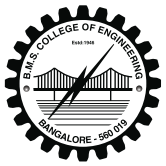

ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ

(ಸ್ವಾಯತ್ತ ವಿದ್ಯಾ ಸಂಸ್ಥೆ)

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Scheme and Syllabus for III – VIII Semester For Batch Admitted 2019

ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ

ಬುಲ್ ಟೆಂಪಲ್ ರಸ್ತೆ, ಬೆಂಗಳೂರು–೫೬೦ ೦೧೯

BMS COLLEGE OF ENGINEERING

Bull Temple Road, Bangalore - 560 019

BMS COLLEGE OF ENGINEERING, BANGALORE-19

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INSTITUTE VISION

Promoting Prosperity of mankind by augmenting human resource capital through Quality Technical Education & Training

INSTITUTE MISSION

Accomplish excellence in the field of Technical Education through Education, Research and Service needs of society

DEPARTMENT VISION

Facilitating the development of competent professionals capable of adapting to the constantly changing global scenario in the field of Electrical Sciences.

DEPARTMENT MISSION

- Impart quality technical education and encourage research in the field of Electrical Sciences.

- Empower every individual to develop as a professional with an ability to apply his/her knowledge and skills to adapt to the evolving technological requirements of society.

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PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives (PEOs) describe the professional accomplishments of our graduates about three-five years after having completed the under-graduate program in Electrical and Electronics Engineering. We describe the progress of our graduates through three PEOs.

The first PEO reflects their professional career pursued and their progress through the knowledge acquired over a period of time through higher education, the second PEO is focused on the utilization of their knowledge technical, analytical and managerial skills for societal progress and on updating them from time to time through career development and training programs.

The last PEO focusses on their display of competence, leadership and dedication in their respective areas of work as they move up the ladder of growth in their profession.

The PEOs of the program are as under:

PEO-1	Possess successful careers in Electrical Sciences, and allied areas and pursue higher education with a broad knowledge base in Mathematics and Engineering principles.
PEO-2	Utilize their technical, analytical, communicative and managerial skills and knowledge for societal progress and enrich them to keep in pace with relevant advancements by engaging themselves in lifelong learning
PEO-3	Exhibit professionalism by displaying competence, leadership, dedication and commitment.

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PROGRAM OUTCOMES (Pos)

Program Outcomes (Pos), are attributes acquired by the student at the time of graduation. The POs given in the Table below, are identical to the Graduate Attributes (GAs) specified by National Board of Accreditation (NBA), and are common across all branches of engineering. These attributes are measured at the time of Graduation, and hence computed every year for the outgoing Batch. The POs are addressed and attained through the Course Outcomes (COs) of various courses of the curriculum, and help in the attainment of the PEOs.

PO 1	**Engineering Knowledge:** Apply the knowledge of mathematics and science engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem Analysis:** identify, formulate, review research literature, and analyze complex engineering problems reaching substantiate conclusions using first principles of mathematics, natural sciences and engineering sciences.
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, societal and environmental considerations.
PO 4	**Conduct investigations of complex problems:** use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid solutions.
PO 5	**Modern tool usage:** create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6	**The engineer and society:** apply reasoning informed by the contextual knowledge to access societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO 8	**Ethics:** apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO 10	**Communication:** communicate effectively on complex engineering activities with the engineering community and with society at large such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and a leader in a team, to manage projects and in multi-disciplinary environments.
PO12	**Lifelong learning:** recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

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PROGRAM SPECIFIC OUTCOMES (PSOs)

The Program Specific Outcomes (PSOs), are defined by the stakeholders of the program, and describe the skills in addition to the POs (defined by NBA), expected from the Electrical and Electronics Engineering student at the time of graduation. Similar to the POs, they are addressed through the outcomes of the courses, exclusive to the branch. The PSOs are developed through the teaching- learning process of various courses of the curriculum. After series of discussions with the stakeholders of the program, the three PSOs are arrived at. Through these PSOs, we attempt to develop the ability to model develop, analyze and assess the performance of systems in the domain of Power systems and Power Electronics and to control and measure the behavior of electrical quantities associated with constituents of energy or allied systems.

PSO-1	Develop models, analyze and assess the performance of different types of generation, transmission, distribution and protection mechanisms in power systems.
PSO-2	Design, develop, analyze and test electrical and electronics systems; deploy control strategies for power electronics related and other applications.
PSO-3	Measure, analyze, model and control the behavior of electrical quantities associated with constituents of energy or allied systems.

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Distribution of Credits among various Curricular Components

Sem	HS	BS	ES	PC	PE	OE	PW	ISR	NC	Total Credits
I		9	11						NC 1	**20**
II		9	11						NC 2	**20**
III	1	4		20					NC 3	**25**
IV	2	4	4	15					NC 4	**25**
V	2			15	6		2		NC 5	**25**
VI	2			11	6	3	2	1	NC 6	**25**
VII	3	2		5	3	3	3		NC 7	**19**
VIII	2					3	9	2	NC 8	**16**
	12	**28**	**26**	**66**	**15**	**9**	**19**			**175**

HS- Humanities and Social Science Course

BS-Basic Science Course

ES-Engineering Science course

PC -Professional Core

PE-Professional Elective

OE-Open Elective

PW-Project Work

ISR-Internship Seminar

NC-Non credit mandatory course

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SCHEME FOR THIRD SEMESTER

Sl No.	Code	Course title	Type	Credits				Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	19MA3BSEM3	Engineering Mathematics -3	BS	3	1	0	4	5	50	50	100
2	19ES3CCECA	Electrical Circuit Analysis	PC	3	1	0	4	5	50	50	100
3	19ES3CCAEC	Analog Electronic Circuits	PC	3	0	1	4	5	50	50	100
4	19ES3CCDEC	Digital Electronics Circuits	PC	3	0	1	4	5	50	50	100
5	19ES3GCFTH	FIELD THEORY	PC	3	1	0	4	5	50	50	100
6	19EE3PCEEM	Electrical and Electronic Measurements	PC	3	0	1	4	5	50	50	100
7	19IC3HSCPH	Constitution of India Professional Ethics and Humanities	HS	1	0	0	1	1	50	50	100
8	19EE3NCPYA	Physical activity (Sports, yoga, Martial Arts)	NC	-	-	-	-	2	-	-	P/NP
		Total		**19**	**3**	**3**	**25**	**33**	**350**	**350**	**700**

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SCHEME FOR FOURTH SEMESTER

Sl No.	Code	Course title	Type	Credits				Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	19MA4BSEM4	Engineering Mathematics -4	BS	3	1	0	4	5	50	50	100
2	19ES4ESCST	Control Systems	ES	3	1	0	4	5	50	50	100
3	19ES4CCLIC	Linear Integrated Circuits	PC	3	0	1	4	5	50	50	100
4	19ES4CCMCS	Microcontrollers	PC	3	0	1	4	5	50	50	100
5	19ES4CCSAS	Signals and Systems	PC	3	1	0	4	5	50	50	100
6	19EE4PCMC1	Electrical Machines-I	PC	3	0	0	3	3	50	50	100
7	19IC4HSEVS	Environmental studies	HS	1	0	0	1	1	50	50	100
8	20HS4ICSAK/ 20HS4ICBAK	*Samskruthika Kannada /Balake Kannada	HS	1	0	0	1	1	50	50	100
8	19EE4NCCLA	Cultural Activity (Music, Dance, Theatre, Folklore)	NC	-	-	-	-	2	-	-	P/NP
		Total		**20**	**3**	**2**	**25**	**32**	**350**	**350**	**700**

*Samskruthika Kannada can be opted by students who have studied Kannada language up to Class XII.

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SCHEME FOR FIFTH SEMESTER

Sl No.	Code		Course title	Type	Credits				Hours	Marks		
					L	T	P	Total		CIE	SEE	Total
1	19EE5PCTND		Transmission and Distribution	PC	3	0	0	3	3	50	50	100
2	19EE5PCMC2		Electrical Machines-II	PC	3	0	1	4	5	50	50	100
3	19ES5CCDSP		Digital Signal Processing	PC	3	0	1	4	5	50	50	100
4	19EE5PCPEN		Power Electronics	PC	3	0	1	4	5	50	50	100
5	19EE5PE1 (Program Elective – I)	DS	Digital system design using Verilog	PE	3	0	0	3	3	50	50	100
		CD	C++ & Data Structures *									
		EA	Electrical Energy Conservation and Auditing									
		MB	Elective based on identified MOOCs									
6	19EE5PE2 (Program Elective – II)	ES	Electrical Energy Systems**	PE	3	0	0	3	3	50	50	100
		AM	Applied Mathematics									
		CS	Communication Systems									
		UP	Utilization of Electric Power									

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SCHEME FOR FIFTH SEMESTER

7	19ES5HSIFE	Innovation for Entrepreneurship	HS	2	0	0	2	2	50	50	100
8	19EE5PWMP1	Mini Project - I	PW	0	0	2	2	4	50	50	100
9	19EE5NCSSK	Soft Skills (Presentation, Technical writing, Public speaking, Team building)	NC	-	-	-	-	2	-	-	P/NP
		Total		**20**	**0**	**5**	**25**	**32**	**450**	**450**	**900**

* This course has an L-T-P of (2-1-0). **This course has an L-T-P of (2-0-1).

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SCHEME FOR SIXTH SEMESTER

Sl No.	Code		Course title	Type	Credits				Hours	Marks		
					L	T	P	Total		CIE	SEE	Total
1	19EE6PCPS1		Power Systems-I	PC	3	1	0	4	5	50	50	100
2	19EE6PCPSP		Power System Protection	PC	3	0	1	4	5	50	50	100
3	19EE6PCMCT		Modern Control Theory	PC	3	0	0	3	3	50	50	100
4	19EE6HSPMT		Product Management Techniques	HS	2	0	0	2	2	50	50	100
5	19EE6PE3 (Program Elective – III)	ED	Control of Electric Drives	PE	3	0	0	3	3	50	50	100
		VL	Circuit Design using VLSI	PE								
		AI	AI techniques to Power System	PE								
		HV	HV Engineering*	PE								
6	19EE6CE1 (Cluster Elective–I)	WS	Wind and Solar Energy systems	PE	3	0	0	3	3	50	50	100
		IT	IoT and its applications	PE								
7	19EE6OE1 (Open Elective–I)	PS	PLC and SCADA (Except EIE)	OE	3	0	0	3	3	50	50	100
		IA	Industrial Automation	OE								

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SCHEME FOR SIXTH SEMESTER

8	19EE6PWMP2	Mini Project -II	PW	0	0	2	2	4	50	50	100
9	19EE6SRISR	Internship Seminar-I	SR	0	0	1	1	2	50	50	100
10	19EE6NCPDC	Professional Development and Communication (PDC)	NC	0	0	0	0	2	00	00	P/NP
		Total		**20**	**1**	**4**	**25**	**32**	**450**	**450**	**900**

* This course has an L-T-P of (2-0-1)

Internship seminar-I includes presentation of work carried out along with report of the internship at the industry / Institution/ valued add courses by the industry/institution attended for a duration of 4-6 weeks during semester breaks.

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SCHEME FOR SEVENTH SEMESTER

Sl No.	Code		Course title	Type	Credits				Hours	Marks		
					L	T	P	Total		CIE	SEE	Total
1	19ES7BSBFE		Biology for Engineers	BS	2	0	0	2	2	50	50	100
2	19EE7PCPS2		Power Systems-II	PC	3	0	1	4	5	50	50	100
3	19EE7PCSPE		Sustainable Practices in Power Engineering (by industry expert)	PC	1	0	0	1	2	50	50	100
4	19EE7CE2 (Cluster Elective–II)	EM	Electrical & Electronics Engineering Materials	PE	3	0	0	3	3	50	50	100
		PQ	Electrical Power Quality									
5	22EE7OE2 (Open Elective – II)	EC	**Electrical Power and Energy Conservation.	OE	3	0	0	3	3	50	50	100
		EV	Electric and Hybrid Vehicles									
6	19EE7PWMPW		Major Project Work- I	PW	0	0	3	3	6	50	50	100
7	19ES7HSPMF		Project Management and Finance	HS	3	0	0	3	3	50	50	100
8	19EE7NCMMC		Mass media communication (Short movies, Documentaries, liberal arts)	NC	-	-	-	-	2	-	-	P/NP
			Total		**15**	**0**	**4**	**19**	**26**	**350**	**350**	**700**

**Except those EEE Students who have taken Electrical Energy Conservation and Auditing -19EE5PE1EA as Program Elective – I

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SCHEME FOR EIGHTH SEMESTER

Sl No.	Code	Course title	Type	Credits				Hours	Marks		
				L	T	P	Total		CIE	SEE	Total
1	19ES8HSIPL	IPR & Cyber Law	HS	2	0	0	2	2	50	50	100
2	19EE80E3 (Open Elective –III)	Operations Research	0E	3	0	0	3	3	50	50	100
		Smart Grid Technologies									
	21EE80E3 (Open Elective – III)	Holistic Approach to Electric Safety									
3	19EE8SRSMR	Internship Seminar-II	PW	0	0	2	2	2	50	50	100
4	19EE8PWMPW	Major Project Work- II	HS	0	0	9	9	18	50	50	100
5	19EE8NCOLC	Online Courses	NC	-	-	-	-	2	-	-	P/NP
		Total		**5**	**0**	**11**	**16**	**27**	**200**	**200**	**400**

Internship seminar includes presentation of work carried out during internships at the industry / institution/ valued add courses conducted by the industry/institution attended.

III Semester Syllabus

BMS COLLEGE OF ENGINEERING, BANGALORE-19
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Course Code	19MA3BSEM3	Course Name	ENGINEERING MATHEMATICS - 3
Credits	04	L – T - P	3 -1- 0

Course outcomes

At the end of the course, the student will have the ability to:

CO 1	Apply Numerical techniques to solve problems arising in engineering.
CO 2	Demonstrate an understanding of Fourier Series, Fourier Transforms and Z- Transforms.
CO 3	Apply the concepts of calculus to functionals.

UNIT-I

MATRICES **9 Hrs**

Introduction: Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of a system of linear equations and solution. Solution of a system of non-homogenous equations: Gauss elimination method, Gauss-Seidel method, LU decomposition method, eigenvalues and eigenvectors of matrices, reduction of a matrix to diagonal form. **(7L + 2T)**

UNIT-II

FOURIER SERIES **9 Hrs**

Introduction: Dirichlet's conditions, Fourier series of periodic functions of period 2π, Fourier series of functions having points of discontinuity. Applications: Fourier series of typical waveforms like saw toothed waveform, triangular waveform, square waveform, half-wave rectifier, full wave rectifier and modified saw tooth waveform, exponential Fourier series, practical harmonic analysis. **(7L + 2T)**

UNIT-III

FOURIER TRANSFORMS **9 Hrs**

Infinite Fourier transform: Fourier Sine and Cosine transforms, properties, Inverse transforms. Convolution theorem, Parseval's identities. **(6L + 3T)**

UNIT-IV

NUMERICAL METHODS **10 Hrs**

Solution of algebraic and transcendental equations: Newton-Raphson method. Finite Differences and interpolation: Forward differences, backward differences. Newton-

Gregory forward interpolation formula, Newton-Gregory backward interpolation formula, Lagrange's interpolation formula, Lagrange's inverse interpolation. Numerical integration: Simpson's $1/3^{rd}$ rule, Simpson's $3/8^{th}$ rule, Weddle's rule.

Numerical solution of ordinary differential equations: modified Euler's method, Runge-Kutta method of fourth order**.** **(8L + 2T)**

UNIT-V

CALCULUS OF VARIATIONS **11 Hrs**

Variation of a functional, Euler's equation, variational problems. Applications: Hanging cable problem, Brachistochrone problem.

Z -TRANSFORMS

Definition, Properties, Transforms of standard functions, Inverse transforms. Solution of difference equations using Z- transforms. **(8L + 3T)**

Choice: **Unit-III and Unit-V**

Text books:

1. Higher Engineering Mathematics, B. S. Grewal,43rd edition, 2014, Khanna Publishers.
2. Advanced Engineering Mathematics, 4th edition, 2011, Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd.

Reference books:

1. Higher Engineering Mathematics, B. V. Ramana, 2007, Tata McGraw Hill.
2. Advanced Engineering Mathematics, Erwin Kreyszig, 10th edition Vol.1 and Vol.2, 2014, Wiley- India.

E Books:

1. https://ocw.mit.edu/courses/mechanical-engineering/2-993j-introduction-to-numerical-analysis- for-engineering-13-002j-spring-2005/lecture-notes/
2. https://www.pdfdrive.com/calculus-of-variations-e34313748.html

Online Courses and Video Lectures:

1. https://nptel.ac.in/courses/111103021/22 (Fourier series and Transforms, Heat and Wave Equations)
2. https://nptel.ac.in/courses/122104018/2 (Numerical Methods)
3. https://nptel.ac.in/courses/111104025/ (Calculus of variation)

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Course Code	19ES3CCECA	Course Name	ELECTRICAL CIRCUIT ANALYSIS
Credits	04	L – T - P	3-1-0

Course outcomes
At the end of the course, the student will have the ability to:

CO 1	Formulate equations based on physical laws and analyze the steady state behaviour of complex electric networks.
CO 2	Apply the knowledge of mathematics and graph theory to the solution of complex electrical networks.
CO 3	Apply mathematical and analytical techniques to analyze transient behaviour of networks.
CO 4	Analyze and model two port networks based on its parameters.

UNIT-I

Basic Concepts: **10 Hrs**

Practical sources, Source Transformations, Network reduction using Star to Delta transformation, vice versa. Loop and nodal analysis with linearly dependent and independent sources for DC and AC circuits, Analysis of networks involving concepts of super node, Super mesh.

UNIT-II

Network Topology: **10 Hrs**

Graph of a network, Concept of tree and Co-tree, Incidence matrix, tie-set, tie-set schedule, cut- set & cut-set schedule, Formulation and solution of equilibrium equations, Principle of duality. Resonant Circuits: Series and parallel resonance, frequency response of series and parallel circuits, Q factor, Bandwidth.

UNIT-III

Network Theorems: **10 Hrs**

Superposition, Reciprocity, Millman's, Thevenin's and Norton's theorems; Maximum power transfer theorem.

UNIT-IV

Transient Behavior and Initial Conditions: **10 Hrs**

Behavior of circuit elements under switching condition and their representation, Evaluation of Initial and Final conditions in RL, RC and RLC circuits. Review of Laplace

transforms, Waveform Synthesis, Initial and Final value theorems, Step, Ramp and Impulse responses, Convolution theorem, solution of simple R-L, R-C, R-L-C networks for AC and DC excitations using Laplace transforms.

UNIT-V

Analysis of Two Port Network and its Parameters: 10 Hrs

Definition of Z,Y,T,H parameters, Modeling, Relationship between parameter sets.

Choice: **Unit-I and Unit-IV**

Text books:

1. "Network Analysis", M.E.Vanvalkenburg, PHI/ Pearson Education, 3rd Edition. Reprint 2002.
2. " Network and systems ", Roy Choudhury, 2nd edition, 2006 reprint, New Age International Publications.
3. Theory and Problems of Electric Circuits, Schaum's Series, 2nd Edition McGrawHill.

Reference books:

1. "Engineering Circuit Analysis", Hayt, Kemmerly and Durbin, TMH 6th 2002.
2. "Network analysis and Synthesis", Franklin F. Kuo, Wiley Edition.
3. "Analysis of Linear Systems", David K. Cheng, Narosa Publishing House, 11th reprint, 2002.
4. "Circuits", Bruce Carlson, Thomson learning, 2000. Reprint 2002.
5. "Network analysis and Synthesis", D. Anand Kumar, PHI Learning, 2019.

E Books:

1. Nptel.ac.in/courses/108105065- Networks signals and systems by Prof T.K. Basu, IIT Kharagpur.
2. Nptel.ac.in/courses/108102042- Circuit Theory by Prof Dutta Roy S.C, IITDelhi
3. www.electrodiction.com/circuit-theory.

MOOCs:

1. http://elearning.vtu.ac.in/06ES34.html
2. https://www.coursera.org/course/circuits

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Course Code	19ES3CCAEC	Course Name	ANALOG ELECTRONIC CIRCUITS
Credits	04	L – T - P	3-1-0

Course outcomes:
At the end of the course, the student will have the ability to:

CO 1	Define ,understand and explain concepts related to diodes and transistors (BJTs and MOSFETs)
CO 2	Apply the knowledge of network theorems to analog electronic circuits
CO 3	Analyze given analog electronic circuits to compute required parameters
CO 4	Design analog electronic circuits for given application and specifications
CO 5	Conduct experiments to demonstrate an application of analog electronics using components/multisim

UNIT-I **8 Hrs**

Diode applications:-Introduction, load line analysis, Series diode configurations, Parallel and series–parallel configurations, clippers, Clampers. **Bipolar Junction Transistor (BJTs):-** DC biasing– Introduction, operating point, voltage divider Bias configuration **BJT AC Analysis:-**Introduction, Application in the AC Domain, BJT Transistor Modeling Transistor model, Voltage Divider Bias

UNIT-II **8 Hrs**

BJT Frequency Response:-Introduction, Logarithms, Decibels , Low frequency Response-BJT Amplifier, Miller effect Capacitance, High Frequency response – BJT Amplifier **Feedback concepts:-**Feedback connection types- Voltage series, Voltage-shunt, Current Series and Current Shunt Feedback. **Practical feedback Circuits:-** Voltage series, Current series feedback and voltage Shunt feedback.

