, short duration outages, sources of power quality events.	30 Hours	1
II	**Power system harmonics**: Harmonics analysis, harmonic sources- static converters, Transformer magnetization and nonlinearities, Rotating machines, arc furnaces.	30 Hours	1
III	**Harmonic effects and measurement**: **I**nterference within the power system, interference with communication, harmonic measurement, power quality analyzer, transient disturbance analyzer, wiring and grounding tester.	30 Hours	1
IV	**Power quality indices:** Distortion factor, THD, ripple factor, Custom power devices: voltage regulation using DSTATCOM, sensitive load protection using DVR, UPQC.	30 Hours	1

Text & Reference books:

1. ‘Understanding power quality problems: voltage sags and interruptions-Math’ H. J. Bollen.
2. ‘Power quality enhancement using custom power devices’ by ArindamGhosh,Gerard Ledwich.
3. ‘Understanding FACTS: concept and Technology of Flexible AC TransmissionSystems’ by NARAIN G. HINGORANI, LASZLO GYUGYI.

BEE2033RELIABILITY OF POWER SYSTEM

Course Objective:

1. To study the various issues affecting reliability of power system.
2. To study the Generation, Transmission, Distribution & Reliability Systems.

Learning Outcome:

At the end of the course, student should be able:

1. To analyze the Probability and Reliability of the system.
2. To analyze in detail and understand about different evaluation schemes.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Probability and Reliability:** Review of probability concepts, probability distributions, applications of binomial distribution to engineering problems, probability distribution in reliability evaluation, reliability indices, network modeling and evaluation of simple and complex networks, system reliability evaluation using probability distributions, frequency and load duration techniques, key indices of power system reliability and their calculation.	30 Hours	1
II	**Maintainability and Availability:** Introduction, maintainability, availability, system down time, reliability and maintainability trade off, instantaneous repair rate, MTTR, reliability and availability functions. **Generation system Reliability Evaluation:** Concept of loss of load probability (LOLP), Energy demand, E(DNS), Evaluation of these indices for isolated systems, generation system, reliability analysis using the frequency and duration techniques.	30 Hours	1

III	**Transmission System Reliability Evaluation:**Evaluation of LOLP and E(DNS), indices for an isolated transmission system, interconnected system reliability, bulk power system reliability.	30 Hours	1
IV	**Distribution System Reliability Evaluation:** Reliability analysis of radial systems with perfect and imperfect switching.	30 Hours	1

Text Books/References:

1. 'Power System Reliability calculation' byBillinton R., MIT Press, USA.
2. 'Reliability Modeling in Electric Power System' by Endreyni, John Wiley, New York.
3. 'Reliability Engineering' by L. S. Srinath, Affiliated East West Press Ltd.
4. 'Reliability Engineering' by K. K. Aggarwal, Kluwer, Academic Publication.

GENERIC ELECTIVE-IV

BEE2041SIGNAL CONDITIONING AND DATA ACQUISITION

Course Objective:

1. To study the various Conversion Techniques.
2. To study the data Acquisition system&Harmonic Analysis of Periodic Signals.

Learning Outcome:

At the end of the course, student should be able:

1. To analyze the Signal conditioning& various Conversion Techniques.
2. To analyze in detail the data Acquisition system&Harmonic Analysis of Periodic Signals.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Signal Conditioning:** Introduction, Amplification, instrumentation amplifiers, optical amplifiers, A.C. & D.C. amplifiers, Operational amplifier specifications, operational amplifier circuit in instrumentation, Adder, subtractor, inverter, integrator, differentiator, logarithmic converter, Differential amplifier, Modulator, Demodulator, filters, types of filters, low pass, band pass, bridges, current sensitive bridge circuit, voltage sensitive bridge circuit, clipping and clamping circuits.	30 Hours	1
II	**A/D & D/A Conversion Techniques:** Resolution and Quantization, aperture time, Sampling D/A converters, A/D conversion techniques, successive approximation, resistor method, voltage to time A/D converter, voltage to frequency techniques, dual flow integration technique, sample and hold circuit.	30 Hours	1
III	**Introduction to data Acquisition system:**Instrumentation system, types of Instrumentation systems, Components of an Analog-Data-acquisition system, Uses of data acquisition system, Use of recorder in digital system, digital recording system, input conditioning equipment, Digitizer, Multiplexer (TDM, FDM). Land line telemetry, R.F. telemetry, Transmission channels, and Modulation methods.	30 Hours	1
IV	**Harmonic Analysis of Periodic Signals:**Fundamentals	30	1

	of Fourier analysis, Practical harmonic analysis using a wattmeter.	Hours	

Text &References Books:

1. 'Measurement system-Application and design' by E.O.Doebelin.
2. 'Electronic Measurement and Instrumentation by Oliver & Cage.
3. 'Microprocessors & Interfacing' by Douglas V.Hall TATA Mc.Graw Hill.
4. 'Operational amplifier ciecuits'by R.F. Coughlin & Driscoll.