UNIT-III **8 Hrs**

Power Amplifiers:- Introduction- Definitions and Amplifier Types, Amplifier Efficiency
Series-Fed Class A Amplifier:- DC Bias Operation, AC operation, Power Consideration, Efficiency.**Transformer coupled Class A Amplifier:-** Operation of Amplifier Stage : DC load line, Quiescent operating point, AC load line , Signal Swing and Output AC power.
Class B operation:- Class B Amplifier Circuits- Transformer coupled Push- Pull Circuits, Complementary Symmetry Circuits, and Amplifier Distortion.

UNIT-IV **8 Hrs**

MOSFETS:- Introduction, Device structure and physical operation Device structure, operation with no gate voltage, creating a channel for current flow, Applying a small VDS, Operation as VDS is increased, Derivation of the id – VDS relationship, The P- Channel MOSFET, Complementary MOS or CMOS, operating the MOS transistor in the sub-threshold region. **Current voltage Characteristics:-** Circuit symbol, id – VDS characteristics, characteristics of the P- Channel MOSFET **MOSFET Circuits at DC:-** The MOSFET as an amplifier and as a switch - Large – signal operation, Graphical derivation of the transfer characteristic, operation as a switch, operation as a linear amplifier. **Biasing in MOS amplifier circuits:-**Biasing by fixing VGS, Biasing by fixing VG and connecting a resistor in the source, Biasing using a drain to gate feedback resistor, biasing using a current source.

UNIT-V **8 Hrs**

Small – signal operation and models of MOSFETs:- The DC bias point, the signal current in the drain terminal ,the voltage gain, separating dc analysis and the signal analysis, small signal equivalent circuit models, the trans conductance gm, the T equivalent circuit model. **Single stage MOS amplifiers:-**The basic structure, characterizing amplifiers, The CS amplifier, The CS amplifier with a source resistance. Common gate (CG) Amplifier, The common Drain or source follower Amplifier.

IC Biasing:- Current sources, current mirror and current steering circuits- The basic MOSFET current source, MOS current steering circuits. **Current mirror circuit with improved performance :-** The Wilson MOS mirror.

Choice: **Unit-I and Unit-V**

Text books:

1. Electronic Devices and Circuit Theory-Robert L.Boylestad and Louis Nashelsky 10th edition (PEARSON EDUCATION)
2. Microelectronic Circuits-Theory and applications by ADEL S. SEDRA and KENNETH C.SMITH FIFTH EDITION (OXFORD INTERNATIONAL STUDENT EDITION

REFERENCE BOOKS:

1. Electronic Devices and Circuits- Millman and Halkias, TMH
2. Electronic Devices and Circuits**-** David A Bell - PHI 4th edition

E Books:

1. www.pyroelectro.com/edu/analog

2. http://freevideolectures.com/course/3020/circuits-for-Analog-System-Design

MOOCs:

1. https://www.mooc-list.com/course/electronic-systems-and-digital-electronics-uninettuno?static=true
2. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6 012-microelectronic- devices-and-circuits-spring-2009/
3. Introductory Analog Electronics Laboratory (Spring 2007) by MIT open courseware Reviewsand Ratings

LABORATORY EXPERIMENT LIST

Sl.No	Title of the Experiments
1	Performance analysis of Transistor as a switch
2	Zener diode characteristics and Zener as regulator
3	Diode clipping circuits- Single/Double ended
4	Diode clamping Circuits – Positive clamping/negative clamping
5	Performance analysis BJT as RC coupled amplifier
6	Design and analysis of BJT as RC phase shift oscillator
7	Design and analysis of Crystal Oscillators
8	To obtain the characteristics of MOSFET (using simulation tool/hardware)
9	To study MOSFET as an amplifier (using Multisim/hardware)
10	To study voltage series feedback amplifier using BJT (using simulation tool/ hardware)
11	Performance analysis of class – B Power Amplifier
12	Compare the performance of the practical circuit with the corresponding simulation

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19ES3CCDEC	Course Name	DIGITAL ELECTRONIC CIRCUITS
Credits	04	L – T - P	3-0-1

Course outcomes:

At the end of the course, the student will have the ability to:

CO 1	Understand, define and explain the fundamental concepts of Digital circuits
CO 2	Apply the knowledge of simplification methods to optimize a Digital circuit
CO 3	Analyse digital circuits and arrive at suitable conclusions
CO 4	Design a digital circuit for given specifications
CO 5	Conduct experiments using digital ICs for a given application/problem statement

UNIT I **8 Hrs**

Introduction: Review of Boolean algebra, logic gates.

Simplification of Boolean functions: Three Variable, Four Variable and Five Variable K – Maps, The Tabulation Method, Design with Basic gates, NAND gates and NOR gates

UNIT II **8 Hrs**

Combinational Logic Circuits: Introduction, Parallel Adders (Carry Look Ahead Adder and Ripple carry adder), Decimal Adder, Code conversion, Magnitude Comparator, Decoders, Multiplexers, Read Only memories (ROM), Programmable Logic Arrays (PLAs).

UNIT III **8 Hrs**

Sequential Logic Circuits:

The Basic Flip-flop circuit, Clocked Flip-flops, Triggering of Flip-flops: Master Slave Flip-Flops, Edge Triggered Flip Flops, Characteristic Equations, Conversion of flip-flops, Shift Registers, Ripple Counters, Synchronous Counters

UNIT IV **8 Hrs**

Sequential systems:

Analysis of Clocked Sequential circuits, State Reduction and Assignment, Design Procedure, Design with State Equations, Sequence detector

UNIT V **8 Hrs**

Logic Families: Characteristic of Digital ICs, Transistor – Transistor Logic, Complementary MOS (CMOS) Logic, Comparison of TTL and CMOS families.

Choice: Unit-II and Unit-III

TEXT BOOKS:

1. Digital Logic and Computer Design- M. Morris Mano, Prentice Hall – Pearson Education
2. Digital Principles and Design- Donald Givone, Tata Mc Graw Hill

REFERENCE BOOKS:

1. Fundamental of Logic Design- Charles Roth Jr., Thomas Learning
2. Digital Logic Applications and principles- John Yarbrough, Pearson Education

E-Books:

1. http://www.panstanford.com/pdf/9789814364591fm.pdf
2. https://easyengineering.net/digital-logic-and-computer-design-by-morris-mano/
3. https://www.sciencedirect.com/book/9780750645829/digital-logic-design
4. https://easyengineering.net/fundamentals-of-digital-circuits-by-anand-kumar/

Moocs:

1. https://nptel.ac.in/courses/108105113/
2. https://nptel.ac.in/courses/106105185/

Laboratory Experiment List

Sl.No	Title of the Experiments
1	Applications of IC 7483 (Adders, Subtractors and Comparators) (Unit-II)
2	Multiplexers (using Gates and IC) and their applications (Unit-II)
3	Decoders/DeMultiplexers (using Gates and IC) and their applications (Unit-II)
4	BCD to Decimal decoder using 7-segment display (Unit-II)
5	Verification of MSJK Flip-flop (using Gates and IC 7476) (Unit-III)
6	Asynchronous counters (using ICs 7476,7490,7493) (Unit-III)
7	Synchronous Counters (using ICs 7476, 74190/74192) (Unit-III)
8	Shift registers and their applications (using ICs 7476, 7495) (Unit-III)
9	Verification of few parameters of TTL (Unit-V)
10	Verification of few parameters of CMOS (Unit-V)

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19ES3GCFTH	Course Name	FIELD THEORY
Credits	04	L – T - P	3-1-0

Course outcomes:

At the end of the course, the student will have the ability to:

CO 1	Define, understand, and explain concepts on Electrostatics and magnetostatics, Time varying fields and Maxwell's equations, EMI and EMC.
CO 2	Apply various properties/ laws/theorems/ Maxwell's equations of electrostatics, magnetostatics to solve/derive examples in different media of time varying fields.
CO 3	Analyse the given specifications of static and time varying Electric, Magnetic field.
CO 4	Make an effective oral presentation on Electromagnetic transmission norms, radiation hazards, effect on Environment, EMI and EMC.

UNIT-I **10 Hrs**

Introduction to electrostatics: Introduction to line integral, surface integral, volume integral of vectors, Coulomb's Law (vector form), Electric Field Intensity(vector form), EFI due to different typesofcharge distributions.

Electric Flux Density (EFD), Gauss' Law, Divergence: Electric Flux Density (EFD), Gauss' Law, Application, Divergence and Divergence Theorem. **(7L+3T)**

UNIT-II **11 Hrs**

Energy and Potential: Energy spent in moving charge, Definition of Potential Difference (PD), PD due to Point Charge and System of Charge, Energy Density.

Current and current density: Current and Current Density, Continuity of Current, Conductor, Properties, and Boundary Conditions. **(8L+3T)**

UNIT-III **8 Hrs**

Dielectric: Dielectric materials, boundary conditions, Poisson's and Laplace's equations: Derivations of Poisson's and Laplace's Equations, solution of Poisson's and Laplace for Single Variables, Capacitance of different configurations using Laplace's equation.

(6L+2T)

UNIT-IV **10 Hrs**

Steady Magnetic Field:

Biot-Savart Law, Ampere's circuital law, curl, Magnetic Flux, Flux Density, Scalar and Vector Magnetic Potentials, Force on a moving charge, Force on different current element,

Inductance and Mutual Inductance Magnetic Boundary Condition. **(8L+2T)**

UNIT-V **11 Hrs**

Time varying fields and Maxwell's equations: Faraday's Law, Displacement Current, Maxwell's Equations in Point and Integral Form, Uniform plane waves, Wave equations , solution of wave equation, wave propagation through good dielectric, good conductor, skin depth, Poynting Theorem. **(9L+2T)**

Choice: **Unit-II and Unit-V**

Text books:

1. Engineering Electromagnetics H Hayt, J A Buck, MJaleelAkhtar Tata McGraw-Hill, 8thEdition, 2014.
2. Electromagnetics, Schaum's Outline series Joseph A Ediminister Tata McGraw-Hill, revised second Edition, 2014.

Reference books:

1. Electromagnetics with Applications, John Krauss and Daniel A Fleisch, McGraw-Hill, 5th Edition, 1999.
2. "Field and wave electromagnetic", David K Chary, Pearson Education Asia, Second Edition – 1989, Indian Reprint – 2001
3. Mathew N. O. Sadiku "Elements of Electromagnetics," Oxford University Publication 2014.

Course Code	19EE3PCEEM	Course Name	ELECTRICAL AND ELECTRONIC MEASUREMENTS
Credits	04	L – T - P	3-0-1

Course outcomes:

At the end of the course, the student will have the ability to:

CO 1	Identify and select suitable bridges for the measurement of electrical circuit parameters
CO 2	Distinguish the concept behind the operation of analog and digital instruments and Oscilloscopes for the measurement of electrical quantities.
CO 3	Select and justify the choice of a suitable transducer for an application
CO 4	Identify, formulate and solve problems related to measurement of electrical quantities through experiments.

UNIT-I **8 Hrs**

Measurement of Resistance: Wheatstone's bridge, bridge sensitivity, limitations. Kelvin's double bridge, loss of charge method. Problems

Measurement of Inductance and Capacitance: Sources and detectors, Maxwell's LC bridge, Anderson bridge, Desauty's bridge, Schering bridge, Errors in ac bridges and method of minimization. Problems.

UNIT-II **8 Hrs**

Measurement of Power, Energy and Power factor: Construction and working of dynamometer wattmeter, errors, LPF wattmeters. Measurement of reactive power in three phase circuits using one wattmeter. Block diagram and working of Electronic energy meter. Construction and operation of single phase dynamometer type power factor meter. Problems.

UNIT-III **8 Hrs**

Extension of Instrument Ranges: Construction and theory of current transformers. Expression for ratio error and phase angle error in CT. Turns compensation, Silsbee's method of CT testing. Problems.

DC Potentiometer: Construction and operation of Crompton's dc potentiometer. Applications of dc potentiometer. Problems.

UNIT-IV **8 Hrs**

Electronic and digital Intruments: Advantages of electronic instruments. Electronic multimeters. Block diagram and working of Ramp type DVM, Integrating type DVM, Servo balancing type DVM. Resolution and sensitivity.

Oscilloscopes: Block diagram and working of DSO, Measurement of voltage, frequency and phase using CRO .

UNIT-V **8 Hrs**

Transducers: Classification of transducers, selection factors, Operation of potentiometric transducer. LVDT, Strain gauges, RTDs, Thermistors, Thermocouples, Piezoelectric transducers. Problems.

Choice: **Unit-I and Unit-III**

Sl.No	Title of the Experiments
1	Measurement of low resistance by Kelvin's double bridge
2	Measurement of medium resistance by Wheatstone's bridge
3	Measurement of inductance of a given coil by Maxwell's LC bridge
4	Measurement of inductance of a given coil by Anderson's bridge
5	Measurement of Capacitance of a given capacitor by Desauty's bridge
6	Measurement of Capacitance of a given capacitor by Schering bridge
7	Measurement of Reactive power in three phase star/delta connected load by one wattmeter method.
8	Calibration of dc ammeter and dc voltmeter using Crompton's dc potentiometer.
9	Measurement of ratio error and phase angle error in current transformer using Silsbee method
10	Plot output voltage versus displacement characteristic of a LVDT
11	Plot output voltage versus temperature characteristic of a Thermocouple.
12	Measurement of voltage, current, frequency and phase difference between two alternating signals using DSO (Demo)

Text books:

1. Electronic instrumentation-H.S.Kalsi, TMH Education Private limited, New –Delhi. 3rd edition,2012
2. A Course in Electrical & Electronic measurements &instrumentation - A.K.Sawhney, Dhanpat Rai and company (Pvt) limited, New –Delhi. Nineteenth revised edition 2011.

Reference books:

1. Modern Electronic instrumentation & measurement Techniques-William.D. Cooper & A.D.Helfrick, Pearson Education. First edition 2015
2. Electronic instrumentation & measurements-David.A.Bell, Oxford University. 3rd edition 2013

E Books:

http://www.free-engineering-books.com/2013/05/electronic-instrumentation-and.html.

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19IC3HSCIP/ 19IC4HSCIP	Course Name	CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND HUMAN RIGHTS
Credits	01	L – T - P	1-0-0

Course outcomes:

At the end of the course, the student will have the ability to:

CO 1	Understand and explain the significance of Indian Constitution as the Fundamental Law of the Land.
CO 2	Analyse the concepts and ideas of Human Rights.
CO 3	Apply the practice of ethical responsibilities and duties to protect the welfare and safety of the public.

UNIT-I

Introduction to Indian Constitution **3 Hrs**

Historical Background of the Indian Constitution. Framing of the Indian constitution: Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India, Fundamental Rights and its limitations. Fundamental Duties and their significance. Directive Principles of State Policy: Importance and its relevance. Case Studies.

UNIT -II

Union Executive and State Executive **2 Hrs**

The Union Executive – The President and The Vice President, The Prime Minister and The Council of Ministers. The Union Parliament – Lok Sabha & Rajya Sabha. The Supreme Court of India. State Executive – The Governors, The Chief Ministers and The Council of Ministers. The State Legislature – Legislative Assembly and Legislative Council. State High Courts.

UNIT -III

Election Commission of India, Amendments and Emergency Provisions **2 Hrs**

Election Commission of India – Powers & Functions – Electoral Process in India. Methods of Constitutional Amendments and their Limitations. Important Constitutional Amendments – 42nd, 44th, 61st,74th, 76th, 77th, 86th and 91st. Emergency Provisions. Case Studies.

UNIT-IV

Special Constitutional Provisions/ Human Rights **3 Hrs**

Special Constitutional Provisions for Schedule Castes, Schedule Tribes & Other Backward Classes. Women & Children. Case Studies. Human Rights/values – Meaning and Definitions, Legislative Specific Themes in Human Rights and Functions/ Roles of National Human Rights Commission of India. Human Rights (Amendment Act)2006.

UNIT-V

Professional Ethics **3 Hrs**

Scope and Aims of Engineering Ethics, Responsibilities of Engineers and impediments to responsibilities. Honesty, Integrity and Reliability; Risks – Safety and Liability in Engineering. Case Studies.

Text Books:

1. "An Introduction to Constitution of India and Professional Ethics" by Merunandan K.B. and B.R. Venkatesh, Meragu Publications, 3rd edition, 2011.
2. "Constitution of India & Professional Ethics & Human Rights" by Phaneesh K. R., Sudha Publications, 10th edition, 2016.

Reference Books:

1. "V.N. Shukla's Constitution of India" by Prof (Dr.) Mahendra Pal Singh (Revised), Eastern Book Company, Edition: 13th Edition, 2017, Reprint 2019.
2. "Ethics in Engineering" by Martin, W. Mike.,Schinzinger, Roland., McGraw-Hill Education; 4th edition (February 6, 2004) .

E-Book:

1. https://books.google.co.in/books/about/Constitution_of_ India_and_Professional_E.html?id=Vcv uVt-d88QC Constitution of India and Professional Ethics, by G.B. Reddy and Mohd Suhaib, I.K. International Publishing House Pvt. Ltd., 2006.
2. http://www.scribd.com/doc/82372282/Indian-Constitution-M-Raja-Ram-2009#scribd Indian Constitution, by M. Raja Ram, New Age International Pvt. Limited, 2009.

IV Semester Syllabus

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19MA4BSEM4	Course Name	ENGINEERING MATHEMATICS - IV
Credits	04	L – T - P	3-1-0

Course outcomes:

At the end of the course students will have the ability to:

CO 1	Understand the basic concepts of differentiation and integration.
CO 2	Apply the concepts of polar curves and multivariate calculus.
CO 3	Apply analytical techniques to compute solutions of first and higher order ordinary differential equations.
CO 4	Apply techniques of vector calculus to engineering problems.
CO 5	Comprehend the generalization of vector calculus in curvilinear coordinate system.

UNIT-I

STATISTICS AND PROBABILITY **10 Hrs**

Curve fitting – Principle of least squares, fitting a straight line, fitting of a parabola, fitting of exponential curve of the form $y = ab^x$. Correlation and regression.

Probability distributions: Discrete distribution - Poisson distribution. Continuous distribution- Normal distribution. **(8L + 2T)**

UNIT-II

JOINT PROBABILITY AND MARKOV CHAIN **9 Hrs**

Joint Probability Distributions: Discrete random variables, Mathematical expectations, Covariance and Correlation.

Markov Chain: Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chain**.** **(7L + 2T)**

UNIT-III

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS **9 Hrs**

Finite-Difference formulas to partial derivatives. Applications: Solution of one-dimensional

heat equation using 2-level formula and Schmidt explicit formula and Crank-Nicolson two-level implicit formula. Solution of one-dimensional wave equation using explicit three level formula and implicit scheme. **(7L + 2T)**

UNIT-IV

COMPLEX ANALYSIS – 1 **10 Hrs**

Functions of a complex variable, limits, continuity and differentiability of a complex valued function, Analytic functions, properties of analytic functions, Cauchy-Riemann equations in Cartesian and polar form, construction of analytic functions by Milne-Thomson method. Conformal mapping: $w = z^2$ and $w = z + \frac{k^2}{z}(z \neq 0)$. Bilinear transformations. **(7L + 3T)**

UNIT-V

COMPLEX ANALYSIS - 2 **10 Hrs**

Complex integration: Line integral, Problems on line integral, Cauchy's theorem, Cauchy's integral formula. Complex series: Taylor's, Maclaurin's and Laurent's series (without proof)-examples. Zeros, Poles and Residues, Cauchy's residue theorem (without proof)-examples. **(7L + 3T)**

Choice: **Unit-IV and Unit-V**

Text books:

1. Numerical Methods for Engineering, R. P. Kanale and S. C. Chapra, 6th edition, McGraw Hill, Publishers.
2. Higher Engineering Mathematics, B. V. Ramana, 2007, Tata McGraw Hill.

Reference books:

1. Advanced Modern Engineering Mathematics, Glyn James, 3rd edition, 2004, Pearson Education.
2. Higher Engineering Mathematics, B. S. Grewal, 43rd edition, 2013, Khanna Publishers.

E Books:

1. https://www.coursera.org/learn/basic-statistics
2. http://wiki.stat.ucla.edu/socr/index.php/Probability_and_ statistics_EBook
3. https://ocw.mit.edu/courses/mathematics/18-112-functions-of-a-complex-

variable-fall- 2008/lecture-notes/

4. https://www.math.ubc.ca/~peirce/M257_316_2012_Lecture_8.pdf

Online Courses and Video Lectures:

1. https://nptel.ac.in/courses/111105090/ (Probability & statistics-Joint distribution, testing of hypothesis)
2. https://nptel.ac.in/courses/111103070/ (Complex Analysis - Analytic functions, Mobius transformation & Residue theorem)
3. https://nptel.ac.in/courses/111107056/ (Complex Analysis - Complex integration, conformal mapping)

E Books:

1. http://en.wikibooks.org/wiki/Control_Systems
2. http://www.electrical4u.com/control-system-closed-loop-open-loop-control-system/#practical- examples-of-open-loop-control-system
3. http://www.facstaff.bucknell.edu/mastascu/eControlHTML/ CourseIndex.html

Moocs:

1. https://swayam.gov.in/explorer
2. https://www.edx.org/course/

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19ES4ESCST	Course Name	CONTROL SYSTEMS
Credits	04	L – T - P	3-1-0

Course outcomes:

At the end of the course students will have the ability to:

CO 1	Apply the knowledge of engineering fundamentals to form mathematical model and obtain transfer function/state space representation of a system.
CO 2	Design LTI systems for given time/frequency domain specifications using different techniques.
CO 3	Analyse the stability of LTI systems in time/frequency domain using different techniques

UNIT-I **10 Hrs**

Introduction: Examples of Control Systems, open loop vs Closed loop Systems.Mathematical Modeling of Linear Systems: Transfer functions, Mechanical Systems, Analogous Systems, Block diagram, Signal Flow graph, Transfer Functions of Lag & Lead Compensators.

UNIT-II **10 Hrs**

Controllers & Time response analysis:

Step response of first order, second order systems, response specification, steady state error and error constants. Effect of PI, PD and PID controllers on the time response of the system.

UNIT-III **10 Hrs**

Stability Analysis:

Concept of stability, R H criterion, applications of RH criterion with limitations.Root locus technique: Introduction to root locus concepts, Construction rules, Analysis of stability by root locus plot.

UNIT-IV **10 Hrs**

Frequency response Analysis:

Frequency domain specification, Polar plots, Nyquist plot, Stability Analysis using Nyquist criterion, Bode plots, GM and PM, Relative stability.

UNIT-V **10 Hrs**

State Variable Analysis:

Concept of state variables, physical variable model, phase variable model, canonical model, obtaining transfer function from state model.

Choice: Unit-I and Unit-IV

Text books:

1. Control Engineering by Nagrath & Gopal, New Age International Publishers
2. Engineering control systems - Norman S. Nise, John WILEY & sons , fifth Edition

Reference books:

1. Modern control Engineering-Ogata, Prentice Hall
2. Automatic Control Systems- B.C Kuo, John Wiley and Sons

E Books:

1. http://en.wikibooks.org/wiki/Control_Systems
2. http://www.electrical4u.com/control-system-closed-loop-open-loop-control-system/#practical- examples-of-open-loop-control-system

MOOCs:

1. https://swayam.gov.in/
2. https://www.edx.org/course/

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19ES4CCLIC	Course Name	LINEAR INTEGRATED CIRCUITS
Credits	04	L – T - P	3-0-1

Course outcomes:
At the end of the course students will have the ability to:

CO 1	Define, understand and explain the DC and AC performance characteristics of op- amp, applications of op-amp, working of 555 timer and voltage regulators
CO 2	Apply the knowledge of KVL and KCL to obtain voltage/current/waveforms at different points in analog electronic circuits such as op-amp amplifiers, rectifiers, filters, waveform generators, PLL, data converters, regulators, comparators,555 timers.
CO 3	Analyse analog electronic circuits such as op-amp amplifiers, rectifiers, filters, waveform generators, PLL, data converters, regulators, comparators,555 timers
CO 4	Design analog electronic circuits such as op-amp amplifiers, rectifiers, filters, waveform generators, PLL, data converters, regulators, comparators,555 timers
CO 5	Conduct experiments using analog electronic components, electronic instruments to function as amplifiers, comparators, rectifiers, filters, astable and monostable circuits using 555 timer, data converters.
CO 6	Engage in self-study/independent study to formulate, design, implement, analyse and demonstrate an application using analog electronic components/SIM tools through a mini project

UNIT-I **8 Hrs**

Operational Amplifier Characteristics:

Introduction, Amplifiers in closed loop configuration, DC Characteristics, AC Characteristics, Frequency compensation.

Operational Amplifier Applications:

Instrumentation Amplifier, V to I and I to V converter,Op-amp circuits using Diodes – Half wave rectifier, Full wave rectifier, peak detector ,Sample and hold circuit.

UNIT-II **8 Hrs**

Comparators and waveform Generators

Introduction, comparator, Regenerative comparator (Schmitt Trigger), Square wave

generator using Astable Multivibrator, Monostable Multivibrator, Triangular wave generator. Sinusoidal oscillators- RC and Wien bridge oscillators.

UNIT-III **8 Hrs**

Voltage Regulators and Active Filters

Introduction, RC Active Filters, First order low pass filter, second order active filter, Higher order low pass filter, High pass active filter, All pass filter-phase shift lead and lag circuit.

UNIT-IV **8 Hrs**

D-A and A-D converters

Introduction, Analog and Digital data converter, specifications of D/A and basic DAC techniques-weighed resistor DAC, R-2R ladder DAC, A-D Converters: Specifications of A/D converter, classification of ADCs- The parallel Comparator (Flash)ADC, counter type ADC, Successive Approximation Converter, single slope type ADC and Dual slope type ADC, Sigma– delta ADC.

UNIT-V **8 Hrs**

Timers: Functional block diagram of 555, Applications-Astable and Monostable multivibrators, Ramp generator.

Phase locked loops: Introduction, Basic principles, phase detector/comparator, voltage controlled oscillator (VCO), PLL in frequency multiplication/Division

Choice: Unit-I and Unit-IV

Text books:

1. Linear Integrated Circuits-2e-S.Salivahanan & V.S.Kanchana Bhaaskaran (Tata McGraw - Hill Publication)
2. Linear Integrated circuits- D Roy Choudhury &shail B Jain (New Age Publication)

Reference books:

1. Opamps and Linear ICs-David A.Bell (Prentice-Hall Publications) (New age Publication)
2. Op-Amps and Linear Integrated Circuits Ramakanth A.Gayakwad,4th ed,PHI

E Books:

1. https://www.analog.com/en/education/education-library/tutorials/analog-electronics.html
2. https://electronicsforu.com/resources/7-free-ebookstutorials-on-op-amp

MOOCs:

1. https://swayam.gov.in/nd1_noc19_ee39/preview – op amp practical applications:design, simulation and implementation by Dr. Hardik J. Pandya , IISc Bangalore
2. Introductory Analog Electronics Laboratory (Spring 2007) by MIT Open Courseware | Reviews and Ratings
3. http://www.pannam.com/blog/free-resources-to-learn-electrical-engineering/

LABORATORY EXPERIMENT LIST

Sl.No	Title of the Experiments
1	Inverting and non-inverting amplifier, voltage follower
2	Inverting and non-inverting summing Amplifier
3	Precision half wave and full wave rectifier
4	Zero crossing detector and Schmitt trigger
5	Wein bridge Oscillator
6	First order active low pass filter
7	First order active high pass filter
8	IC 723 as low voltage and high voltage regulators
9	D to A converter
10	A to D converter
11	555 as astable multivibrator
12	555 as monostable multivibrator

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19ES4CCMCS	Course Name	MICROCONTROLLERS
Credits	04	L – T - P	3-0-1

Course outcomes:
At the end of the course students will have the ability to:

CO 1	Understand and explain architecture of microprocessors and microcontrollers, pipelining, addressing modes, data types in Embedded C, serial communication, timer configuration and interrupt handling of microcontroller, memory expansion, control signal and wait states
CO 2	Calculate instruction execution time, delay, baud rate, and develop assembly and C Code, identify the timer mode, serial communication mode and interrupt priorities
CO 3	Design an 8051 system by interfacing 8051 to external memory , I/O, peripheral devices and external devices
CO 4	Analyse the code in assembly as well as Embedded C
CO 5	Conduct experiments by simulating, interfacing, debugging and executing the assembly and Embedded C code

UNIT I **8 Hrs**

Fundamentals of Microprocessors: Block diagram approach for Microprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems.

Overview of the 8051 family. The 8051 Architecture Internal Block Diagram, ,address, data and control bus, working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Memory architecture-Harvard and Princeton. Data and Program Memory, Timing diagrams and Execution Cycles, Pipelining.

UNIT II **8 Hrs**

Instruction Set and Assembly Language Programming: Introduction, Instruction syntax, assembler directives, Immediate addressing, Register addressing, Direct addressing,

Indirect addressing, Relative addressing, Indexed addressing, bit inherent and bit direct addressing, 8051 Instruction set- Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions, Assembly language programs.

UNIT III **8 Hrs**

Embedded C Programming: C Data Types, Timer and counter programming, Basics of Serial communication, Programming UART for serial communication, 8051 Interrupt programming.

UNIT IV **8 Hrs**

Memory and I/O Interfacing: 8051 interfacing to external memory- memory address decoding, 8051 interfacing with external ROM, 8051 data memory space, accessing external data memory in 8051 C, interfacing with 8255.

UNIT V **8 Hrs**

Interfacing Applications: Interfacing 8051 to LCD, Stepper motor, DC Motor, ADC and DAC, Sensor interfacing for control applications.

CHOICE: UNIT II and UNIT III

Lab Experiments

PART A: The experiments here can be implemented on a simulator using KEIL IDE.

1. Assembly Language Programs to
   - (i) Data Transfer Operations
   - (ii) Arithmetic, Logical Operations
   - (iii) Conditional Operations
   - (iv) Bit Manipulations
   - (v) Port Functioning
   - (vi) Delay operations using Timers
2. Embedded 'C' programs for Arithmetic, Logical , Port operations on simulator

PART B: Interfacing of hardware modules to microcontrollers such as

- (i) Stepper motor
- (ii) Key Board

(iii) LCD

(iv) ADC, DAC

(v) Serial Communication

(vi) Temperature sensor interface for monitoring and control

(vii) Sensing of humidity and Co2 for control applications

The experiments may be implemented using KEIL IDE with embedded 'c' programming. The application examples may be modified on similar lines as mentioned in PARTB (vi) and (vii)

Text Books:

1. M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, "The 8051Microcontroller and Embedded Systems: Using Assembly and C",Pearson Education, 2007.
2. R. S. Gaonkar, ", Microprocessor Architecture: Programming and Applications with the 8085", Penram International Publishing, 1996

References:

1. K. J. Ayala, "8051 Microcontroller", Delmar Cengage Learning,2004.
2. R. Kamal, "Embedded System", McGraw Hill Education,2009.
3. D.A. Patterson and J.H. Hennessy, "Computer Organization and Design: The Hardware/Software interface", Morgan Kaufman Publishers, 2013.
4. D. V. Hall, "Microprocessors & Interfacing", McGraw Hill Higher Education, 1991.

BMS COLLEGE OF ENGINEERING, BANGALORE-19
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Course Code	19ES4CCSAS	Course Name	SIGNALS AND SYSTEMS
Credits	04	L – T - P	3-1-0

Course outcomes:
At the end of the course students will have the ability to:

CO 1	Apply the knowledge of mathematics to obtain desired parameter of a given signal/system.
CO 2	Analyze the given system in time domain and frequency domain to arrive at valid conclusion.
CO 3	Design a system to meet desired specifications.
CO 4	Ability to engage in independent study to make an effective presentation and submit report on applications of signal processing concepts in various domains.

UNIT-I **11 Hrs**

INTRODUCTION TO SIGNALS: Definitions of a signal, elementary signals, classification of signals and basic operations on signals. **(9L+2T)**

UNIT-II **10 Hrs**

INTRODUCTION TO SYSTEMS: Definitions of a system, properties of systems, systems viewed as Interconnections of operations, Differential and difference equation representations and block diagram representations of LTI systems. **(8L+2T)**

UNIT-III **12 Hrs**

IMPULSE RESPONSE REPRESENTATION OF LTI SYSTEMS:
Introduction to impulse response representation, Convolution Sum and Convolution Integral, relation with system properties, Interconnection of LTI systems (properties of convolution). **(9L+3T)**

UNIT-IV **07 Hrs**

APPLICATION OF FOURIER ANALYSIS: Fourier representation for Four classes of signals, properties of Fourier transform (proof excluded), frequency response of LTI systems, solution of difference and differential equations. **(5L+2T)**

UNIT-V **10 Hrs**

APPLICATIONS OF Z-TRANSFORMS: Introduction to bilateral and unilateral Z-transforms, Properties (proof excluded), Analysis of LTI Systems: Transfer function and structures for implementing LTI system, Causality and stability, frequency response, and solution of difference equations. **(7L+3T)**

Choice: Unit-I and Unit-III

Text books:

1. Simon Haykin and Barry Van Veen "Signals and Systems", John Wiley & Sons, 2001.Reprint 2002
2. Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, "Signals and Systems" Pearson Education Asia/ PHI, 2nd edition, 1997. Indian Reprint 2002

Reference books:

1. H. P Hsu, R. Ranjan, "Signalsand Systems",Scham's outlines, TMH, 2006
2. B. P.Lathi, "Linear Systems and Signals",Oxford UniversityPress, 2005
3. Ganesh Rao and SatishTunga, "Signals and Systems", Sanguine Technical Publishers, 2004

E Books:

1. NPTEL lecture Video on Signals and Systems by Prof. S.C.Dutta Roy, http://www.satishkashyap.com/2012/04/iit-video-lectures-on-signals-and.html
2. NPTEL lecture Video on Signals and Systems by Prof. T.K. Basu,IIT Kharagpur. http://www.nptel.ac.in/courses/108105065/
3. NPTEL on line Course Modules–IIT Bombay –Signals and Systems http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Signals%20a nd%20System/TOC-M1.html

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19EE4PCMC1	Course Name	ELECTRICAL MACHINES -I
Credits	03	L – T - P	3-0-0

Course Outcomes:
At the end of the course, the student will have the ability to:

CO 1	Describe the operating principles and characteristics of Transformers and Induction Motors.
CO 2	Analyze the operation of Transformers and Induction Motors using phasor diagrams and circuit model of machines
CO 3	Describe the methods of testing and estimate performance of Transformers and Induction motors

UNIT-I **8 Hrs**

Single Phase Transformers: Resistance and leakage reactance, Practical transformer - vector diagram of practical transformer on load, Lumped parameters, Equivalent Circuit model of a transformer-Approximate and simplified, OC and SC tests- predetermination of Efficiency, Voltage regulation, parameters of equivalent circuit.

Three Phase Transformers – Introduction, Constructional features of three phase transformers, choice between single unit and bank of three single phase transformers, Three phase transformer connections – star-star, star-delta, delta-star, delta-delta, open delta (V-V), Comparative features.

UNIT-II **8 Hrs**

Testing and parallel operation of transformers:

Polarity test, Back to Back test, Parallel operation of transformers – Necessity of Parallel operation, conditions for parallel operation - single phase and three phase, Load sharing in case of similar and dissimilar transformers.

Auto Transformers: Construction, principle, applications and comparison with two winding transformers (Cu- Saving).

Tap changing transformers: No load and on load tap changing transformers.

UNIT-III **8 Hrs**

Three phase Induction Motor - Principle of operation-slip, frequency of rotor current/EMF, speed of rotor field, rotor EMF, rotor current and power factor. Rotor Torque - Expression for rotor torque, Torque - slip curve, starting torque, Full load torque, pull out torque. Effect of parameter variation on torque speed characteristics (Variation of stator

and rotor resistances, stator voltage, frequency). Losses and power flow in three phase Induction motor- rotor output and motor torque, synchronous watt. Equivalent circuit model - Electrical equivalent of mechanical load, relation between rotor input and rotor cu-loss, Phasor diagram of three phase Induction motor. Comparison of three phases IM and Transformer. Methods of starting and speed control of three phase Induction motors

UNIT-IV **9 Hrs**

Testing and performance of Three Phase IM - Stator resistance test, no load test, blocked rotor test. Circle diagram – construction and predetermination of performance (efficiency, slip, torque, power factor, and current, at any given load and at maximum conditions), factors affecting performance of three phase Induction motor, cogging and crawling. High torque cage motors – Deep bar cage rotor motor, double cage rotor motor. Applications of three phases Induction motor, Measurement of slip – Stroboscopic method, Induction Generator-Self Excitation, Doubly fed Induction machines.

UNIT-V **7 Hrs**

Single Phase Induction Motors

Constructional features double revolving field theory, equivalent circuit, determination of parameters, Split-phase starting methods and applications.

Choice: Unit-I and Unit-III

Text books:

1. Theory and performance of Electrical Machines- J.B. Gupta, S.K. Kataria and sons-New Delhi,2013
2. Electrical Machinery - Dr. P.S. Bhimbra, ,Khanna Publications, 7th Edition, 2007.
3. Principles of Electric Machines and Power Electronics - P.C Sen, John Wiley and Sons,2007.
4. Electric Machinery- A.E. Fizgerald and C. Kingsley, McGraw Hill Education 2013.

Reference books:

1. Electric Machines – Ashfaq Husain, Dhanpat Rai and Co. , Second Edition,2014
2. Performance and Design of Alternating Current Machines- M. G. Say, John Wiley and Sons Publications, 3 rd Edition,2002
3. Alternating current Machines – A S Langsdorf, McGraw Hill Education -1984.

E Books:

1. http://nptel.ac.in/courses/108105017/
2. http://nptel.ac.in/courses/108106072

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19IC4HSEVS	Course Name	ENVIRONMENTAL STUDIES
Credits	02	L – T - P	2-0-0

Course Outcomes:

At the end of the course, the student will have the ability to:

CO 1	Understand the components and impacts of human activities on environment.
CO 2	Apply the environmental concepts for conservation and protection of natural resources.
CO 3	Identify and establish relationship between social, economical and ethical values from environmental perspectives.

UNIT I

INTRODUCTION TO ENVIRONMENT: 6 Hrs

Definition about Earth, atmosphere, hydrosphere, lithosphere and biosphere. Structure of Atmosphere: Troposphere, Stratosphere, Mesosphere, Ionosphere, Exosphere. Internal structure of the Earth: Crust, Mantle, Core. Ecosystem, types of Ecosystem: Land, Forest, Water, Desert, Marine. Effects of Human activities on Environment: Agriculture, Housing, Industries, Mining and Transportation.

UNIT II

NATURAL RESOURCES: 6 Hrs

Water resources: availability, use and consequences of over utlisation, water conflicts. Case studies Mineral resources: Definition, types, environmental impact of mining. Forest resources: Uses, effects of deforestation, remedial measures. Energy resources: renewable and non-renewable, growing needs, types of energy resources: hydroelectric, wind power, fossil, solar, nuclear and bio gas. Hydrogen as an alternate future source of energy.

UNIT III

ENVIRONMENTAL POLLUTION: 6 Hrs

Introduction, causes, effects and control measures.

Water pollution, land pollution, noise pollution, air pollution and marine pollution-case studies. Environmental management: Solid waste, hazardous waste, e-waste, bio medical waste.

UNIT IV

SOCIAL ISSUES AND ENVIRONMENT 4 Hrs

Population growth. Climatic changes: Global warming, acid rain, ozone layer depletion.

Water conversation: rain water harvesting and ground water recharging. Disaster management: floods, earthquakes, landslides-case studies
Environmental Protection Acts: Air, Water, land and Noise (Prevention and Control of pollution), Forest conservation, Wildlife protection.

Text Books:

1. Environmental studies by - Dr. Geethabalakrishanan (Revised Edition)
2. Ecology by – Subramanyam (Tata McGraw Hill Publication)
3. Environmental studies by – Dr. J.P.Sharma (Third edition)
4. Environmental studies by – SmritiSrivastav

Reference Book:

1. Environmental studies by – Benny Joseph
2. Environmental studies by – Dr. D.L.Manunath

LEARNING RESOURCES:

1. NPTEL (Open Sources / power point and visuals)
2. Ecological studies / IITR / Open Sources
3. Ministry of Environment and forest & wildlife.

MOOC's:

MOOCS – https://www.coursera.org / course / sustain

V SEMESTER SYLLABUS

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19EE5PCTND	Course Name	TRANSMISSION AND DISTRIBUTION
Credits	03	L – T - P	3-0-0

Course Outcomes:

CO 1	Select a suitable insulator & design the transmission line for the required sag.
CO 2	Develop mathematical models of the transmission line with different configurations and determine the parameters
CO 3	Develop network models of different types of transmission lines and assess their performance.
CO 4	Analyze and distinguish different distribution system topologies, underground cable grading and earthing types and their basis for selection.
CO 5	Ability to engage in independent study to make an effective presentation and submit report on applications of transmission and distribution concepts in various domains.

PRE-REQUISITES:

Knowledge of Basic Electrical Engineering, Field Theory

COURSE DESCRIPTION:

This course discusses insulators used for the overhead lines along with the string efficiency and methods to improve it, mechanical design of transmission lines including the sag and tension calculations, wind and ice loadings, insulated cables including the grading and calculation of capacitances in single core and three core cables, The fundamental concepts and detailed calculations of line parameters such as inductances and capacitances, performance analysis of the overhead lines with different equivalent models used for the calculation of regulation and efficiency, types of distributors and grounding system.

UNIT-I **08 Hrs**

TYPICAL TRANSMISSION & DISTRIBUTION SYSTEMS SCHEME- Standard voltages for generation, transmission and distribution. Advantages of high voltage transmission. Feeders, distributors &service mains. Mechanical design of Transmission Lines- Types of conductors, conductor materials , Calculation of sag in conductors i) At equal supports ii) At different level supports. Effect of ice covering and wind pressure, factors affecting sag.