BEE2042 SATELLITE COMMUNICATION ENGINEERING

Course Objective:

1. To study the basic concept of Satellite communication.
2. Knowing the various aspects like orbital mechanics, launching techniques and link design.
3. To study the earth station technology and different access system.
4. To study about Propagation effect in Satellite Communication.

Learning Outcome:

1. Students will gain knowledge in orbital aspects involved in satellite communication.
2. Analyze link budget of satellite signal for proper communication.
3. Ability to know how to place a satellite in an orbit.
4. Ability to calculate the basic parameters in satellite communication.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Elements of Satellite Communication:** Overview of Satellite Communication, Frequency Allocation for Satellite Communication, Kepler's Law, Definition of terms for Earth Orbiting Satellite: Apogee and Perigee Heights, Look Angle Determination. Orbital Perturbations, Launches and Launch Vehicles, Orbital Effects in Communication Systems Performance.	30 Hours	1
II	**Satellite Subsystems:** Attitude and Orbit Control System, Telemetry, Tracking, Command and Monitoring, Power System, Communication Subsystems:	30 Hours	1

	Description, Transponders. Satellite Antennas.		
III	**Link Design and Propagation Effect:** Factors effecting Satellite Design, Basic Transmission Theory: Link Power Budget Equation. System Noise Temperature and G/T Ratio. Uplink Design: Input Backoff. Downlink Design: Output Backoff. Equipments for Earth Stations: LNA, HPA, FDM System, TDM System. Attenuation and Depolarization, Atmospheric Absorption, Rain and Ice Effect.	30 Hours	1
IV	**Satellite Services:** VSAT: Network Architecture, Access Control Protocol, Basic Technique, VSAT Earth Station. Direct Broadcast Satellite: Digital DBS TV, Error Control and Master Control Station. Global Positioning System: Principle of GPS, GPS Receivers and Codes. Satellite Signal Acquisition	30 Hours	1

Text &Reference Book:

1. 'Satellite Communications' by B. Pratt, A. Bostian, Wiley India.
2. 'Satellite Communications' by D. Roddy, TMH, 4th Ed.
3. 'Global Mobile Satellite Communication' by S. D. Ilcev, Springer.
4. **'**Mobile and Personal Communication Systems and Services' by R. Pandya, PHI.

BEE2043INTRODUCTION TO FLEXIBLE AC TRANSMISSION SYSTEM (FACTS) CONTROLLERS

Course Objective:

1. To enable the students gain knowledge on the concepts and technology of flexible AC transmission systems.
2. To learn about AC transmission system.

Learning Outcome:

At the end of the course, student should be able:

1. To understand the need for FACTS.
2. To learn shunt and series compensation techniques.
3. To learn about controlled voltage and face angle regulator.
4. To learn the concept of unified power flow controller.

Course Contents:

Module	Course Topics	Total	Credits

		Hours	
I	**Introduction:** The concept of flexible AC transmission, Reactive power control in electrical power transmission lines, uncompensated transmission line, series and shunt compensation, Overview of FACTS devices, Static Var Compensator (SVC), Thyristor Switched Series capacitor (TCSC), Unified Power Flow controller (UPFC), Integrated Power Flow Controller (IPFC).	30 Hours	1
II	**Static-Var Compensator and application (SVC):** Voltage control by SVC, advantages of slope in dynamic characteristics, Influence of SVC on system voltage, Applications - enhancement of transient stability, Steady state power transfer – enhancement of power system damping, Prevention of voltage instability.	30 Hours	1
III	**Thyristor Controlled Series Capacitor (TCSC) and applications:** Operation of the TCSC, different modes of operation, Modeling of TCSC, variable reactance model, modeling for stability studies. Applications - improvement of the system stability limit, enhancement of system damping, voltage collapse prevention.	30 Hours	1
IV	**Emerging FACTS controllers:** Static Synchronous Compensator (STATCOM) – operating principle – V-I characteristics, Unified Power Flow Controller (UPFC) – Principle of operation - modes of operation – applications, Modeling of UPFC for power flow studies, Coordination of FACT controllerFACTs Controller interactions – SVC–SVC interaction, Co-ordinations of multiple controllers using linear control techniques – Quantitative treatment of control coordination.	30 Hours	1

Text & Reference books

1. Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.
2. A.T.John, "Flexible AC Transmission System", Institution of Electrical andElectronic Engineers (IEEE), 1999.
3. NarainG.Hingorani, Laszio. Gyugyl, "Understanding FACTS Concepts andTechnology of Flexible AC Transmission System", Standard Publishers, Delhi2001.