Overhead Line Insulators-Types of insulators, potential distribution over a string of suspension insulators. String efficiency & methods of improving string efficiency.

UNIT-II **08 Hrs**

CABLES: General construction of a cable, types of cables, material used, expression for insulation resistance, dielectric stress, power factor, capacitance, charging current of a single core power cable, grading of cables, capacitance grading & inter sheath grading, measurement of capacitance of a three core cable, determination of maximum current carrying capacity of cables.

SUB STATION: Classification of substations – indoor and outdoor, Selection of site for substation, Busbar arrangement schemes and single line diagrams of substations.

UNIT-III **08 Hrs**

LINE PARAMETERS-Calculation of inductance of single phase, 3 phase line with equilateral & unsymmetrical spacing (transposed), calculation of capacitance of a single phase line, 3 phase line with symmetrical and unsymmetrical spacing (transposed) without considering the effect of earth on transmission line capacitance.

CORONA: -Phenomena, disruptive and visual critical voltages, corona loss. Advantages and disadvantages of corona. Methods of reducing corona.

UNIT-IV **08 Hrs**

MODELING AND PERFORMANCE OF TRANSMISSION LINES: Classification of lines, Short Transmission lines, medium Transmission lines - nominal T method, nominal π method and long transmission lines – Rigorous solution method, ABCD constants of Transmission lines, calculation of voltage regulation and transmission efficiency.

UNIT-V **08 Hrs**

DISTRIBUTION NETWORK: Classification, radial distribution systems, ring distribution system, DC distribution system with concentrated loads and uniform loading, AC distribution.

EARTHING: Basic terms of earthing, methods of neutral grounding.

Choice: **Unit-I and Unit-III**

Text books:

1. Electrical Power Transmission and Distribution-S. Sivanagaraju and S. Satyanarayana, Pearson Education,2009

2. Transmission and Distribution of Electrical Power - J.B.Gupta, S.K.Kataria and sons,10th edition,2012

Reference books:

1. Elements of Power System Analysis- W.D. Stevenson, Mc.Graw - Hill. Comp.Ltd,1994
2. Electric power generation Transmission & Distribution- Dr. S. N. Singh, PHI learning Pvt Ltd, New Delhi, 2nd Edition,2010
3. Electrical Power Systems- C.L.Wadhwa, New Age International publishers, 6th Edition,2013

E Books:

1. NPTEL courses in Electrical Engineering :Power system generation, Transmission & distribution: Video Lecture Numbers:10,11,12,13, 18,19,20,23 by Prof .D. P. Kothari, Centre for Energy Studies ,IIT New Delhi.

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19EE5PCMC2	Course Name	ELECTRICAL MACHINES-II
Credits	04	L – T - P	3 -0- 1

Course outcomes
At the end of the course, the student will have the ability to:

CO 1	Describe the constructional details, principle of operation, characteristics and speed Control of DC machines and select DC motors for specific application.
CO 2	Evaluate the performance of DC machine by testing them in both generating and motoring modes
CO 3	Describe the constructional details, principle of operation of synchronous machine in generating and motoring modes and their selection for specific application
CO 4	Evaluate the performance of synchronous machine during parallel operation.
CO 5	Laboratory testing of electrical machines to obtain performance and characteristic

UNIT-I **08 Hrs**

DC machine

Construction, DC armature windings- Terminology and Types, Circuit model of a DC machine- generating and motoring modes, Characteristics of generator and motor (Qualitative analysis only),Armature Reaction, Commutation. Power flow in DC machines - Motoring and Generating modes. Speed control of DC shunt and DC series motors - Voltage, Flux, and Armature Rheostat control, Applications of DC machines.

UNIT-II **08 Hrs**

Testing of DC machines

Direct and indirect methods, predetermination of losses and efficiency by Swinburne's test Hopkinson's test and Retardation test. Field test on DC series motor

UNIT-III **08 Hrs**

Synchronous Machine:

Synchronous generators: Operating Principle, constructional features - revolving field vs revolving armature, stator construction, salient pole type and non-salient pole type rotor construction, winding factors ,EMF equation, wave shape of EMF induced, armature

reaction and its nature in Synchronous Generators.

Synchronous Motor: Principle of operation, methods of starting, nature of armature reaction in synchronous motors, power flow and efficiency of synchronous motor, Hunting and Damping, Applications of synchronous machines.

UNIT-IV **08 Hrs**

Voltage regulation and methods of synchronization:

Synchronous impedance, OC and SC tests, Voltage regulation, predetermination of voltage regulation by EMF, MMF and ZPF methods. Slip test on salient pole alternator, voltage regulation of salient pole alternator using Xd and Xq. Need and conditions for parallel operation of alternators, Methods of synchronizing a three phase alternator to bus bars (all dark lamps method, two bright one dark lamps method). Load sharing between two alternators in parallel.

UNIT-V **08 Hrs**

Expression for power exchanged between bus bars and the Synchronous machine with and without armature resistance, conditions for maximum power, Power angle characteristics, Effect of change in excitation, effect of change in prime mover input and effect of change in load for both generating and motoring modes.

Choice: **Unit-I and Unit-IV**

Text books:

1. Theory and Performance of Electrical Machines- J.B. Gupta, S.K. Kataria and Sons-New Delhi.
2. A Course in Electrical machines, Prof. Bimbra

Reference books:

1. Theory of Alternating Current Machinery- Alexander S. Langsdorf, Tata Mcgraw-HillPublishing Company Limited, New Delhi, Second Edition. [Methods of Synchronization]
2. Electrical Machines – Abhijit Chakrabarti ,Sudipta Debnath, Mcgraw Hill Education (India) Private Limited, New Delhi
3. Electrical Machines - I.J. Nagrath D.P. Kothari, Tata Mcgraw-Hill Publishing

Company Limited, New Delhi, Second Edition

E Resources:

1 http://nptel.ac.in/courses/108105017/

2 http://nptel.ac.in/courses/108106072

3. YouTube Videos on DC Machines and Synchronous machines by IIT Delhi

LIST of Laboratory experiments:

1. Swinburne's Test
2. Hopkinson's Test
3. Retardation Test
4. Parallel operation of two single phase Transformers
5. No load and Blocked rotor tests on 3 phase Induction motor
6. Predetermination of Voltage Regulation of non-salient pole alternator by EMF and MMF methods
7. Slip Test on salient pole alternator for predetermination of voltage regulation.
8. Predetermination of Voltage Regulation of non-salient pole alternator by ZPF method.
9. Synchronization of alternator with bus bars.
10. V- curves of Synchronous motor

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19ES5CCDSP	Course Name	DIGITAL SIGNAL PROCESSING
Credits	04	L – T - P	3-0-1

Course outcomes: The course outcomes will be attained through theory and laboratory assessments.

At the end of the course, the student will have the ability

CO 1	To apply knowledge of Mathematics and Engineering to understand Sampling and Reconstruction of signals from the given samples.
CO 2	To identify and analyze a signal and its sampling frequency, determine the computing requirements to obtain the DFT and Power Spectral Density of given signals.
CO 3	To implement the processes of FFT to reduce the computational complexity and to increase the speed and thereby perform long data sequence convolution.
CO 4	To Design and implement Filter algorithms and realize real time Digital Signal Processing
CO 5	To understand and formulate algorithms of Multi-rate signal processing using sampling rate conversion for signal analysis/ synthesis.
CO 6	To use current techniques and modern tools to carry out the Adaptive filtering as a perquisite to Data science.

Prerequisites: Signals and systems

UNIT-I **08 Hrs**

Introduction to DSP, Frequency-domain Sampling ,DFT , IDFT, DFT as a Linear Transformation (Matrix formulation), Properties of DFT: Periodicity, Linearity, Circular Time shifting, Circular Frequency Shifting, Circular Time Reversal, Conjugation and Conjugate Symmetry (Symmetry properties), Duality, Circular Convolution (Multiplication of two DFTs),Circular correlation, Multiplication (or Modulation) property, Parseval's Relation.

UNIT-II **08 Hrs**

Use of DFT in linear filtering, linear convolution of two finite duration sequences, overlap add and save methods. Relation between DFT and other transforms. Direct computation of DFT. Necessity for efficient computation of DFT. Radix 2 Fast Fourier Transform (FFT) algorithm for DFT computation. Decimation in time algorithm, decimation in frequency algorithms. Radix 2 FFT algorithm for computation of Inverse Discrete Fourier Transform. (IDFT).

UNIT-III **08 Hrs**

Introduction to realization of digital systems, block diagrams representation, Realization of Infinite Impulse Response (IIR) systems: parallel form, cascade form. Introduction to IIR filters, Pole zero placement method for simple IIR Filters, Impulse invariant & Bilinear Transformations, Design of analog Butterworth and Chebyshev filters, Design of Digital Butterworth and Chebyshev filters.

UNIT-IV **08 Hrs**

Realization of Finite Impulse Response (FIR) systems: Direct Form, Linear Phase Form. Introduction to FIR filters, Frequency response of ideal digital low pass filter, high pass filter, Frequency sampling technique of designing FIR filters, Windowing design of FIR filters using Rectangular, Triangular & Hamming windows.

UNIT-V **08 Hrs**

Application of digital filters in noise cancellation; Limitations of Linear filters, Random noise cancellation, Adaptive filters, LMS Algorithm, Applications. Decimation by a factor D, Interpolation by a factor I, Sampling conversion by a Rational factor I/D. Introduction to Multi-rate Digital Signal Processing.

Choice: **Unit-I and Unit-III**

Text books:

1. Digital Signal Processing, Principles, Algorithms and Applications, John G. Proakis, Dimitris K Manolakis, Pearson education/PHI, (4th Edition)
   e-book: https://www.amazon.com/Digital-Signal-Processing-John-Proakis/dp/0131873741
2. Digital Signal Processing, Tarun Kumar Rawat, Oxford University Press (16 December 2014)
   e-book:https://www.amazon.in/Digital-Signal-Processing-Tarun-Kumar/dp/0198081936

Reference books:

1. Fundamentals of Digital Signal Processing, Lonnie Ludeman, John Wiley & Sons; Wiley International 1st Edition, 1988.
2. Discrete-Time Signal Processing, Alan V. Oppenheim, Ronald W. Schafer, John R. Buck, Prentice-Hall Signal Processing Series, 2nd Edition, 1999

3. Understanding Digital Signal Processing, Richard G. Lyons Prentice Hall, March 25, 2nd Edition 2004
4. Digital Signal Processing: Fundamentals and Applications, Li Tan, Academic Press, 1st edition 2007
5. Schaum's Outline of Digital Signal Processing, Monson Hayes, McGraw- Hill, 1st edition, 1998

E-Learning:

1. https://nptel.ac.in/courses/117/102/117102060/
2. https://nptel.ac.in/noc/courses/noc17/SEM1/noc17-ee05/

LIST OF LAB EXPERIMENTS: -

1. Signal Generation i.e. Generation of Elementary signals.
2. Listen to sounds by signals and the effect of sampling on it.
3. To study the relation between analog angular frequency in radians /second and digital angular frequency Ω in radians/sample.
4. Sampling theorem and its significance. Aliasing effects
5. Obtaining information about the frequency components present in a signal from the available samples of the signal in the time domain.
6. Reconstruction of a signal given, from information about it in the frequency domain. To determine the Inverse Discrete Fourier Transform (IDFT)of a sequence and a signal.
7. To obtain the frequency response of a signal using the built in FFT function in MATLAB and to interpret the results indicated by the FFT plot.
8. Study of Digital Low Pass Filters and their application to removal of distortions in an input signal.
9. Study of Digital High Pass Filters and their application to removal of distortions in an input signal.
10. Compute and plot the power spectral density of the composite signal.
11. Write a program to compute convolution of the two sequences (x[n]*h[n]) and plot the sequence and convolved signal.
12. Find circular convolution using FFT of the given two sequences.
13. Write a program to up sample and down sample a given sequence.
14. Write a program to up sample and down sample a given sequence by a sampling factor

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE5PCPEN	Course Name	POWER ELECTRONICS
Credits	04	L – T - P	3-0-1

Course Outcomes:

CO 1	Explain the working ,sketch the steady state and dynamic characteristics of power semiconductor devices, power converters, compare their performances, effects, derive expressions for their performance parameters etc.
CO 2	Formulate equations and estimate and design circuit components, power loss for given specifications of device operation.
CO 3	Apply relevant expressions to analyze the performance of power converters.
CO 4	Independently, and in a group study, collate information/data, comprehend a topic
CO 5	Make effective technical presentations on the work carried out and communicate effectively to an audience.
CO 6	Design, simulate and build efficient power conversion systems/subsystems for given specifications for various applications and effectively interpret the results obtained.

Course Description :

The course deals with the principle of operation and characteristics of various power switching devices both classical and emerging.and the ,principle and analysis of operation of power conversion systems such as controlled rectifier circuits, inverters and DC choppers.

UNIT-I **08 Hrs**

Introduction - Applications of Power Electronics, introduction to switching devices: Ideal characteristics, characteristics of practical devices, Power Semiconductor Devices, Control Characteristics of Power Devices, types of Power Electronic Circuits, peripheral Effects. Power Diodes, Types : Rectifier, Schottky barrier, Fast Recovery, Ultra Fast and their usage, Thyristors, device model, switching characteristics, di/dt and dv/dt limitations.Power BJTs: Steady state characteristics (Qualitative analysis only). Power MOSFETs: device operation, switching characteristics, IGBTs: device operation, output and transfer characteristics, switching characteristics. Gate drive circuits: MOSFET/IGBT gate drivers, Isolation of gate drives, snubber circuits.

UNIT-II **08 Hrs**

DC-DC Converters - Introduction, principle of step-down operation and it's analysis with RL load (only CCM mode of operation), and principle of step-up chopper with R load, performance parameters, Chopper/Converter classification (Quadrant classification). Steady-State Analysis of First-Quadrant Chopper-Fed dc-Motor Drive.

UNIT-III **08 Hrs**

Emerging Technologies and New devices :

Introduction to wide band gap power devices SiC and GaN devices, Types of SiC Power Devices, SiC MOSFET Device Structure and Features, Vd-Id characteristics, Drive Gate Voltage and ON Resistance, SiC Power Modules**.**

UNIT-IV **08 Hrs**

Controlled rectifiers - Introduction, principle of phase controlled converter operation, Single phase fully controlled converters, Single phase semi-converters, Three phase fully controlled converters (RL load, Continuous current conduction operation only). Introduction to Power Factor Correction Method : Passive and Active PFC Corrections.

UNIT-V **08 Hrs**

Inverters- Introduction, principle of operation, performance parameters, Single phase bridge inverters, Three phase inverters, voltage control of single phase inverters- single pulse width, multiple pulse width and sinusoidal pulse width modulation, Current source inverters.

Choice: **Unit-I and Unit-IV**

Text books:

1. Power Electronics – Circuits, Devices and Applications - Muhammad H Rashid, Pearson edition pvt ltd , Third Edition,2004

eference books:

1. Power Electronics – Converters, Applications and Design - Ned Mohan, Tore M. Undeland and William P Robbins, John Wiley &sons , 3rd Edition,2002
2. Power Electronics Essentials and Applications-L.Umanand,Wiley India Pvt. Ltd.2009
3. Power Electronics – Principles and Applications - Joseph Vithayathil, TATA McGraw-hill Edition,2010
4. Power Electronics - M.D.Singh, K B Khanchandani, TMH ,Second edition,2008

E Resources:

1. NPTEL Lecture on "Power Electronics”
   http://nptel.ac.in/courses/108105066/
2. NPTEL Lecture on "Power Electronics" http://nptel.ac.in/courses/108101038/#
3. https://www.infineon.com/dgdl/Infineon-HV_Floating_MOS_Gate_Drivers-

ApplicationNotes-v01_00- EN.pdf?fileId=5546d4626c1f3dc3016c47de609d140a
4. https://www.rohm.com/electronics-basics/sic/what-are-sic-semiconductors
5. https://gansystems.com/design-center/application-notes/

LABORATORY EXPERIMENT LIST

Sl.No	Title of the Experiments
1	Experimental determination of Static V-I Characteristics of SCR
2	Experimental determination of Static V-I Characteristics of MOSFET
3	Experimental determination of Static V-I characteristics of IGBT
4	Experimental on Digital Triggering of SCR
5	Experimental determination of Simulation and Practical realization of step down DC-DC converter with R load and R-L load
6	Experimental determination of Simulation and Practical realization of Step up DC-DC converter with R-Load and R-L load.
7	Experimental determination of Experiment on Single Phase fully controlled Bridge rectifier with R load, R-L load with and without freewheeling diode.
8	Speed control of Separately excited DC motor using a Chopper
9	Experiment of Speed control of Universal motor using single phase AC voltage controller.
10	Experiment on Single Phase/Three Phase Inverter

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

(PROGRAM ELECTIVE-I)

Course Code	19EE5PE1DS	Course Name	DIGITAL SYSTEM DESIGN USING VERILOG
Credits	03	L – T - P	3 -0- 0

Course Outcomes:

CO 1	Apply the knowledge of HDL for modelling and functional verification of digital circuits.
CO 2	Analyze digital circuits using suitable Verilog HDL modelling.
CO 3	Design a digital circuit for complex systems using Verilog HDL and state machines.
CO 4	Program a given application/problem statement using EDA tools.

Prerequisites:

Digital Electronics

UNIT-I **08 Hrs**

Introduction to Verilog:

Design Methodology-An Introduction Verilog History, System representation, Number representation and Verilog ports. Verilog Data Types: Net, Register and Constant. Verilog Operators: Logical, Arithmetic, Bitwise, Reduction, Relational, Concatenation and Conditional. Verilog Primitives.

UNIT-II **08 Hrs**

Modeling Styles:

Dataflow Modeling: Boolean Equation-Based Models of Combinational Logic, Propagation Delay and Continuous Assignments.

Structural Modeling: Design of Combinational Logic, Verilog Structural Models, Module Ports, Top-Down Design and Nested Modules. Gate level modeling

UNIT-III **08 Hrs**

Behavioral Modeling: Behavioral Models of Flip-Flops and Latches, Comparison of Styles for Behavioral modeling, Behavioral Models of Multiplexers, Encoders, and Decoders. Test benches.

UNIT-IV **08 Hrs**

Synchronous sequential circuits: Moore and Mealy FSM, Design and implementation of sequence detector, serial adder, code converter.

UNIT-V **08 Hrs**

Implementation Fabrics:

Introduction of Programmable Logic Array (PLA), Programmable Array Logic (PAL), Programmability of PLDs. Complex PLDs (CPLDs), Field-Programmable Gate Arrays (FPGA).The Role of FPGAs in the ASIC Market, FPGA Technologies. Comparison of design implementation using CPLDs, FPGA and ASIC.

Choice: Unit-II and Unit-III

Text books:

1. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design & Synthesis", SunSoft Press, 2ndEdition, 2009, ISBN: 978-81-7758-918-4.
2. Stephan Brown and Zvonk Vranesic, "Fundamentals of digital logic with Verilog design", 2nd edition MGH, 2008

Reference books:

1. Roth, Charles; John, Lizy K.; Kil Lee, Byeong Digital Systems Design Using Verilog ISBN 10: 1285051076 / ISBN 13: 9781285051079.
2. M.D. Ciletti Advanced Digital Design with the Verilog HDL Published by Prentice Hall PTR -2nd Editions ISBN: 0136019285.

E Books:

1. http://access.ee.ntu.edu.tw/course/dsd_99second/2011_ lecture/W2_HDL_Fundamentals_2011-03-02.pdf
2. http://ece.niu.edu.tw/~chu/download/fpga/verilog.pdf

MOOCs:

1. Electronic Design Automation http://nptel.ac.in/courses/106105083
2. Digital system design with PLDs and FPGAs http://nptel.ac.in /courses/117108040/ Fundamentals of HDL (Lecture #008)
3. https://www.youtube.com/watch?v=rdAPXzxeaxs&index=8&list= PLE3BC3EBC9CE 15FB0

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19EE5PE1CD	Course Name	C++ & DATA STRUCTURES
Credits	03	L – T - P	2 -1- 0

Course outcomes

At the end of the course, the student will have the ability to:

CO 1	Apply the basic concepts of C++ programming in developing the code for various applications.
CO 2	Write C++ programs using salient features of OOPs such as Classes, Objects, Data Abstraction, Data encapsulation, Overloading, Inheritance, Polymorphism and file handling concepts for various applications.
CO 3	Apply C++ programming concepts to realize various data structures.
CO 4	Identify and apply a suitable data structure for a given application.

UNIT-I **07 Hrs**

Principles of Object Oriented Programming - Basic Concepts of OOPS, OOP Languages, Pre-processors directives and header files, structure of C++ program, compiling and linking, Tokens, keywords, identifiers and constants, datatypes, symbolic constants, variables, Storage Classes, operators, manipulators, control and statement loops.

Functions in C++: Introduction, Main function, function prototype, call by reference, return by reference, inline functions.

UNIT-II **08 Hrs**

Classes and objects: Specifying a class, member functions, arrays within a class, static data members and member functions, arrays of objects, returning objects.

Constructors and Destructors - Constructors, parameterized constructors, multiple constructors in a class, copy constructor, dynamic constructors and destructors.

Operator overloading and type conversions: Overloading unary and binary operators, overloading using friends, rules of overloading, function overloading, friend functions.

UNIT-III **08 Hrs**

Inheritance - Introduction, defining derived classes, Types of inheritance: Single, multilevel, multiple, hierarchical, hybrid.

Pointers, Virtual and Polymorphism: Pointers, pointers to objects, this pointer, pointers to derived classes, virtual functions.**Templates :** Class templates, Function

templates. **Exception handling**: Basics, Throwing and catching mechanisms, rethrowing an exception.

UNIT-IV **08 Hrs**

Managing console I/O operations: C++ streams, C++ stream classes, unformatted and formatted I/O operations. File operations: Introduction, classes for file stream operations, Opening and closing a file using constructors, detecting end-of-file.

Data structures Data Representation, Introduction, Linear lists, Formula-based representation, linked representation, Indirect addressing, Arrays.

UNIT-V **08 Hrs**

Stacks: The abstract data types, Derived classes, Formula-based representation, Linked representation, Applications. **Queues:** The abstract data types, Derived classes, Formula based representation, Linked representation, Applications Trees, Binary trees, Properties and representation of binary trees, Common binary tree operations, Binary tree traversal the ADT binary tree, Binary Search Trees.

Choice: **Unit-III and Unit-IV**

Text books:

1. Object oriented Programming with C++ -E Balaguruswamy ,TMH publications 6thedition,2015
2. Data structures, Algorithms, and applications in C++ - Sartaj Sahni, McGraw Hill.2000.

Reference books:

1. Robert Lafore, Object oriented Programming with turbo C++ ,GALGOTIA Publications, 2007.
2. D.S. Malik, Data Structures using C++, India edition, CENGAGE Learning, 2003

E Books:

1. C++ programming by Wikibooks upload. wikimedia.org/Wikipedia/commons/4/4b/C++_Programming2008-4-18.pdf
2. Introduction to data structures and algorithms (http://nptel.ac.in/courses/106102064/)

e-Learning:

1. https://swayam.gov.in/nd1_noc20_cs07/preview
2. https://www.programiz.com/cpp-programming
3. https://nptel.ac.in/courses/106/106/1061 06133/

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE5PE1EA	Course Name	ELECTRICAL ENERGY CONSERVATION AND AUDITING
Credits	03	L – T - P	3-0-0

Course Outcomes: Upon the completion of the course the student must develop

CO 1	Ability to gain and apply knowledge to address resolution of power crisis in India. Understanding of Conventional and Alternate energy sources, Analysis of different load demand and balancing generation with variation in demand. Ability to select and apply different methods of tariffs used in practice.
CO 2	Ability to motivate and apply the energy conservation techniques, ensure safety in various sectors of energy use. Minimize Losses.
CO 3	Understanding selection of energy source, ensuring its availability, efficient delivery and conservation by minimizing wastage. Auditing and monitoring mechanism for its efficient use and means of storage if necessary, in various sectors.
CO 4	Ability to analyze different load curves, load control of various energy sectors, and means to cater to such demands. Encourage optimal use of electricity and implement green energy sources.

Pre-requisites: Basic electrical engineering

Course Description: Objective: Understand Energy studies and Energy management to optimise use of present and future energy sources. Focus on Electrical Power which forms the most vital component of Energy. It is essential to ensure its uninterrupted availability, cost effectiveness, safe utilisation and its environmental impact. Understand the technical, commercial and social factors that affect Supply & Demand of Electrical energy. On completing the course, one would have a good knowledge on judicial use of energy sources and the safety measures to be adopted, economic analysis of problems related to Supply and Use of energy. Analyse Cost/Benefit, Market Forces and Risks for alternate Energy Policy option. Acquire skills to develop Systems, Analyses and Evaluate energy related problems and seek solutions.

UNIT-I **08 Hrs**

Introduction: Electrical Energy Supply, Demand, Losses and reasons of power crisis in India. Per capita energy consumption. Growth and future Energy demand in India. Conventional and Alternate energy sources. Energy Storage and Safety measures. Concept of power flow equivalence. Definitions: Load and Load curves, Maximum Demand, Group Diversity factor, Peak Diversity factor, Load factor, Capacity factor, Utilization factor,

Type of load, Demand Response, Dynamic Response.Tariff: Objective, General Tariff forms, Types of Tariff, Simple Numerical / simple case study.

UNIT-II **08 Hrs**

Energy Management: Strategy, techniques, importance, Global need to save energy, Environmental considerations. Energy conservation: Introduction, motivation for Energy conservation, principles of Energy conservation, Energy outages – Issues and Remedy, Protection and Safety, Mitigating energy losses.

UNIT-III **08 Hrs**

Energy Providers: Generation, Transmission and Distribution systems, Sectors of Utilisation: Household (Lamps, Fans, Refrigerators, heating equipment), Commercial, Transport, Agriculture, MSME, Large scale Industries (Cement, Chemical, Iron and Steel, Textile). Numerical problem/ case study on Energy conservation in domestic sector.

UNIT-IV **08 Hrs**

Energy Audit: Energy Conservation and Impact: Aim of Energy Audit, Energy flow diagram, Energy management team, Considerations in implementing Energy conservation programs, Periodic progress review for optimization of energy use. Instruments for Energy Audit. Energy Audit for illumination system, heating, Ventilation, Air-condition systems and Buildings. Certifying agencies in India. Numerical problem/ Case studies (in domestic sector only).

UNIT-V **08 Hrs**

Demand Side Management: Concept of Demand Side Management (DSM), Issues, Load management/ Optimization of energy use as a DSM Strategy, Applications of Load control, Tariff options for DSM. Environmental considerations and Green energy concepts. Engineering Depth and Versatility for Developing society.

Choice: Unit-I and Unit-IV

Text books:

1. Generation of Electrical Energy: B.R.Gupta, Chand & Company, 5th Edition
2. Energy Management: Umesh Rathore, S.K.Kataria & Sons, 2nd edition, 2004

Reference books:

1. Energy Management Handbook

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE5PE2ES	Course Name	ELECTRICAL ENERGY SYSTEMS
Credits	03	L – T - P	2 -0- 1

Course outcomes: At the end of the course, the student will have the ability to:

CO 1	Interpret the data available on the nation's energy scenario, distinguish the contributions of conventional and non-conventional sources.
CO 2	Describe the operation of different kinds of conventional and non- conventional energy resources and assess their environmental impact and viability in different social situations.
CO 3	Evaluate various factors that contribute to the economic operation and efficient management of Energy systems.
CO 4	To expose the students in Renewable Energy Sources and Emerging Technologies.

Prerequisites: Basic Electrical Engineering

Course Description: This course focuses on the current energy scenario in the country and the role of conventional & non–conventional energy sources. The operation of different conventional power plants, working of solar photovoltaic and wind energy systems and their importance, hybrid system, tariff for power generation are dealt with. The necessity of power factor improvement to reduce load, plant capacity and cost of power are covered, and also concept smart grid and its objectives.

UNIT-I **05 Hrs**

Introduction to Energy Sources

General, Conventional and Non-Conventional Energy Sources, world energy futures, Energy sources and their availability, Energy scenario in India, Principle of Fluidisation and Fluidised Bed Combustion(FBC) and Advantages of Fluidised Bed Combustion, Prospects of Renewable Energy Sources.

UNIT-II **05 Hrs**

Detailed Study of Conventional Energy Sources

Selection of site, classifications, general arrangement and operation of hydro Power Plant, Site selection & Operation of thermal power plant and nuclear power stations.

UNIT-III **06 Hrs**

Solar Photovoltaic System

Basic Solar Electric power generation: Solar Photo-Voltaic (SPV), Solar Cell Principles, Conversion Efficiency and Power Output, I-V and P-V characteristics of a solar cell, Solar cell connecting arrangements, Classifications of solar cells, partial shading its impact and remedies, maximum tracking – centralized and decentralized SPV systems-standalone and grid connected system.

UNIT-IV **05 Hrs**

Wind Energy System

Nature of the wind, wind survey in India. Basic principle of wind Energy Conversion System (WECS) and its Components, Types of wind turbines, Advantages and disadvantages of WECS, Introduction to Hybrid (Solar- wind) system, Concept of Smart Grid and objectives of smart grid

UNIT-V **05 Hrs**

Economic aspects

Introduction, important terms related to economics of generation: Connected load, maximum demand, demand factor, average load, load factor, plant capacity factor, plant use factor, load duration curve. Tariff and its types.

Choice: Unit-II and Unit-III

Text books:

1. Non-conventional Energy Sources- G. D. Rai, Khanna Publishers, 2011.
2. Renewable Energy Sources and Emerging Technologies-D.P. Kothari, K.C.Singal & Rakesh Ranjan, P.H.I, New Delhi, 2011.
3. Power System Engineering -A. Chakrabarti, M. L. Soni, and P.V. Gupta, U.S. Bhatnagar, Dhanpatrai and Co., New Delhi, 2008.

Reference books:

1. Electric Power Generation, Transmission and Distribution-Dr. S. N. Singh, P.H.I., New Delhi, 2nd edition, 2011.
2. Electrical Power Generation - Prof.B.N.Yoganarasimhan, 2005.

E Books:

1. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=

web&cd=4&cad=rja&ua ct=8&ved= 0ahUKEwjf2I XfwfTMAhUGr48K HQY4D2UQFggvMAM&url=http%3A% 2F%2Fwww. theiet. org%2Ffactfiles%2Fenergy%2Fsmart-gridspage. cfm%3 Ftype% 3Dpdf&usg=AFQjCNE7w- 9jRar0rDoUDIxfs 07KbWWvw&bvm =bv.122676328,d.c2I.

2. https://beeindia.gov.in/sites/default/files/1Ch1.pdf

List of lab experiments:

Sl.No	Title of the Experiments
1	Creation, loading of solar PV characteristics and irradiance profiles.
2	Variation in Power output plot of P v/s load current for load variations and fixed irradiance.
3	Plot of power output v/s load current for variable irradiance fixed load.
4	I-V Characteristics at different temperatures fixed irradiance.
5	I-V Characteristics at fixed temperature variable irradiance.
6	Effect of partial shading on the I-V and P-V characteristics with & without Bypass diodes.
7	Maximum power point tracking with variable load for constant irradiance
8	Maximum power point tracking with fixed load and variable irradiance
9	Experiment to plot Torque v/s Speed and Power v/s Speed characteristics of the turbine at different wind speed and load configuration.
10	Experiment on performance assessment of solar-wind hybrid power system.
11	Demo on wind monitoring system.

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE5PE2AM	Course Name	APPLIED MATHEMATICS
Credits	03	L – T - P	3 -0- 0

Course outcomes: At the end of the course, the student will have the ability to:

CO 1	Demonstrate an understanding of the various types of errors and basic concepts of programing in matlab.
CO 2	Apply mathematical tools like Matlab and Mathematic to solve system of algebraic equations, ordinary differential equations and partial differential equations related to electrical engineering problems.
CO 3	Analyse the numerical solutions for the convergence, stability and consistency.
CO 4	Formulate engineering problems from given data
CO 5	Conduct numerical experiments to solve problems Electrical Engineering problems

Course Objectives: The objective of the course is to acquaint the students with numerical techniques with a sense of algorithms and some applications through various mathematical tools such as Matlab and Mathematica.

UNIT-I **08 Hrs**

ERRORS and APPROXIMATIONS: mathematical modelling-review of Taylor series-numerical error (floating-point representation, computer arithmetic, round-off errors, and loss of significance in numerical computations) - Sensitivity analysis and condition numbers- programming in MATLAB.

UNIT-II **08 Hrs**

LINEAR SYSTEM OF EQUATIONS: Gauss Jordan method-Cholesky's triangulization method-Crout's method-Thomas algorithm for tridiagonal systems-Jacobi's ieration method-Gauss Seidel iteration method- Symmetric matrix eigenvalue problems.

UNIT-III **08 Hrs**

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS: One-step methods-Marching methods-Matlab function for Ordinary Differential Equations-System of first order Ordinary Differential Equations –Initial value problems- Two-Point boundary value problems- multistep methods and stiff equations (comparison of various MATLAB stiff solvers) -FFT and spectral methods.

UNIT-IV **08 Hrs**

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS: solution of elliptic equations- one-dimensional parabolic equation-two-dimensional parabolic equation-one-dimensional hyperbolic equation and two-dimensional hyperbolic equation.

UNIT-V **08 Hrs**

OPTIMIZATION: Numerical Optimization-multidimensional optimisation-Gradient methods-Newton's method-Methods based on the concept of Quadratic convergence-Powell's method, Fletcher-Reeves method.

Choice: Unit-II and Unit-V

Text books:

1. Numerical Computing with MATLAB, SIAM, Cleve Molar
2. Numerical methods for Engineers, C Chapra & R P Canale, 6th edition, Mc, Graw Hill, 2009

Reference books:

1. Applied Numerical Methods using Matlab-Rao V Dukkipati, New Age International Publishers, first edition, 2011.
2. Mathematical Programming Techniques, N.S. Kambo, East-West Press Pvt. Ltd. 2008.

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE5PE2CS	Course Name	COMMUNICATION SYSTEMS
Credits	03	L – T - P	3-0-0

Course outcomes: At the end of the course, the student will have the ability to:

CO 1	Acquire basic knowledge of communication systems.
CO 2	Characterize and analyze different modulation techniques for analog & digital communication
CO 3	Analyze the effect of noise on analog signals

Prerequisites: Signals and Systems, Basic Electronics

Course Description: This course provides an understanding of communication theory as applied to transmission of information bearing signals with equal emphasis given to both analog and digital communication techniques. This is a foundation course for Computer Communication Networks and Distribution computing courses.

UNIT-I **08 Hrs**

Amplitude modulation: Time-Domain Description, Frequency domain description, Generation of AM waves, Detection of AM waves, Double Sideband – Suppressed Carrier Modulation, Time-Domain Description,Frequency domain description Generation of DSBSC waves, Coherent Detection of DSBSC Modulated waves. Costas Receiver, FDM

UNIT-II **08 Hrs**

Angle modulation: Basic Concepts, Frequency Modulation, Narrow Band Frequency Modulation, Wide Band Frequency Modulation, FM waves, Generation of FM waves, Direct FM, demodulation of FM waves.

UNIT-III **08 Hrs**

Noise in Analog modulation systems: Signal-to-noise ratios, AM receiver model, Signal-to - noise ratios for coherent reception, DSBSC receiver, SSB receiver, noise in AM receivers using envelope detection, threshold effect, FM receiver model, noise in FM reception, FM threshold effect, pre-emphasis and de-emphasis in FM systems..

UNIT-IV **08 Hrs**

Pulse modulation: Sampling theorem for low-pass and band-pass signal, PAM, natural sampling, flat-top sampling, signal recovery through holding, quantization of signals, quantization error, Pulse Code Modulation, delta Modulation, Adaptive delta modulation

UNIT-V **08 Hrs**

Digital Modulation: Introduction, Binary Shift Keying, Phase – Shift Keying, Frequency – Shift Keying, Summary of Three Binary Signalling Schemes, line codes, TDM.

Choice: Unit-I and Unit-III

Text books:

1. An introduction to Analog and Digital communication - Simon Haykin, Wiley publications, 2nd Edition,2010
2. Principles of communication systems -Taub and Schilling, Tata McGraw Hill Publications, 4th edition,2015

Reference books:

1. Electronic Communication Systems - Blake, Thomson publishers, 2nd Edition,2002.
2. Electronic Communication Systems -George Kennedy, Tata McGraw Hill Publications, 4th edition,1999

E-learning:

1. NPTEL course: Communication Engineering by Prof. Surendra Prasad, Department of Electrical Engineering, Indian Institute of Technology, Delhi
2. NPTEL course: Advance Digital Communication by Dr. P.R. Sahu, IIT Guwahati

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE5PE2UP	Course Name	UTILIZATION OF ELECTRIC POWER
Credits	03	L – T - P	3 -0- 0

Course outcomes: At the end of the course, the student will have the ability to:

CO 1	Understand the necessity and utility of Electric Power in various systems and explain the concepts of electric heating, welding, lighting schemes and electric traction and electric vehicles using electrical engineering principles
CO 2	Apply principles to comprehend the lighting calculations in any lighting scheme, Performance of furnaces, dynamics of train movement, Energy consumption in traction and characteristics of motors for traction and EV
CO 3	Analyze the behaviour of Traction motors during starting, braking and their speed control and the traction drives, Motors for EV propulsion
CO 4	Design the heating element of furnace, design of lighting schemes for given specifications.

Prerequisites:

Principles of DC Motors, Induction Motor and their characteristics, Concepts of Power electronic converters

Course Description:

The course imparts knowledge about various types of Electric heating and welding employed in different industrial applications, interior and exterior illumination systems and design of lighting schemes. Traction systems and their behavior, Speed control and Braking of motors used in traction, Power Supply used for traction. Traction Drives, This course will serve to educate students on aspects of Electric vehicles and EV mechanics

UNIT-I **08 Hrs**

Illumination - Laws of illumination– MHCP and MSCP – lighting calculation – Lighting schemes – Design of lighting schemes – Requirements of good lighting, Illumination for different purposes, Factory lighting, Flood lighting – Electrical lamps – Gaseous discharge lamps –Induction Lamps, CFL and LED lamps Star rating concept of energy efficient utilities

UNIT-II **08 Hrs**

Electric Heating & Welding - Advantages of Electric Heating- Modes of heat transfer- Resistance heating, Induction Heating- High frequency eddy current heating- Dielectric heating, Arc furnaces, heating of buildings. Power Supply requirements

Types of electric welding, Resistance and arc welding- Ultrasonic welding- Laser Beam

Welding, Power supply for requirements for welding- Control devices and welding equipments.

UNIT-III **08 Hrs**

Electric Traction -Systems of Track Electrification, Electric Traction Services, - electric trains- electric buses- trams and trolleys, Mechanics of Train movement, Typical Speed-Time curves-Schedule speed, Average speed, Dead weight, accelerating weight and adhesion weight- Tractive effort –Power, Energy output from the driving axles- Specific energy output- Specific Energy consumption-Factors affecting energy consumption, Nature of electric load- coefficient of adhesion- duty cycle of traction motors- load sharing between traction motors— braking—power factor and harmonics, Calculation of traction Drive rating and energy consumption, Traction motors -motors employed in traction-traction motor control

UNIT-IV **08 Hrs**

Traction Drives

Conventional AC and DC traction drives- DC Traction Drives employing resistance control, 25 kV, 50 Hz AC traction using on load transformers and tap changers, Semiconductor converter controlled drives- 25 kV AC traction using Semiconductor converter controlled dc motors, DC Traction employing i) chopper controlled motors ii) polyphase AC motors, AC traction employing polyphase AC motors : PWM , VSI induction motors drives, CSI squirrel cage induction motor drives, Load commutated inverters (LCI) synchronous motor drives Electric Drive Systems, Components used for interlocking and sequencing operations and protection

UNIT-V **08 Hrs**

Electric Vehicles and Hybrid Electric Vehicle:

Vehicle fundamentals, Dynamic equation, Maximum tractive effort, Configuration of Electric Vehicles, Performance of Electric vehicles, Traction Motor Characteristics, Tractive effort and transmission equipment, Tractive effort in normal driving and energy consumption, Concept and Architecture of Hybrid Electric Vehicle (HEV) -series and parallel types

Motors for EV propulsion: Motor and Engine Ratings, EV and HEV Motor requirements

Choice: Unit-III and Unit-V

Text books:

1. A Course in Electrical Power–SoniGupta & Bhatnagar, ,DhanpatRai and Sons,1987. Unit I,II,III
2. Fundamentals Of Electric Drives– G.K.Dubey -2nd EditionAlpha Science International-Unit IV.
3. Modern Electric ,Hybrid Electric and Fuel cell Vehicles- Mehrdad Eshani etal, CRC Press-Unit V

Reference books:

1. Utilization of electric energy-Openshaw Taylor, Orient Longman89,1971
2. Electric Power-Uppal S. L., Khanna Publications,1992

E Books:

1. Light Emitting Diodes (LEDs) For General Illumination (PDF 72P), http://www.freebookcentre.net/Electronics/Light-Emitting- Diodes PDF | 72 Pages
2. www.edisontechcenter.org/InductionLamps.

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19ES5HSIFE	Course Name	INNOVATION AND ENTREPRENEURSHIP
Credits	02	L – T - P	2-0-0

Course Outcomes:

CO 1	Apply new ideas of design thinking, methods and ways of thinking
CO 2	Able to formulate goals as entrepreneur for a startup defining your goals as an entrepreneur
CO 3	Able to identify business opportunities by performing market research and choosing target customer
CO 4	Engage with a range of stakeholders to deliver creative and sustainable solutions to specific problems communicate effectively both orally and in writing
CO 5	Work effectively with peers with diverse skills, experiences and be able to critically reflect on own practice

UNIT-I **06 Hrs**

Ideation and Innovation

Problems and Pain Points, Ideation and Problem Solving, Design Thinking, Team importance and Leadership, Market Segmentation, Beachhead Market, Building End User Profile, Total Addressable Market (TAM) Size for the Beachhead Market, Profile the Persona, Full Lifecycle Use Case, High-Level Product Specification, Quantify the Value Proposition, Identify Your Next 10 Customers, Define Your Core, Chart Your Competitive Position

UNIT-II **05 Hrs**

Product Acquisition by customer

Determine the Customer's Decision Making Unit (DMU), Process to Acquire a Paying Customer, Mapping sale process, Total Addressable Market Size for Follow-on Markets

UNIT-III **05 Hrs**

Business from Product

Design a Business Model, Set your Pricing Framework, Calculate the Lifetime Value (LTV) of an Acquired Customer, Map the Sales Process to Acquire a Customer, Calculate the Cost of Customer Acquisition (COCA)

UNIT-IV **05 Hrs**

Designing, building and scaling of the product

Identify key Assumptions, Test Key Assumptions, Define and build Minimum Viable Product (MVP), Test with Customer, Repeat Cycle to Reach Product Market Fit.