GENERIC ELECTIVE-V

BEE2051SCADA AND ENERGY MANAGEMENT SYSTEM

Course Objective:

1. To enable the students gain knowledge on factors involved in the SCADA & energy management.
2. To learn how to manage energy.

Learning Outcome:

At the end of the course, student should be able:

1. Controlling a power system by SCADA.
2. To control and supervision of energy management.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**SCADA:** Purpose and necessity, general structure, data acquisition, transmission & monitoring, general power system hierarchical Structure. Overview of the methods of data acquisition systems, commonly acquired data, transducers, RTUs, data concentrators, various communication channels- cables, telephone lines, power line carrier, microwaves, fiber optical channels and satellites. **Supervisory and Control Functions:** Data acquisitions, status indications, majored values, energy values, monitoring alarm and event application processing. Control Function: ON/ OFF control of lines, transformers, capacitors and applications in process in industry - valve, opening, closing etc. Regulatory functions: Set points and feed-back loops, time tagged data, disturbance data collection and analysis. Calculation and report preparation.	30 Hours	1
II	**MAN- Machine Communication:** Operator consoles and VDUs, displays, operator dialogues, alarm and event loggers, mimic diagrams, report and printing facilities.	30 Hours	1

III	**Data basis:**SCADA, EMS and network data basis. SCADA system structure - local system, communication system and central system. Configuration- NON-redundant- single processor, redundant dual processor, multicontrol centers, system configuration. Performance considerations: real time operation system requirements, modularization of software programming languages.	30 Hours	1
IV	**Energy Management Center:** Functions performed at a centralized management center, production control and load management economic dispatch, distributed centers and power pool management.	30 Hours	1

Text &References Books:

1. Torsten Cergrell, "Power System Control Technology", Prentice Hall International.
2. George L Kusic "Computer Aided Power System Analysis",, Prentice Hall of India.
3. A. J. Wood and B. Woolenberg, "Power Generation Operation and Control", John Wiley & Sons.
4. Sunil S Rao, "Switchgear Protection & Control System" Khanna Publishers 11th Edition.

BEE2052INTRODUCTION TOROBUST AND ADAPTIVE CONTROL

Course Objective:

1. To understands the concept of robust and adaptive control along with the structure of the same.
2. Analyzing the stability of linear as well as non-linear systems. To study stability of non-linear systems also.
3. To study the uncertainties present in the system and analysis of robustness.
4. To study the different adaptive control strategies and their robustness.

Learning Outcome:

1. Concept of robust and adaptive control along with the structure of the same. Also the performance objectives and design constraints or the control engineers.
2. Lyapunov stability theory for continuous as well as discrete time system and stability for varying time system also.
3. Different uncertainties present in the system and analysis of robustness.
4. Different adaptive control strategies and their robustness.

Course Contents:

Module	Course Topics	Total Hours	Credits

I	**Introduction:** Overview of classical control, Introduction of robust control and Adaptive control schemes, Features of robust control, Relationship between Non- Adaptive, robust and Adaptive Control, Performance objectives and design constraints for the control engineers.	05 Hours	1
II	**Analysis Tools (Lyapunov's stability theory**): Definition for continuous-time systems, Definition for discrete-time systems, Lyapunov stability theorems, Lyapunov's second method for stability, Stability for linear state space models, Stability for systems with inputs, Barbalat's lemma and stability of time-varying system.	08 Hours	1
III	**Introduction to Robust Control System:** Robust control system and system sensitivity, Analysis of robustness, Systems with uncertain parameters, Types of uncertainties: additive and multiplicative with examples, Design of robust control systems using worse case polynomial and Routh-Hurwitz criteria.	08 Hours	1
IV	**Types of Adaptive Control strategies**: Introduction, Gain Scheduling Regulators, Self-Tuning Regulators. Model Reference Adaptive Control-Robustness of adaptive systems to disturbance and measurement noise-Parameter convergence: persistent excitation- Parameter projection, e-modification, sigma-modification- Adaptive control in the presence of input saturation- Adaptive back stepping-Overview of adaptive output feedback control theory. L1 adaptive control: transient performance and robustness-Norms and gains for signals and systems-Small-gain theorem-Achievable performance: Reference system and guaranteed performance bounds-Design system and decoupled performance bounds- State feedback architecture-Output feedback architecture-Unknown high-frequency gain-Output feedback for non SPR reference systems.	Hours	1