UNIT-V **05 Hrs**

Startup and Entrepreneurship in India

Starting company in India, IP landscape, Incubation, Government support, Taxation, Startup culture and leadership, Open innovation, Social Innovation, Intrapreneurship, entrepreneurship abroad.

Reference books:

1. Disciplined Entrepreneurship: 24 Steps to a Successful Startup (Wiley, 1st Edition) Bill Aulet, ISBN: 1118692284, 2013
2. The Startup Owner's Manual: The Step-by-Step Guide for Building a great company by Steve Blank K&S Ranch Publishers, K&S Ranch, 2016
3. Innovator's Dilemma: When New Technologies Cause Great Firms to Fail by Christensen, Harvard Business Review Press, 2011

E Books:

https://segera-wisuda.blogspot.in/2016/05/46-ebooks-entrepreneurship -download-free.html

MOOCs:

https://ocw.mit.edu/courses/sloan-school-of-management/15-390-new-enterprises-spring- 2013/assignments/assignment-12/

https://www.edx.org/course/entrepreneurship-101-who-customer-mitx-15-390x

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE5PWMP1	Course Name	MINI PROJECT-I
Credits	02	L – T - P	0 -0- 2

Course Outcomes:

CO 1	Ability to survey/research literature, and formulate a complex engineering problem.
CO 2	Apply the fundamental knowledge of mathematics, science and engineering principles in design of solutions of system components.
CO 3	Identify, Select, and Apply a suitable engineering/IT tool in modeling /data interpretation /analytical studies, conduct experiments leading to a logical solution.
CO 4	Design a system/engineering problem. system component/process,build it and test its functioning as a solution to an
CO 5	Communicate effectively to a diverse audience and develop technical reports / publications.

Student groups can take up project work in any of the domains of either Electrical and Electronics or interdisciplinary where the preliminary idea is conceived and relevant designs arrived at and implemented through simulations/hardware.

VI SEMESTER SYLLABUS

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

(PROGRAM CORE)

Course Code	19EE6PCPS1	Course Name	POWER SYSTEMS-I
Credits	04	L – T - P	3-1-0

Course outcomes: At the end of the course, the student will have the ability to

CO 1	Model and analyze power systems using complex mathematical transformations under short circuit and unbalanced conditions
CO 2	Analyze different unsymmetrical faults on unloaded alternator and on complex power systems using symmetrical component transformations
CO 3	Apply mathematical techniques to evaluate system stability.
CO 4	Ability to engage in independent study to make an effective presentation and submit report on applications of power systems concepts in various domains

Prerequisites: Transmission and Distribution, Electrical Energy Systems

Course Description:

This course covers various techniques for analysis of different types of faults occurring in the Power System. Methods of evaluating Power System Stability are also discussed.

UNIT-I **08 Hrs**

Representation of Power system Components: Circuit models of Transmission line, Synchronous machines, Transformer and load. Single line diagram, impedance and reactance diagram. Per unit system, per unit impedance and reactance diagrams

UNIT-II **08 Hrs**

Symmetrical 3 - Phase Faults: Transients on a transmission line, Short-Circuit currents and the reactance of synchronous machines on no load and on load, Short circuit of a loaded synchronous machine, Short circuit current computation through Thevenin's theorem. Formation of Z-bus using building algorithm (Without Mutuals), fault analysis using Z-bus matrix.

UNIT-III **08 Hrs**

Symmetrical components - Resolution of unbalanced phasors into their symmetrical components, Analysis of unbalanced load against balanced Three-phase supply, Analysis of balanced and unbalanced loads against unbalanced 3 phase supply, Phase shift of symmetrical components in star-delta transformer bank, Power in terms of symmetrical components. Sequence impedances and networks of power system elements (alternator, transformer and transmission line) Sequence networks of power systems

UNIT-IV **08 Hrs**

Unsymmetrical faults - Unsymmetrical faults on an unloaded alternator with and without fault impedance. Unsymmetrical faults on a power system with and without fault impedance. Open conductor faults in power system.

UNIT-V **08 Hrs**

Stability Analysis- Importance of stability analysis in power system planning and operation, classification of power system stability, Rotor dynamics and the swing equation. Power angle equation, Steady State Stability, synchronising power coefficients, Transient Stability, Equal area criterion for transient stability evaluation and its applications.

Choice: Unit-II and Unit-V

Text books:

1. Elements of Power System Analysis - WD Stevenson, McGraw Hill Publications,2nd Edition,1994.
2. Modern Power System Analysis I – Nagrath and DP Kothari, Tata McGraw Hill Publications, 3rd Edition,2003

Reference books:

1. Power System Analysis – Grainger and Stevenson
2. Power System Analysis - Hadi Sadat, Tata McGraw Hill Publications, 3rd edition,2002
3. Computer Techniques and Models in Power Systems- Uma Rao
4. Computer aided Power System Analysis – G L Kusic, CRC Press, 2nd edition,2008

E-Learning:

NPTEL Course titled: Computer Aided Power System Analysis. Link:
http://nptel.ac.in/courses/108107028/

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE6PCPSP	Course Name	POWER SYSTEM PROTECTION
Credits	04	L – T - P	3-0-1

Course Outcome:

CO 1	Apply the knowledge to comprehend the need for protective equipment such as fuse and switches.
CO 2	Identify the components of the relay and circuit breakers to distinguish the parameters affecting their operation
CO 3	Comprehend/ compare the working of Electromechanical relays, static relays and comparators.
CO 4	Conduct relevant experiments to investigate the performance of switch gear under different situations

Course Description: This subject is a core subject and very important for any practicing electrical engineer. The electrical engineer has to deal with many switchgears and protection systems of various elements of power systems. The subject curriculum focuses on the study of fundamentals of power system protection, electromagnetic relays which are important one. It also covers the protection of feeders, transmission lines, transformers, generators and induction motors. The subject deals with the principles of circuit breaking and circuit breaker fundamentals. It also covers the working principle of protective switch gears like CT and PT. The topics covered in the curriculum are chosen in such a way that the students get a very good idea of the underlying principles of switchgear and protection.

UNIT-I **08 Hrs**

Switches and Fuses: Fuse law, characteristics of fuses, fuse material, types of fuses, limitations and Application of fuse. Introduction to MCBs.

Protective Relaying:, states of protection system, components of protection system, CT, PT, Zones of protection, primary and backup protection, Requirement of Protective Relaying , Essential qualities of Protective Relaying, Classification of Protective Relays.

UNIT-II **08 Hrs**

Circuit breakers: Theory of arc formation and its extinction (AC and DC), Arc interruption theories– slepian's theory and energy balance theory, re-striking and recovery voltage, Rate of rise of Re striking voltage, Numericals. Specifications of circuit breakers, different

types of circuit breakers like Air, Vacuum and SF6, comparative merits and demerits.

UNIT-III **08 Hrs**

Electromechanical and static Relays: Constructional and operating principles of electromagnetic relays (directional and non-directional), torque equation, Numericals. Basic principles and general equation of static
relay, Phase comparator: co-incidence type. Amplitude comparator: rectifying bride type. Duality principle. Application of relays: Over current/ under voltage Instantaneous, DMT and IDMT type relays.

UNIT-IV **08 Hrs**

Protection Schemes: Transmission line protection: zone protection, Distance relays: mho and reactance relays and its characteristics, Direction relays: directional and non-directional, differential relays: Merz-Price differential (current differential and voltage differential), Transformer Protection: Buchholz's relay and its operation, Generator Protection: Stator faults-Rotor faults and earth fault protection.

UNIT-V **08 Hrs**

Digital Relaying: Merits and Demerits of digital relaying, generalized block diagram of digital relaying, Adaptive relaying, tripping mechanism of relay, different relay algorithms, overcurrent relay coordination in interconnected power system, numerical protection of generator.

Choice: **Unit-III and Unit-IV**

Lab Experiments

Sl.No	Title of the Experiments
1	Over current characteristics of Electro mechanical relays
2	Over voltage/ Under voltage characteristics of Electro mechanical relays
3	Over voltage characteristics of static relays
4	Under voltage characteristics of static relays
5	Over voltage/ under voltage characteristics of numerical relays.
6	Over current characteristics of numerical relays
7	Fuse characteristics.

8	Over current/over voltage relay modeling using PSCAD
9	Plotting directional and non-directional characteristics of distance relay using PSCAD
10	Plotting MHO characteristics of an impedance relay using PSCAD
11	Modeling of surge arrestor using PSCAD

Text books:

1. Switchgear & Protection- Sunil S.Rao -Khanna Publishers.
2. Power System Protection and Switchgear by Badri Ram and D N Vishwakarma, 2nd edition, McGraw Hill Publication.
3. Power System and Switchgear by Bhavesh Bhalia, R P Maheshwari and Nilesh G Chothani, Oxford university press
4. Fundamentals of Power System protection- Y G. Painthankar and S R Bhide-PHI publication, 2007.
5. Power System Protection, Static Relays with Microprocessor applications"- T.S. MadavaRao, TMH, Second editon, 2004

Reference books:

1. A Course in Electrical Power- Soni, Gupta &Bhatnagar- 3rd Edition, DhanapatRai publication.
2. Power System Protection & Switchgear- Ravindarnath& Chandra-New age publications.
3. Electrical Power-Dr S. L. Uppal- Khanna Publishers.
4. "Power System Protection"-Patra. S.P. Basu. S.K. Choudhari.S. Oxford and IBH Publications.
5. "Protective Relays and Protection" -VanWarrington A. R. and Van C, Vol, I & II Chapman and Hall, 1968

MOOCs:

1. http://nptel.ac.in/syllabus/108101039/

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19EE6PCMCT	Course Name	MODERN CONTROL THEORY
Credits	03	L – T - P	3 -0- 0

Course outcomes: At the end of the course, the student will have the ability to

CO 1	Create state models using physical variables, mathematical variables and to solve the state equation.
CO 2	Apply appropriate techniques to analyze the system for its controllability and observability.
CO 3	Apply relevant concepts to design systems with state feedback to meet the specifications; mathematically represent nonlinear systems and analyze a few simple models.

UNIT-I **08 Hrs**

State Variable Analysis and Design - Introduction, concept of state, state variables and state model, state modeling of linear systems, linearization of state equations. State space representation using physical variables & canonical variables

UNIT-II **08 Hrs**

Derivation of transfer function from state model, Eigen values, Eigen vectors, generalized Eigen vectors. Solution of state equation ,state transition matrix and its properties, computation using Laplace transformation, power series method, Cayley -Hamilton method

UNIT-III **08 Hrs**

Concept of controllability &observability, methods of determining the same, Effect of Pole-Zero cancellation. Duality.

UNIT-IV **08 Hrs**

Pole placement techniques - Stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design, and design of state observer.

UNIT-V **08 Hrs**

Non-Linear systems - Introduction, behavior of non-linear system, common physical non linearity –saturation, friction, backlash, dead zone, relay, multivariable non-linearity. Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories.

Choice: **Unit-III and Unit-V**

Text books:

1. Digital control &state variable methods- M.Gopal,THM Hill , 2nd edition ,2003
2. Control system Engineering- I.J .Nagarath & M.Gopal, New Age International (P)Ltd, 3rd edition,2003

Reference books:

1. State space Analysis of Control Systems- Katsuhiko Ogata- Prentice Hall Inc,2007
2. Automatic Control Systems- Benjamin C. Kuo & Farid Golnaraghi , John Wiley & Sons, 8th edition,2003
3. Modern Control Engineering- Katsuhiko Ogata-PHI 2003
4. Modern control systems-Dorf& Bishop- pearson education,1998

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19EE6HSPMT	Course Name	PRODUCT MANAGEMENT TECHNIQUES
Credits	02	L – T - P	2-0-0

Course outcomes : At the end of the course, the student will have the ability to

CO 1	Understand the principles of product management and apply them to conduct market research.
CO 2	Develop Template for value proposition creation and business case.
CO 3	Create tools to measure success of products and utilize the process for product development.
CO 4	Apply Pricing strategies and revenue models and Check list for Make or Buy decision of products.
CO 5	Comprehend appropriate methods and resources of different case studies through individual or team work.
CO 6	Develop decision making skills in real life as a product manager.

Course Description:

The product management techniques elective course is aimed exactly at bringing the time-tested industry best practices and trends in product creation to the engineering students, so that they can apply the learning in their final year project. In the longer term, they can contribute effectively with a good understanding of the real world ecosystem and stakeholders in the product creation journey.

UNIT-I **06 Hrs**

Introduction: What is product management? Key functions of a product manager, Hard skills needed, Product manager vs product owner vs program manager, Career insights

UNIT-II **05 Hrs**

Business model canvas: Building blocks of BMC, Value proposition part1: Opportunity-Target segment, Insight, Competition, Net promoter score (NPS), Value proposition part2: Offering- Benefit, Reason to win, Differentiator, Value statement, **Product roadmap:** Significance, Generating product roadmaps, Communication of roadmap

UNIT-III **05 Hrs**

Finance for decision making: Product cost built up, Cost drivers, Pricing strategy, Revenue models, Business case, NPV, cashflow, payback

UNIT-IV **05 Hrs**

New Product Introduction: Make or Buy, Product development and release process Waterfall Vs Agile, UI/UX, Software Vs Hardware product development, Product documentation

Product lifecycle management: Product lifecycle, Product performance analysis Phase in / phase out, Day-Day challenges

UNIT-V **05 Hrs**

Trends: Design thinking, Hackathon, Co-creation

Choice: **Unit-III and Unit-IV**

Text books:

1. Course material created by the course Instructor
2. Principles of Managerial Finance (14th Edition) (Pearson Series in Finance), Lawrence J Gitman
3. Monetizing innovation, Madhavan Ramanujam and Georg Tacke

Reference books:

1. Jugaad innovation,Navi Radjou, Jaideep Prabhu, Simone Ahuja
2. The Venture Imperative, Heidi Mason and Tim Rohner
3. Strategic management,Fred R. David
4. Value proposition design,Author: Alex Osterwalder, Yves Pigneur, Greg Bernarda, Alan Smith

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE6PE3ED	Course Name	CONTROL OF ELECTRIC DRIVES
Credits	03	L – T - P	3 -0- 0

Course Outcomes:

CO 1	Apply the fundamental concept to comprehend the working of industrial Drives and dynamics.
CO 2	Apply the knowledge to select appropriate motor for the specified application to meet customer requirements.
CO 3	Analyse the performance of dc motor drives for various operating condition
CO 4	Analyse the performance of induction motor during unbalanced condition, control of induction motors with the help of power electronic circuits

Course Description: The aim of this course is to equip students with knowledge of variable-speed drives and motion control systems which are used in many industrial processes such as in conveyors, machine tools, pumps, compressors, mining drives, electric vehicles, ship propulsion, wind energy systems, air-craft actuators, servo drives and automation systems, to name a few. The course stresses the basic understanding of characteristic of machines driven from appropriate power electronic converters and controllers. The steady-state behavior of such drives will be primarily covered and some dynamic issues of drive representation and control system design will also be introduced.

UNIT-I **08 Hrs**

An Introduction to Electrical Drives & Its Dynamics

Electrical drives. Advantages of electrical drives. Parts of electrical drives, choice of electrical drives, status of dc and ac drives, Dynamics of electrical drives, Fundamental torque equation, speed torque conventions and multi-quadrant operation. Equivalent values of drive parameters, components of low torques, nature and classification of load torques, steady state stability.

UNIT-II **08 Hrs**

DC Motor Drives

Starting braking, single phase fully controlled rectifier, control of separately excited dc motor, Single-phase half controlled rectifier control of separately excited dc motor.

Three phase fully controlled rectifier - control of separately excited dc motor, three phase half controlled rectifier - control of separately excited dc motor, multi-quadrant operation of separately excited dc motor fed from fully controlled rectifier.

UNIT-III **08 Hrs**

Unbalanced Analysis Of Induction Motor

Operation with unbalanced source voltage and single phasing, operation with unbalanced rotor impedances, analysis of induction motor fed from non-sinusoidal voltage supply, starting methods of the induction motor.

UNIT-IV **08 Hrs**

Control Of Induction Motor Drives

Stator voltage control, V/f control, Slip regulation, speed control of static Kramer's drive, current control, VSI fed induction motor, CSI fed induction motor.

UNIT-V **08 Hrs**

Special Machines and Industrial Applications

Brushless DC motor, stepper motor and variable reluctance motor drives. Industrial application: cement mills, rolling mills, textile mills, paper mills.

Choice: Unit-II & Unit-IV

Text books:

1. Fundamentals of Electrical Drives, G.K Dubey, Narosa publishing house, 2nd Edition, 2002.
2. Electric Drives by Vedam Subramaniam.
3. M.H Rashid, "Power Electronics, Circuits, Devices & Applications" Third Edition, PHI, New Delhi 2004

Reference books:

1. Electrical Drives, N.K De and P.K. Sen- PHI, 2009
2. Electric Motor Drives, Modeling, Analysis and Control, R.Krishnan,PHI,2008
3. Power Electronics, Devices, Circuits and Industrial Applications, V.R. Moorthi, "Oxford University Press, 2005
4. Power electronics and variable frequency drives technology and applications ,Edited Bimal K.BOSE

E-Learning:

1. http://nptel.ac.in/courses/108108077/(NPTEL Lecture by Prof. Gopakumar, IISC)
2. http://nptel.ac.in/courses/108104011/ (NPTEL Lecture by Prof.S.P.DAS, IIT Kanpur **)**

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE6PE3VL	Course Name	CIRCUIT DESIGN USING VLSI
Credits	03	L – T - P	3-0-0

Course Outcomes: Upon the completion of the course the student must develop

CO 1	Ability to describe and compare methodology of fabrication process. various types of VLSI technology. Also understand the
CO 2	Ability to apply the knowledge of MOS technology for simple analog/digital circuits.
CO 3	Ability to use scaling methods based on various circuit parameters and apply scaling to build prototype circuits.
CO 4	Ability to identify the various NMOS and CMOS technology to be used based on their applications and demonstrates the working of a few VLSI circuits

Prerequisites: Digital Electronics, Analog Electronics, Fundamentals of HDL

Course Description: This course helps to understand the basic concepts of various MOS technologies such as NMOS and CMOS technologies. This course also helps to identify and understand the concept of delays in NMOS/CMOS technologies. Stick diagrams, mask layouts concepts. Scaling of various parameters based on application. Design of various combinational and structural circuits as applied to basic VLSI circuits can also be adopted.

UNIT-I **08 Hrs**

A Review of Microelectronic 3 and an Introduction to MOS and VLSI technologies, MOS transistors fabrication – NMOS and CMOS (N-Well & P-Well), thermal aspects, production of E-beam masks.

UNIT-II **08 Hrs**

Relationship between Drain to Source current Ids versus Vds. MOS transistor characteristics- trans-conductance (gm) and output conductance (gds), figure of merit, NMOS Pass transistor concept. NMOS and COMS inverters. Latch up of CMOS.

UNIT-III **08 Hrs**

Stick diagrams, design, symbolic diagrams of NMOS in NMOS design style and CMOS in CMOS design style. Importance of Lambda based rules. Basic Circuit Concepts: Sheet resistance, capacitance layer, inverter delays (NMOS, CMOS and Cascade), wiring capacitance.

UNIT-IV **08 Hrs**

Scaling of MOS Circuits. Scaling model and scaling factors. Limitations of scaling. Subsystem Design and Layout - Some architecture issues- other systems considerations. Some observations on design process. Two input NMOS & CMOS - NAND and NOR gates

UNIT-V **08 Hrs**

Forms of CMOS logic- Pseudo NMOS logic, Dynamic CMOS logic, CMOS domino logic, n-p CMOS logic. Examples of structural design-A Parity generator, Bus Arbitration logic for n-line bus, 4x1 multiplexers, Four line Gray code to Binary code converter, two phase clocking. Concept of dynamic register element, Dynamic shift register. An Illustration of design process.

Choice: **Unit-IV and Unit-V**

Text books:

1. Basic VLSI Design -Pucknell Douglas Al , PHI, 3rd Edition,1994

Reference books:

1. Fundamentals of Modern VLSI Devices-Yuan TaunTak H Ning, Cambridge Press, South Asia Edition 2003..
2. Modern VLSI Design - Wayne wolf , Pearson Education Inc. 3rd edition 2003
3. Online NPTEL courses on VLSI designs

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE6PE3AI	Course Name	AI TECHNIQUES TO POWER SYSTEM
Credits	03	L – T - P	3-0-0

Course outcomes: At the end of the course, the student will have the ability to

CO 1	To understand the fundamentals of soft computing techniques.
CO 2	To apply knowledge of Mathematics and Engineering to understand the importance of ANN, Fuzzy and GA.
CO 3	To apply the knowledge of AI for power system applications.