Text &Reference Books:

1. S.H. Zak, Systems and Control, Oxford Univ. Press.
2. H.K. Khalil, Nonlinear Systems, Prentice Hall, N.J.
3. Kemin Zhou, Essentials of Robust Control, Prentice Hall.
4. Feng Lin, Robust Control Design, John Wiley & Sons, Ltd.

BEE2053INTRODUCTION TOINTELLIGENT INSTRUMENTATION

Course Objective:

1. To understand the concept of current trends in the instrumentation engineering.
2. To understand Lab-VIEW, Virtual Instruments (VIs) and sub VIs created on this platform.
3. To understand the different Transducers, sensors and data acquisition in the instrumentation engineering.
4. To understand the structure and working of PC hardware and instrumentation busses.

Learning Outcome:

1. Concept of current trends in the instrumentation engineering.
2. Lab-VIEW, Virtual Instruments (VIs) and sub VIs created on this platform.
3. Different Transducers, sensors and data acquisition in the instrumentation engineering.
4. Structure and working of PC hardware and instrumentation busses.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Virtual Instrumentation:** Introduction to instrumentation and intelligent instrumentation, Software based instruments, Introduction to data flow & graphical programming techniques, Evolution of Virtual Instrumentation, Virtual Instrumentation.Definition, Architecture, Advantage of VI techniques, Presentation, Control and Functional Integration, VIs and sub Vis, Loops and charts, arrays, clusters and graphs, case and sequence structure, formula nodes, string and file I/O, Code Interface Nodes and DLL link.	15 Hours	1
II	**Transducers:** Introduction to transducers, Electro mechanical transducers, Resistance, Inductance, Capacitive and Piezoelectric transducers. Thermoelectric and Photoelectric transducers, Analog and digital transducers including semiconductor and optical type, Application to measurement of temperature, Pressure, Flow, Displacement and other non-electrical quantities.	07 Hours	1
III	**Sensors and Data Acquisition:** **Sensors:** Introduction, Type of sensors, Sensor Standards and Protocols, Sensor Performance Characteristics, Intelligent Sensors. **Data Acquisition:** Introduction to data acquisition	08 Hours	1

	system, A/D and D/A converters, Sample and hold circuit, MUX and DEMUX, Signal transmission, Introduction to DAQ cards.		
IV	**PC Hardware Review and Instrumentation Buses:** Introduction, Structure, Timing and interrupts, DMA, operating system, ISA, PCI, USB and PCMCIA Buses, IEEE488.1 & 488.2 serial, Interfacing-RS 232C, RS422, RS423, RS485, USB, VXI, SCXI, PXI.	10 Hours	1

Text &Reference Books:

1. 'Intelligent Instrumentation' by G. C. Barney, Prentice Hall.
2. Virtual Instrumentation using LABVIEW, J. John, S Gupta.
3. LabVIEW based Advanced Instrumentation Systems, S. Sumathi and P. Surekha.
4. Lisa, K. Wells & Jeffery Travis, "Lab VIEW For every one", Prentice Hall.

OPEN ELECTIVE

OEE2001 ENERGY MANAGEMENT

Course Objective:

1. To develop a deep idea in the field of energy management.
2. To learn about the efficient management of electrical energy.