UNIT-I **08 Hrs**

INTRODUCTION

Definition of AI difference between soft computing techniques and hard computing systems, expert systems brief history of ANN, Fuzzy and GA.

UNIT-II **08 Hrs**

ARTIFICIAL NEURAL NETWORK

Introduction, History of neural network research, Basic concepts of Neural Networks, Human brain, Model of Artificial Neuron, Neural Network architectures, Single layer feed forward Network; Multi-layer feed forward network, recurrent networks, characteristics of Neural Network, Learning Methods Perceptron, ADALINE MADALINE Networks. Architecture of Back propagation Network, Non-linear activation operators, single and multilayer ANN, learning methods like Back propagation, LM etc. training and testing of ANN.

UNIT-III **08 Hrs**

FUZZY LOGIC

Introduction, Comparison between Fuzzy and crisp logic, Fuzzy sets, Membership function, Basic fuzzy set operations, properties of Fuzzy set, fuzzy relations, Fuzzy interference system, Mamdani, Sugeno, Fuzzy rule based system, defuzzification methods.

UNIT-IV **08 Hrs**

GENETIC ALGORITHM

Introduction, Genetic Algorithms, Procedure of Genetic Algorithms, Genetic Representations, Initialization and Selection, Genetic Operators, Mutation, the Working of Genetic Algorithms, Evolutionary Programming, the Working of Evolutionary Programming

UNIT-V **08 Hrs**

APPLICATION TO POWER SYSTEM

Applications of ANN, Fuzzy logic and GA for fault analysis, operation of relay and circuit breakers.

Choice: Unit-II and Unit-IV

Text books & Reference books:

1. Artificial Intelligence and Intelligent Systems, OXFORD University Press, New Delhi, 2005- N. P. Padhy
2. Understanding Neural Networks and Fuzzy Logic: Basic concepts and Applications, Prentice Hall India Private Limited, New Delhi, 2002- Stamations V. Kartalopoulos
3. Artificial Intelligence Techniques in Power Systems, IEE Power Engineering Series, UK, 1997- Kevin Warwick, Arthur Ekwue and Raj Aggarwal
4. Intelligent Systems and Signal Processing in Power Engineering, Springer Berlin Heidelberg, New York- Abhisek Ukil
5. Neural Networks, Fuzzy logic and Genetic algorithms By S. Rajasekaran, G. A. Vijayalakshmi Pai PHI publication,
6. Optimization for Engineering Design by Kalyanmoy Deb PHI publication
7. Multi-objective Optimization using Evolutionary Algorithms By Kalyanmoy Deb Willey Publication

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19EE6PE3HV	Course Name	HV ENGINEERING
Credits	03	L – T - P	2-0-1

Course outcomes: At the end of the course, the student will have the ability to

CO 1	Apply the knowledge to comprehend Generation of High Voltage.
CO 2	Apply the knowledge to identify suitable dielectrics in various HV applications.
CO 3	Analyse the Breakdown Phenomenon in Insulators.
CO 4	Analyse the factors affecting HVAC & HVDC measurements.
CO 5	Conduct experiments on Solids, Liquids (conventional & bio-friendly) to assess the dielectric behavior under power frequency and high frequency

Pre-requisites: Engineering Physics

Course Description: Upon completion of the course, students will have: knowledge of high voltage applications and general knowledge about high voltage engineering, knowledge of the basic gaseous and liquid dielectrics, their properties and behavior under high voltage stresses. Students will have knowledge of the high voltage testing equipment and requirements for high voltage testing procedures. Students would also have ability to use the above mentioned knowledge to inspect high voltage equipment and materials used in high voltage applications. They will be able to analyze and understand the electrical insulation condition in different types of applications, to detect malfunctions related to dielectric materials**.**

UNIT-I **04 Hrs**

INTRODUCTION TO HIGH VOLTAGE TECHNOLOGY AND APPLICATIONS

Electric Field Stresses, Control of Electric Stress, Solids, Gas / Vaccum as Insulator, Liquid Dielectrics, Properties, Types and Applications of insulating materials in transformers, Rotating machines, Circuit Breakers, Cable, Power Capacitors and bushings

UNIT-II **05 Hrs**

BREAKDOWN IN GASEOUS AND LIQUID DIELECTRICS

Gases as insulating media, collision process, Ionization process, Townsend's Criteria of Breakdown in Gases, Corona discharge, Paschen's Law and its significance.

Concept of self-restoring and non self – restoring insulation, enclosed and exposed insulation.Liquid as insulator, Breakdown in pure and impure liquid dielectrics: Suspended particle theory, electronic breakdown, cavity breakdown (bubble's theory) and electro convection breakdown. Bio-friendly liquid Dielectrics used in practice: Introduction , Advantages and Disadvantages, Necessity of Treatments and Applications

UNIT-III **05 Hrs**

GENERATION OF HV AC & DC VOLTAGE

HVAC-HV transformer; Need for cascade connection and working of transformers units connected in cascade. Series resonant circuit- principle of operation and advantages. Tesla coil.HVDC- voltage doubler circuit, Calculation of high voltage regulation, ripple and optimum number of stages for minimum voltage drop.

UNIT-IV **05 Hrs**

GENERATION OF IMPULSE VOLTAGE

Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator- expression for Output impulse voltage. Multistage impulse generator, working of Marx impulse Generator. Rating of impulse generator. Components of multistage impulse generator. Generation of switching impulse voltage. Generation of high impulse current.

UNIT-V **05 Hrs**

MEASUREMENT OF HIGH VOLTAGES

Standard sphere gap Measurements of HVAC, HVDC, and Impulse voltages; Factors affecting the measurements. Electrostatic voltmeter-principle, construction, advantage and disadvantage.

Choice: **Unit-II and Unit-V**

Text books:

1. High Voltage Engineering, M.S.Naidu and Kamaraju- 4th Edition, THM, 2008.
2. High Voltage Engineering Fundamentals, E.Kuffel and W.S. Zaengl, 2nd Edition, Elsevier Press, 2005.

Reference books:

1. High Voltage Engineering ,C.L.Wadhwa, New Age International Private limited, 1995.
2. High Voltage Insulation Engineering by Ravindra Arora, Wolfgang, Mosch, NewAGe

International (P) Ltd, 1995
3. Electrical breakdown of gases. J.M. Meek and J.D. Craggs, "Oxford university press, 11953

E Books:

1. https://www.amazon.in/High-Voltage-Engineering...Kuffel-ebook/dp/B008GRKLZ8
2. https://www.amazon.com/High-Voltage-Engineering-Farouk...ebook/.../B00L2EBED...

Lab Experiments:

1. Measurement of HVAC using a)Sphere Gap b) Point –Plane c) Plane – Plane Breakdown
2. Measurement of Impulse Breakdown
3. Measurement of HVDC using a) Point –Plane b) Plane – Plane Breakdown
4. Measurement of Breakdown of Liquid Dielectric- Mineral Oil, Bio-Friendly Oils
5. Measurement of Dissipation Factor and Relative Permittivity of Liquid Dielectric at a) Power Frequency b) High Frequency
6. Tests on Solid Dielectrics –
   a) Breakdown Voltage Measurement
   b) Dissipation Factor and Relative Permittivity at Power Frequency and High Frequency

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE6CE1WS	Course Name	WIND AND SOLAR ENERGY SYSTEMS
Credits	03	L – T - P	3-0-0

Course outcomes

At the end of the course, the student will have the ability to:

CO 1	Ability to asses nature, storage and end use of energy and impact on environment
CO 2	Ability to estimate solar and wind energy resource available in a given location
CO 3	Ability to design simple solar PV systems and estimate performance
CO 4	Ability to design simple wind -electric systems and estimate performance

UNIT-I **08 Hrs**

Principles of Renewable Energy

Energy and sustainable development, Principle and major issues, simple numerical model,Global resources, Energy sources, Environmental energy, primary supply to end use, Energy planning, Energy currents, Dynamic characteristics, Quality of supply, Dispersed versus centralized energy, Complexity of systems, Situation dependence.Technical Implications- End use requirement and efficiency, Matching supply and demand, Control options, Social implications, pollution and the environmental impact, the future.

UNIT-II **08 Hrs**

Solar Resource and Solar Geometry

Solar spectrum, Earth's orbit, altitude angle at solar noon, solar position at any time of day, Sun path diagrams for shading analysis, solar time and civil time (clock time), sunrise and sunset, clear sky, direct beam radiation, Total clear sky insolation on a collecting surface – Direct beam radiation, Diffuse radiation and Reflected radiation. Tracking systems, monthly clear sky insolation, Solar radiation measurement- Epply Pyranometer, Angstrom compensated type Pyrheliometer, Abbot silver disc Pyrheliometer, Average-monthly insolation.

UNIT-III **08 Hrs**

Photovoltaic Materials and PV cell

Crystalline silicon technologies and thin film photovoltaics, PV cells to modules and modules to arrays. Introduction to basic semiconductor physics, pn junction diode, generic

photovoltaic cell, I-V and P-V curves under STC, impacts of temperature and insolation on I-V and P-V curves, maximum power, Equivalent circuit of PV cell Physics of shading, Bypass diodes for shade mitigation, blocking diodes, fill factor, efficiency of PV cell.

UNIT-IV **08 Hrs**

Photovoltaic systems

Types of PV systems, current voltage curves for loads, MPP trackers, and hourly I-V curves. Grid Connected PV systems- DC and AC rated power, interfacing with the utility, "Peak Hour" approach to estimate PV performance, capacity factor, system sizing, economics. Standalone PV systems - Estimating the load, system voltage, Inverters for standalone systems, storage battery and sizing , sizing the PV array. PV system design for residential load, PV powered water pumping, simple approach to PV –pump design, Environmental impact of solar PV.

UNIT-V **08 Hrs**

Introduction to wind energy nature and origin, power in the wind, temperature and altitude correction for air density, impact of tower height, average power in the wind, wind histogram, wind power density (qualitative analysis only).

Types of wind turbine, maximum rotor efficiency, simple estimates of wind turbine energy Wind turbine electric generators- synchronous generators and Induction generators, speed control for maximum power, variable slip induction generators. Wind to electric energy conversion schemes, grid connection of wind electric energy, storage requirements of wind electric energy, wind farms, cost of electricity from wind turbines, Environmental impacts of wind turbines.

Choice: Unit-II and Unit-IV

Text books:

1. Energy Technology, S. Rao and Dr. B.B. Parulekar, Khanna Publishers 3rd edition 2007
2. Non-conventional Energy Sources G.D. Rai, Khanna Publishers 4 th edition 2011.
3. Solar Energy: Fundamentals, Design, Modeling and Applications, G.N. Tiwari, Narosa publications
4. Solar cells Operating Principle, system application and Technology Martin A. Green Prentice Hall, New Delhi, 2008
5. Solar Photovoltaics:Chetan Singh Solanki , PHI Learning; 3 edition , 2015

Reference books:

1. Renewable Energy Resources, John Twidell and Anthony Weir 2 nd edition 2006 Taylor and Francis Group, ISBN: 0-419-25320=3
2. Renewable and Efficient Electric Power systems, Gilbert M. Masters, Stanford University, Willey Interscience, ISBN 0-471-280607
3. Wind and Solar Power Systems: Design, Analysis, and Operation,Mukund R. Patel, Second Edition,CRC press, 2005

E Books:

1. https://books.google.co.in/books?isbn=3319149415
2. https://books.google.co.in/books?isbn=0070260648
3. https://books.google.co.in/books?isbn=1139461559

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE6CE1IT	Course Name	IOT AND ITS APPLICATIONS
Credits	03	L – T - P	3-0-0

Course outcomes

At the end of the course, the student will have the ability:

CO 1	To understand the fundamentals of IOT.
CO 2	To discuss and analyze the importance of architecture of an IP-based IOT, actuators, sensors, communication protocol, message formatting, IOT networking, cloud and Fog computing.
CO 3	To develop codes using commonly used boards and programming languages for IOT - Arduino and Python.
CO 4	To apply IOT for energy management systems and agriculture.

UNIT-I **08 Hrs**

Introduction to Internet Of Things (IOT) : Internet of Things, Wireless Ad-hoc and Sensor Networks , IoT- enabled Applications , Home and Building Automation, Smart Cities ,Smart Grids, Industrial IoT ,Smart Farming.

Standards: "Traditional" Internet Review, Physical/Link Layer, IEEE 802.3 (Ethernet), IEEE 802.11 12 ,Network Layer , IPv6 and IPv4 , Transport Layer, TCP and UDP , Application Layer , HTTP , AMQP .

UNIT-II **08 Hrs**

Design of the Architecture of an IP-based IOT : Physical/Link Layer IEEE 802.15.4 and ZigBee , Low-power Wi-Fi , Bluetooth and BLE , Powerline Communications, Network Layer , The 6LoWPAN Adaptation Layer, Transport Layer , Application Layer.

IOT networking : MQTT- Introduction, components, methods, communication; CoAP: Introduction, Protocol overview, CoAP messaging, Reliability, Piggy-backed and separate responses, CoAP message format, Blockwise transfers, Multicast communication, Resource discovery and resource directory, HTTP/CoAP proxying

UNIT-III **08 Hrs**

Sensors: Definition, Analog sensors, digital sensors, Scalar sensors, Vector sensors, Sensor types.

Actuators: Definition, Types.

Sensor Networks: Wireless Sensor Networks: Sensor Nodes, Sensor web, Social

sensing, Applications.

UNIT-IV **08 Hrs**

Introduction to Arduino: Arduino Programming: Datatypes , Function Libraries, Operators, Control statements, Loops, Arrays, Strings, Math Library, Random number, Interrupts, Examples on integration of sensors and actuators using Arduino.

Introduction to Python Programming:

Python Programming: Variables, Datatypes, Control statements, Funtions, Modules, Exception handling, File and Image Read Write operations, Example Programs. Networking in Python

UNIT-V **08 Hrs**

Cloud Computing: Services, Sensor-Cloud,

Fog computing

Applications: Energy Management in Smart cities, IOT applications to agriculture.

Choice: Unit-I and Unit-IV

Text books:

1. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri, "Internet of Things: Architectures, Protocols and Standards", ISBN: 978-1-119-35967.
2. Arshdeep Bahga, "Internet of Things - A hands on approach", ISBN: 978-0996025515.

Reference books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
2. Interconnecting Smart Objects with IP- J. P Vasseur, Adam Dunkels, 2010

E Books:

IoT-From Research and Innovation to Market Deployment_IERC

MOOCs:

Introduction to Arduino Uno by IIT Kharagpur https://www.youtube.com/watch?v=NkZdosZH6Wo

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

(OPEN ELECTIVE-I)

Course Code	19EE6OE1PS	Course Name	PLC AND SCADA (Except EIE)
Credits	03	L – T - P	3-0-0

Prerequisites: None

Course Description: This course develops the functional design, hardware configuration, programming and application of Programmable Logic Controllers (PLC). The design and programming of control circuits using examples from industrial applications will be emphasized. The application of PLC's in process automation will be examined. An overview of functional hardware design will be included. The equipment used will be small and medium sized PLC's with both digital and analog capabilities.

Course outcomes:

At the end of the course, the student will have the ability:

CO 1	Gain knowledge about the working of Data Loggers, DDC, SCADA, DCS, PLC and its uses in solving engineering problems.
CO 2	Apply the concepts of automation for various processes.
CO 3	Analyze and formulate the requirements of appropriate ladder programs to provide solutions using PLCs.
CO 4	To design and apply program control, arithmetic, relay, data handling, sequencer, timer and counter instructions in development of solutions

UNIT-I **07 Hrs**

Computers In Process Control

Data loggers – Data Acquisition Systems (DAS) –Computer controlled system configurations –direct control, supervisory computer control, Introduction to SCADA- Evolution, Objectives, SCADA Architecture- IEC61850 Standard, Elements, Functions, Applications and Benefits of SCADA systems.

UNIT-II **08 Hrs**

Programmable Logic Controller (PLC) Basics

Introduction and importance of PLC, Types of PLC, Basic architecture of CPU of PLC, Basic wiring diagram of PLC, PLC operation and various standards, input/output modules- power supplies and isolators. General PLC programming procedures-programming on-off inputs/ outputs.

UNIT-III **08 Hrs**

Programming of PLC Using Timers and Counters

Introduction to programming standards of PLC, basic relay instruction, timer and counter instructions, Related programming and practice examples.

UNIT-IV **08 Hrs**

Advanced Instructions in PLC

PLC intermediate functions: Arithmetic functions - comparison functions, logic functions – Data handling instructions. PLC sequencer instructions, PLC program flow instructions, Designing of I/O system, creating ladder diagram from process control description.

UNIT-V **08 Hrs**

Distributed control systems (DCS)

Definition – merits and demerits, Local Control Unit (LCU) architecture – hierarchical system structure functional level, database organization, field stations, intermediate stations, central computer station, monitoring and command facilities.

Choice: Unit-III and Unit-IV

Text books:

1. John.W. Webb, Ronald A Reis, "Programmable Logic Controllers - Principles and Applications", Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, "Programmable Logic Controllers", McGraw Hill, New York, 2004
3. M.Chidambaram, "Computer Control of Process," Narosa Publishing, New Delhi, 2003.
4. Gary Dunning "introduction to Programmable logic controllers" 3 edition, CENGAGE learning.

Reference books:

1. B.G. Liptak, "Process software and digital networks," CRC press, Florida-2003
2. Curtis D. Johnson "Process control instrumentation technology," Prentice Hall, New Jersey 2006
3. Krishna Kant, "Computer-Based Industrial Control," PHI, New Delhi, 2004

E-Learning :

1. http://www.nptel.ac.in/courses/108106022/8
2. http://nptel.ac.in/courses/108105062/

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

(OPEN ELECTIVE-I)

Course Code	19EE6OE1IA	Course Name	INDUSTRIAL AUTOMATION
Credits	03	L – T - P	3-0-0

COURSE OBJECTIVES:

CO 1	The purpose of this course is to understand the various techniques employed in the industrial and process automation
CO 2	To Identify and learn about different types of sensors and transducers used in the automation industry and its application
CO 3	To identify and learn various types of controllers that are employed in the automation industry like CNC, PLC, ROBOTS and DCS.

COURSE OUTCOME:

a) Through the videos and practical experiments, the industry is brought to the class room. Various industry applications like automotive, concrete products making, sugar centrifuge, steel plants etc., will be discussed during the course.

b) Students get a chance to see and use the components that are presently being used in the industry and learn about different manufacturing methods used in the industry

c) This course, to great extent, prepare the students for the industry and therefore improves the chances of employability. (students become industry ready). This course also teaches the latest info in this industry.

UNIT-I **08 Hrs**

Introduction to the field of automation:

Introduction to automation, purpose and need. Evolution of automation viz mechanical. Hydraulics, electrical and programmable automation (different generations). Automation videos example. Importance of control monitoring and protection in automation. examples through videos. Different segments of automation like factory automation and process automation. Difference between, CNC controller, PLC controller, robots, DCS (distributed control system) PC based automation, Data acquisition systems. Different layers in automation.

UNIT-II **08 Hrs**

Electrical systems in automation

a) Understanding of the power distribution through single line diagram and plant layout. Power control centre (PCC) and motor control centre (MCC). Role of Earth

leakage relay/CBCT (core balanced current transformer), VCB, ACB, MCCB, MCB, MPCB, OLR, contactors and relay.

b) Induction Motor Working principle, Need for starters, DOL, RDOL,star delta starters. VFDs and its interface. Parameterization of VFDs, Methods of speed control, Step speed, analog, networking. Braking methods employed. Dynamic braking, regen braking

c) Servo motor working principle, speed and position loop description

d) Stepper motor working principle and its controls

UNIT-III **08 Hrs**

Sensors, transducers and encodes in automation

a) Digital sensors

Inductive proximity sensors and its working principle. Different types like flush, non flush, ring type. Various industry applications (like end travel sensing, metal sensing). Capacitive type proximity sensors and its working principle, various industry applications (like rice mill etc.,) Limit switches and its industry applications (like dead stop). Photo sensors (diffused beam, through beam, slotted sensor) working principle and industry application. Interface the above sensors with PLC

b) Analog sensors

Ultrasonic sensor for distance and level measurement (ON/OFF type, Analog type). Laser and Radar sensor for distance and level measurement with its industrial use application. Advantage and disadvantages. Conventional conductive sensor used in water tanks for level measurement. Light curtains for industrial safety. Touch and color sensors and its working principles and industrial applications. Temperature transducers, pressure transducers, current and voltage transducers. LVDT.

c) Encoders

Absolute encoders, incremental encoders, different types like rotary linear etc., reed switches, other devices like hoppers, alarms, messaging systems.