Learning Outcome:

At the end of the course, student should be able:

1. Understand about the principles of energy audit.
2. May able to understand about electrical load, lighting management and economic aspects of energy management.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction:**Energy sources, Energy demand and supply, Energy crisis, Future scenario, Energy system efficiency, Energy conservation aspects, Instrumentation and measurements. **Principles of Energy Management and Energy Audit:** General principles, Planning and program, Introduction to energy audit, General methodology, Site surveys, Energy systems survey, Energy audit, Instrumentation, Analysis of data and results.	30 Hours	1
II	**Electrical Load and Lighting Management:** General principles, Illumination and human comfort, Lighting systems, Equipment's, Electrical systems, Electrical load analysis, Peak load controls. **Heating and Cooling Management:** General principles of energy managements in HVAC systems, Human comforts and health requirements, HVAC systems, Boiler and heat sources, Chillers, fans, pumps, cooling towers, Modeling of heating and cooling loads in buildings, Energy management opportunities.	30 Hours	1

III	**Process Energy Management:** Principles, Process heat, Combustion, Automatic fuel controls, Steam generation and distribution, Hot water and pumping, Furnaces and ovens, Process electricity, Compressed air, Manufacturing process, Energy storage for process industries, Process control. **Integrated Building systems:** General principles, Environment conformation, Passive design considerations, Building envelope design consideration, Integration of building system, Energy storage-cold storage techniques, Economic analysis.	30 Hours	1
IV	**Economic Aspects of Energy Management:** General considerations, Economic analysis methods, Life-cycle costing, Break even analysis, Benefit cost analysis, Payback period analysis, Present worth analysis, Equivalent annual cost analysis, Use of computers, Management of energy with environment aspects.	30 Hours	1

Text &Reference books:

1. 'Rural Energy Management' by S Kaushik, T Verma, Deep and Deep Publishers.
2. 'Energy Management' by W R Murphy, G Mckay, B.S. Publications.
3. 'Renewable Energy and Energy Management' by S. C. Patra, B.C Kurse, R. Kataki, International Book Co.
4. 'Operations and Maintenance Manual for Energy Management' by J Piper, Standard Publishers.

OEE2002NON-CONVENTIONAL ENERGY RESOURCES

Course Objective:

1. To develop a strong foundation in the field of Non-Conventional energy resources.
2. The subject gives the knowledge about different forms ofNon-Conventional energy.

Learning Outcome:

At the end of the course, student should be able:

1. Understand about Non-Conventional energy resources.
2. May able to apply concept of Non-Conventional Energy Sources over conventional and have sufficient knowledge about Economic Operations of different power plants.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction:** Indian and global energy sources, Energy exploited, Energy planning, Introduction to various sources of energy, Solar thermal, Photovoltaic, Water power, wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy. Solar radiations: Extraterrestrial radiation, Spectral distribution, Solar constant, Solar radiations on earth, Measurement of solar radiations, Solar radiation geometry, flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, Zenith angle, solar altitude angle expression for angle between incident beam and the normal to a plane surface (no derivation), Local apparent time, Apparent motion of sun, Day length.	30 Hours	1
II	**Solar energy:** Solar thermal power and its conversion, Solar collectors, Flat plat, Concentric collectors, Cylindrical collectors, Thermal analysis of solar collectors. Solar energy storage, Different systems, solar pond. Applications, Water heating, Space heating & cooling, Solar distillation, solar pumping, solar cooking, Greenhouses, Solar power plants.	30 Hours	1

	Biogas: Photosynthesis, Bio gas production Aerobic and anaerobic bio-conversion process, Raw materials, Properties of bio gas, Transportation of bio gas, bio gas plant technology & status, Community biogas plants, Problems involved in bio gas production, Bio gas applications, Biomass conversion techniques, Energy plantation, Fuel properties.		
III	**Wind energy:** Properties of wind, Availability of wind energy in India, wind Velocity, win machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Economic issues, Recent development. **Electrochemical effects and fuel cells:** Revisable cells, Ideal fuel cells, other types of fuel cells, Efficiency of cells, Thermions systems. **Tidal power:** Tides and waves as sources of energy, Fundamentals of tidal power, Use of tidal energy Limitations of tidal energy conversion systems. **Hydrogen Energy:** Properties of hydrogen in respect of its use as source of renewable energy, Sources of hydrogen, Production of hydrogen, Storage and transportation, Problems with hydrogen as fuel.	30 Hours	1
IV	**Thermoelectric systems:** Kelvin relations, power generation, Properties of thermoelectric materials, Fusion Plasma generators. **Geothermal energy:** Hot springs, Steam ejection, Principal of working, types of geothermal station with schematic representation, Site selection for geothermal power plants. Advanced concepts Problems associated with geothermal conversion. **Ocean energy:** Principal of ocean thermal energy conversion, Power plants based on ocean energy,	30 Hours	1

	problems associated with ocean thermal energy conversion systems.		

Text &Reference books:

1. ‘Renewable energy soucesa and conversion technology’ by Bansal Keemann, Meliss," Tata McGraw Hill.
2. ‘Non-Conventional energy Sources’ by RaiG.D, Khanna Publishers.
3. ‘Nonconventional Energy’ by Ashok V. Desai, New Age Internantional Publishers Ltd.

BEE2505 ELECTRICAL MACHINES

Course Objective:

1. To develop a strong foundation in the field of electrical machines.
2. About the performance of electrical rotating machines (s).
3. To give the students a fair knowledge on the working of various AC machines & Fractional hp M/c.

Learning Outcome:

At the end of the course, student should be able:

1. To analyze the performance of different types of Tests.
2. Understand about the working of different various DC &AC machines (s).
3. Have sufficient knowledge about electrical machines.
4. To appreciate the applications of them.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Single Phase Transformer:** Phasor diagram, efficiency and voltage regulation, All day efficiency, O.C. and S.C. tests, Sumpner;s test, Polarity test. **Auto Transformer:** Single phase and three phase auto transformers, volt-amp, relation, efficiency, merits & demerits and applications. **Three Phase Transformers:** Construction, three phase transformer phasor groups and their connections, open delta connection, three phase to 2 phase, 6 phase or 12 phase connections, and their applications.	30 Hours	1
II	**D.C. Machines:** Construction of DC Machines, Armature winding, Emf and torque equation, Armature Reaction, Commutation, Interpoles and Compensating Windings, Performance Characteristics of D.C. generators,Performance Characteristics of D.C. motors,Starting of D.C. motors , 3 point and 4 point starters , Speed control of D.C. motors: Field Control , armature control and Voltage Control (Ward Leonard method);Efficiency and Testing of D.C. machines (Hopkinson's and Swinburne's Test).	30 Hours	1

III	**Three phase Induction Machine:** Constructional features, Rotating magnetic field, Principle of operation Phasor diagram, equivalent circuit, torque and power equations. Torque- slip characteristics, no load & blocked rotor tests, efficiency, Induction generator & its applications. **Alternator:**Construction, e.m.f. equation, Voltage regulation and its determination by synchronous impedance method. **Synchronous Motor:** Starting, effect of excitation on line current (V-curves), synchronous condenser. **Servo Motor:** Two phase a.c. servo motor & its application.	30 Hours	1

Text &Reference books:

1. 'Electrical Machinery' by P.S.Bimbhra, Khanna Publication.
2. 'Electric Machines' byAshfaqHussain, DhanpatRai& Company.
3. 'Electrical Machinery' byFitzgerald A.E. & Kingsley, Tata McGraw Hill.
4. 'Electric Machines' by D.P.Kothari&I.J.Nagrath, Tata McGraw Hill.

BEE2555 ELECTRICAL MACHINES & AUTOMATIC CONTROL LAB

Note: To perform at least eight experiments of Electrical Machines and 3 experiments of Automatic Control System:

A. Electrical Machines:

1. To obtain speed-torque characteristics and efficiency of a dc shunt motor by direct loading.
2. To obtain efficiency of a dc shunt machine by no load test.
3. To obtain speed control of dc shunt motor using (a) armature voltage control (b) field control.
4. To determine polarity and voltage ratio of single phase and three phase transformers.
5. To obtain efficiency and voltage regulation by performing O.C. and S.C. tests on a single phase transformer at full load and 0.8 p.floading.
6. To obtain 3-phase to 2-phase conversion using Scott connection.
7. To perform load test on a 3-phase induction motor and determine

(a) speed- torque characteristics (ii) power factor v/s line current characteristics.

8. To study speed control of a 3-phase induction motor using:

(a) Voltage Control

(b) Constant (Voltage/ frequency) control.

9. To perform open circuit and short circuit test on a 3-phase synchronous machine and determine voltage regulation at full load and unity, 0.8 lagging and 0.8 leading power factor using synchronous impedance method.
10. To determine V-curve of a 3-phase synchronous motor at no load, half load and full load.

B. Automatic Control System:

1. To determine transient response of a second order system for step input for various values of constant 'K' using linear simulator unit and compare theoretical and practical results.
2. To study P, PI and PID temperature controller for an oven and compare their performance.
3. To determine speed – torque characteristics of an a.c. 2-phase servo motor.
4. To study and calibrate temperature using Resistance Temperature Detector (RTD)
5. To study dc servo position control system within P and PI configurations.
6. To study synchro transmitter and receiver system and determine output V/s input characteristics.
7. To study open loop and closed loop control of a dc separately excited motor.