UNIT-IV **08 Hrs**

Mechanical systems in automation

a) Different types of mechanical systems used in automation like, Belt conveyor, chain conveyor, roller conveyor, friction conveyors, screw conveyors, eccentric cams,

Geneva indexing, rotary tables, trolleys with wheels, rack and pinion applications, ball screws, lead screws, Merits and demerits of the systems. How each of them interfaced with electrical motors and sensors

b) Components used in pneumatic systems like FRLMS, cylinders, regulators, etc., automation in pneumatic conveying systems, Hydraulic systems, components and its usage in automation

Components of automation:

a) PLC and its hardware description

Introduction to logic controller, CPU architecture and program execution methods, Scan time/sweep time, Digital input methods, pnp/npn architecture, digital outputs, analog inputs, (voltage vs. current) analog outputs. Special inputs like high speed inputs, RTDs, thermocouples etc

Interface of all the above sensors, transducers, motors and hydraulic valves to the PLC, wiring diagrams through electromechanical relays and solid state relays

UNIT-V **08 Hrs**

Programming the controller (software)

Different methods of programming the PLC. Introduction to ladder programming, Data structures like I, Q, AI, AQ, M, R etc., instructions like NO, NC, Transition coils, set/reset coils, timers, counters, control functions, relational functions, arithmetic functions. All instruction with industrial example. Demonstration using the kit. Students also will be give kit to programme. Programmes like elevator, cuber, run out table, cascade speed controls, stepper motor controls etc will be made and demonstrated with industrial examples

HMI and SCADA (software)

HMI and its features live demonstration with programming., Scada and its applications with mimic diagrams, tag database, RDBMS, alarms , trend charts, logging and report generation etc. features demonstration.

Text books:

1. Programmable Logic Controller W Bolton 5th Edition ISBN: 978-1-85617-751-1, Elsevier Publication 2009
2. 'Instrument Engineers' Handbook, Process Control Bela G. Liptak 4th Edition
3. Practical SCADA for industry David Bailey Edwin Wright ISBN:0750658053, Elsevier Publication 2003

4. Human-Machine Interface Design for Process Control Applications -Jean-Yves Fiset ISBN:1934394351, 9781934394359, ISA Publications 2009.
5. Introduction to Hydraulics and Pneumatics – Ilango Sivaraman, Second edition, PHI Learning Pvt Ltd., Publication.

Reference books:

1. Programmable Logic Controller Frank D. Petruzella Third Edition TaTa McGraw- Hill Edition, 2010
2. Understanding Distributed Processor Systems for Control. Samuel M. Herb ISA Publication, 1999
3. Computer control of processes - M.Chidambaram, Narosa publishing, Reprint 2010
4. Computer Based Industrial control- Krishna Kant, Prentice Hall of India. 6th Edition, 2004
5. Distributed computer control for industrial automation popovic and bhatkar Publication by Marcel Dekker, Inc. New York, NY, USA ©1990
6. DC Motors, Speed Controls, Servo Systems – Sam Stuart Third Edition Elsevier Science Publication, ISBN:9781483148373.

LAB EXPERIMENTS/ DEMONSTRATIONS

1. Speed control of induction motor using VFD step speed method (with out plc)
2. Speed control of induction motor using VFD analog method using potentio meter (with outplc)
3. DOL and RDOL with PLC
4. Use timers in the plc to generate step speed (each 5 seconds)
5. Program an elevator using PLC, induction motor, 2 proximity sensor
6. Program and run a pick and place unit, using pneumatic cylinders and valves.
7. Program an ice vending machine, using, PLC, photo sensor, induction motor.
8. Program an alarm system using up counters
9. Change the speed of an induction motor using ultrasonic/laser sensor depending on the distance.

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE6PWMP2	Course Name	MINI PROJECT-II
Credits	02	L – T - P	0 -0- 2

Course Outcomes:

CO 1	Ability to survey/research literature, and formulate a complex engineering problem.
CO 2	Apply the fundamental knowledge of mathematics, science and engineering principles in design of solutions of system components.
CO 3	Identify, Select, and Apply a suitable engineering/IT tool in modeling /data interpretation /analytical studies, conduct experiments leading to a logical solution.
CO 4	Design a system/ system component/process, build it and test its functioning as a solution to an engineering problem.
CO 5	Communicate effectively to a diverse audience and develop technical reports / publications.

Student groups can take up project work/continue the work taken up in Mini project-I in any of the domains of either Electrical and Electronics or interdisciplinary where the preliminary idea is conceived and relevant designs arrived at and implemented through simulations/hardware.

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE6SRISR	Course Name	INTERNSHIP SEMINAR-I
Credits	01	L – T - P	0-0-1

Course Outcomes:

CO 1	Engage in exposure to industrial practices.
CO 2	Analyze and interpret technical information.
CO 3	Select and apply modern engineering tools
CO 4	Communicate Effectively to an Audience, and design documentation (written graphical and visual forms)
CO 5	Engage in independent learning.

Internship seminar-I is the presentation of work carried out by students along with report of the internship carried out during semester breaks at the industry / institution/ through valued add courses provided by the industry/institution attended for a duration of 4-6 weeks .

VII SEMESTER SYLLABUS

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19ES7BSBFE	Course Name	BIOLOGY FOR ENGINEERS
Credits	02	L – T - P	2-0-0

Course outcomes:

At the end of the course, the student will have the

CO 1	Ability to understand and explain basic concepts of Biology
CO 2	Ability to apply the knowledge of Biology to convey the role of basic building blocks of life
CO 3	Ability to understand and analyse basics of Radiation and its effects on Human Body
CO 4	Understand role of Biology in organic farming

UNIT-I **05 Hrs**

Introduction: Why Engineers Should Study Biology?, What Is life?, The Hierarchy of Life, Evolution, Taxonomy, Interaction of Living Things with the Environment, Brief History of Life, Basic Organic Chemical Structure.

UNIT-II **06 Hrs**

Composition of Living Things: Carbohydrates, Lipids, Proteins, Nucleic Acids, Hybrid and Other Compounds

The Cell: The Common Denominator of Living Things, Prokaryotes and Eukaryotes, The Biological Membrane, Eukaryotic Cell Structure and Function, Cell Reproduction.

UNIT-III **05 Hrs**

Introduction to Radiation: Where does Radiation Come from, Types of Radiation, Types of Ionizing Radiation ,X-rays for Medical Use and Generators, Types of Electromagnetic Waves, Ionization of Radiation –Property of Ionizing Radiation, Types of Radiation and Biological Effects ,Penetrating Power of Radiation, Penetrating Power of Radiation within the Body, Penetrating Power and Range of Effects on the Human Body

UNIT-IV **05 Hrs**

Radiation Effects on Human Body: Types of Effects, Exposure Modes and Effects, Classification of Radiation Effects, Deterministic Effects and Stochastic Effects. Mechanism of Causing Effects on human Body: Ionization due to Radiation, Damage and Repair of DNA, DNA→Cells→Human Body, Radiation Damage to DNA, Lapse of Time after Exposure and Effects, Deterministic Effects, Radiosensitivity of Organs and Tissues, Stochastic Effects

Cell phone Radiation Hazards: Introduction, Mutation

UNIT-V **05 Hrs**

Organic Farming: History and Background, Requirements of Plants for Soil-Derived Nutrients: Effects of Nitrogen, Phosphorous and Potassium on Plant Growth and Quality, Symptoms of Nitrogen, Phosphorous and Potassium Deficiency in Crops

Unit choice: Unit II and Unit V

Text books:

1. Arthur T. Johnson, Biology for Engineers, Second Edition, CRC Press 2019
2. Hand Book on " Basic Knowledge and Health Effects of Radiation" by Radiation Health Management Division, Ministry of the Environment, Government of Japan and National Institutes for Quantum and Radiological Science and Technology
3. David A. Vaccari, Peter F. Strom and James E. Alleman, Environmental Biology for Engineers and Scientists Wiley Interscience, 2006
4. Allen V. Barker, Science and Technology of Organic Farming, CRC Press, 2010

Reference books:

1. Suraishkumar, Madhulika Dixit, Biology for Engineers and Non – Biologists, IIT Madras, Oxford University Press
2. Naren, Anubhav E, Vinay C, Mohsen G, 'Electromagnetic Radiation Due to Cellular, Wi-Fi and Bluetooth Technologies: How Safe are we?', IEEE Access Special section on Antenna Propagation for 5G and beyond, pp42980 – 43000, January 2020
3. Sapna E.T., India's Organic Farming Revolution, University of Iowa Press, Iowa City, 2014

E Resourse:

1. https://letstalkscience.ca/educational-resources/backgrounders/ radiation-effects-on-body

MOOCs

1. https://nptel.ac.in/courses/121/106/121106008/

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE7PCPS2	Course Name	POWER SYSTEMS-II
Credits	04	L – T - P	3-0- 1

Prerequisites: Transmission and Distribution, Electrical Energy Systems, Power Systems I

Course Description: This course will cover the various Load flow analysis techniques for the Power System, economic operation of power systems and load frequency control.

Course outcomes:

At the end of the course, the student will have the ability:

CO 1	Apply knowledge of Advanced Mathematics and Electrical Engineering concepts to formulate and solve complex power system problems such as load flow, economic dispatch and load frequency control.
CO 2	Analyze steady state power system performance based on the load flow model; from the dynamic model of speed governor-turbine system, assess the static performance of the closed loop system.
CO 3	Investigate the effect of variation of control parameters such as transformer taps, reactive power etc., on the overall power system behavior
CO 4	Using optimization techniques, economically schedule the load among all the generators in a power system so that the fuel costs are minimized; as load varies throughout the day, determine the savings incost.
CO 5	Write computer programs and/or use standard application software to simulate the power system. Using these modern tools, conduct power flow studies and perform economic dispatch on complex power systems.

UNIT-I **08 Hrs**

Network Formulation, representation of transmission lines and transformers with off nominal turns ratio, Formation of Y_{bus} by inspection. Bus incidence matrix, Primitive network – impedance form and admittance form, Y_{bus} by singular transformation

UNIT-II **08 Hrs**

Power flow equations, Classification of buses, Operating constraints, Data for load flow; Gauss-Seidel Method – Algorithm and flow chart for PQ and PV buses, Acceleration of convergence

UNIT-III **07 Hrs**

Newton-Raphson Method – Algorithm and flow chart for NR method in polar coordinates,

Algorithm for Fast Decoupled load flow method, Comparison of Load Flow Methods

UNIT-IV **08 Hrs**

Economic Operation of Power System: Introduction, Performance curves, Economic generation scheduling neglecting losses and generator limits, Economic generation scheduling including generator limits and neglecting losses; Economic Dispatch including transmission losses, Derivation of transmission loss formula, iterative technique for solution of economic dispatch with losses.

UNIT-V **08 Hrs**

Power system control and operating states, digital computer configuration, automatic generation control, area control error, Automatic load frequency control, Automatic load frequency control of single area systems, Speed governing systems Hydraulic valve actuator, Turbine generator response, Static performance of speed governor, Closing of ALFC loop, Concept of Control Area, Static response of primaryALFC loop.

Unit Choice: Unit II and Unit IV

Text books:

1. Computer Methods in Power System Analysis-G. W., Stagg, and A. H.- EI-abiad, McGraw Hill International Student Edition. 1968
2. Computer Techniques in Power System Analysis- M. A-Pai, TMH, 2ndedition, 2006.
3. Modern Power System Analysis, IJ Nagrath and DP Kothari, 3rd Edition, Tata McGraw Hill Publications,2003
4. Power System Analysis, W.D Stevenson, TMH
5. Computer Techniques and Models in Power Systems, K. Uma Rao, I.K International.

Reference books:

1. Computer Aided Power System Analysis, GL Kusic, 2nd edition, PHI, 2010
2. Power System Analysis and design, Glover & Sarma, Thomson 3rd Edition
3. Power System Analysis, Hadi Sadat, 3rd edition, Tata McGraw Hill Publications, 2007
4. Electrical Energy Systems Theory, O.J Elgerd, TMH,2008

E-Learning :

1. NPTEL Course titled: Computer Aided Power System Analysis. Link: http://nptel.ac.in/courses/108107028/

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Sl.No		Experiments
1	Using MATLAB package	Formation for symmetric π /T configuration for Verification of AD−BC=1, Determination of Efficiency and Regulation for a given transmission line.
2		Determination of Power Angle Diagrams, Reluctance Power, Excitation voltage, Emf, and Regulation for Salient and Non-Salient Pole Synchronous Machines
3		To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters/ Fault Location/ClearingTime/Pre-Fault Electrical Output for a Single Machine Connected to Infinite Bus through a Pair of identical Transmission Lines Under 3-Phase Fault On One of the Two Lines.
3		Y Bus Formation for Power Systems with and without Mutual Coupling, by Singular Transformation and Inspection Method.
5		Formation of Z Bus(without mutual coupling) using Z-Bus Building Algorithm.
6		Determination of Bus Currents, Bus Power and Line Flow for a Specified System Voltage (Bus) Profile
7		Formation of Jacobian for a System not Exceeding 4 Buses (No PVBuses) in Polar Coordinates.
8	Using Mi-Power	Load Flow Analysis using Gauss Siedel Method, NR Method and Fast Decoupled Method for Both PQ and PV Buses.
9		To Determine Fault Currents and Voltages in a Single Transmission Line System with Star-Delta Transformers at a Specified Location for LG and LLG faults by simulation.
10		Optimal Generation Scheduling for Thermal power plants by simulation

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19EE7PCSPE	Course Name	SUSTAINABLE PRACTICES IN POWER ENGINEERING (By Industry expert)
Credits	01	L – T - P	1 -0- 0

Course outcomes:
At the end of the course, the student will have the ability:

CO 1	Comprehend the design and challenges in LV distribution products and systems, selection of various switch gears for LV distribution, Robust design Issues in Switch Gears & Protection of LV distribution, Various means and operational methods for Quality Assurance.
CO 2	Analyze and Improve the performance of electrical systems that exist for societal use for Safety, Sustainability, Energy Efficiency,Quality, Economics and Reliability.
CO 3	Assess and ensure adherence to Regulations & Specifications of electrical products and systems. Understand modes of Testing & Certification. Develop technology and processes to apply ethical norms and evolve standard practices.
CO 4	Make effective reports/presentations on various aspects of the studies (Self-study; Assignments ; Exploration ; Recommendations) carried out.

Course Description:
Electrical Engineering Graduates should have Design and Application knowledge of Low Voltage Distribution Systems to sustain availability of uninterrupted electrical power, at optimum cost, ensuring safety of end users and establishments. This course elaborates on the industrial approach of using related fundamentals for Design & Development of LV Distribution Products & Services, and their integration in a system. It covers modes of anticipating practical problems & failures, and addressing such issues by building robust design, judicious selection of equipment / switch-gears, ensuring mandated installation, undertaking desired testing & certification, organising maintenance, and incorporating control mechanism to ensure specified performance and life.

UNIT-I **04 Hrs**

Build Sustainability - Sustain Self & Business, Introduction to Industrial Practices for Sustenance & Growth. Define and Add Value, Improve Capability & Deliverables, Enrich Society, Reduce Losses and Improve Efficiency.

UNIT-II **05 Hrs**

Sustainable LV distribution systems –. Range, Functionality, and Integration of products into systems Mechanical equivalence of electrical power. Fundamentals of Electrical Contacts for Break-Make-Withstand (BMW) of electric-current at different levels (Rated, Overload, Inrush, Short-circuit)

UNIT-III **05 Hrs**

Robust Design to ensure Sustainability - Make products Safe & Provide products for Safety. Avoid unwanted interruptions. Selectivity / Discrimination. Domain & Design Tools knowledge. Understand & Use Design language, Regulatory requirements – OSHA, ROHS, WEEE

UNIT-IV **05 Hrs**

Considerations for Robust Design - Safety of People & Installations. Regulations & Specifiers – BIS, IEC, UL. Assurance for Life. End of Life & Hazards. User Confidence. Failure modes and Mitigants. Criteria for Fail-Safe Design

UNIT-V **05 Hrs**

Testing Validation and Controls for Robust Design - Quality, Reliability, DFSS, Poka-Yoke, Design Margin & Trade-offs. Evaluation, Certification and Third-Party recognition. Field Performance & Feed-back. Parts & Process Control. QMS – Internal & External defects ppm monitoring

Unit Choice: **Unit II and Unit III**

Text books:

1. Lectures and Uploaded pre-work material by Course Designer
2. Self-Study & Assignments circulation
3. Electrical Contacts: Principles and Applications, Second Edition Paul G. Slade, by CRC Press

Reference books:

1. Lectures delivered, and circulated slides by Course Designer.
2. Strategy for Sustainability: A Business Manifesto by Adam Werbach, Harvard Business Press.

E-Learning:

1. https://www.ge.com/power
2. Leads provided during Course presentation & slides circulation

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

(CLUSTER ELECTIVE-II)

Course Code	19EE7CE2EM	Course Name	ELECTRICAL & ELECTRONICS ENGINEERING MATERIALS
Credits	03	L – T - P	3-0-0

Prerequisites: Basics of Physics & Chemistry

Course Description: This course will enable students to

i. Know about the basics of kinetics, chemical bonding and structure of materials.

ii. Analyze the facts of conductors, resistors and dielectric materials.

iii. Study different types and properties of semiconductors.

iV. Know about the concept of magnetic materials and their properties.

V. Measure different electrical and magnetic properties of materials.

Course outcomes:

At the end of the course, the student will have the ability:

CO 1	Understand the different types of physical phenomenon responsible for different properties of Engineering materials.
CO 2	Apply the knowledge of crystal geometry, atomic structure and chemical bonding to find out different structures and properties of engineering materials.
CO 3	Analyze different theories proposed to explain the behavior and properties of conductors, semiconductors, dielectrics and magnetic materials.
CO 4	Analyze different experimental methods to measure different properties of conductor, semiconductor, dielectric and magnetic materials.

UNIT-I **07 Hrs**

Introduction, Equilibrium, kinetics and crystal geometry:

Materials science & Engineering: Classification of engineering materials, level of structure, structure-property relationship in materials.

Crystal geometry: The space lattice, space lattice and crystal structure, crystal direction and planes.

UNIT-II **09 Hrs**

Atomic structure, chemical bonding and structure of solid:

Atomic structure: Quantum states, ionization potential, electron affinity and electro-negativity

Chemical bonding: bond energy, bond type and bond length, ionic bonding, covalent bonding, metallic bonding, variation of bonding character and properties.

Structure of solids: crystalline and non-crystalline states, covalent solids, metal and alloys, ionic solids, the structure of silica and the silicates.

UNIT-III **07 Hrs**

Conductors, Resistors and Dielectric materials:

Conductors and resistors: The resistivity range, the free electron theory, conduction by free electrons, conductor and resistor materials, super conducting materials.

Dielectric materials: Polarization and dielectric constant, temperature and frequency effects, electric breakdown, ferroelectric materials, piezoelectricity, dielectric losses

UNIT-IV **08 Hrs**

Semiconductors:

Classifying materials as semiconductor, the chemical bond in Si and Ge, the density of carriers in intrinsic semiconductor; the energy gap, the conductivity of intrinsic semiconductors, extrinsic semiconductors, carrier density in n-type semiconductors, p-type semiconductors, Hall effect and carrier density, photoconductivity, fabrication of integrated circuit

UNIT-V **08 Hrs**

Magnetic Materials, Measurement of Electrical and Magnetic properties :

Classification of magnetic materials, diamagnetism, the origin of permanent magnetic dipoles in matter, soft magnetic materials, hard magnetic materials, some properties of ferromagnetic materials, antiferromagnetic materials,

Measurement of Electrical and Magnetic properties: Conductivity measurements, dielectric measurements, magnetic measurements, measurements of semiconductor parameters.

Unit choice: Unit II and Unit IV

Text books:

1. "Materials Science and Engineering", V. Raghavan, PHI Learning Private Limited, Fifth Edition. 42nd reprint 2013.
2. "Electrical Engineering Materials", A.J. Dekker, Prentice Hall of India Private Limited, 13th re- print1988.

Reference books:

1. "An Introduction to Electrical Engineering Materials", C.S. Indulkar and S. Thiruvengadam, S. Chand & Company Ltd. 3rd Edition, reprint 1985.
2. "Electronic Engineering Materials and Devices", John Allison,Tata McGraw-Hill Publishing Company Ltd. 9th reprint 1990.

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19EE7CE2PQ	Course Name	ELECTRICAL POWER QUALITY
Credits	03	L – T - P	3 -0- 0

Prerequisites:

Course Description:

Course Description: This course covers an overview of modern power systems, need for power quality monitoring, origin of power quality problems, classification of power quality disturbances, harmonic distortion and analysis, types of loads that cause power quality problems, methods of mitigation of PQ problems and instruments used for measuring the power quality. This course would enable the students with sufficient awareness about the various issues affecting power quality as well as techniques available to improve the quality of power Course Outcomes

Course outcomes:

At the end of the course, the student will have the ability:

CO 1	Explain the issues and concerns of power quality, classify, sketch and identify various power quality phenomena normal as well as abnormal, define several standards related to power quality, the effect of distributed generation, origin of power quality variations, consequences and effect of frequency variations, effects of harmonic distortions, explain the working of instruments and mitigation methods used for PQ problems
CO 2	Analyse power quality issues and interpret data presented through case studies for power quality issues and suggest suitable remedial measures.
CO 3	Independently and/or in a group design experiments, model, simulate, measure using specialized equipment, study, collate information/data, on loads that cause power quality problems in different field set-ups such as domestic /bulk consumers of electricity.
CO 4	Make effective technical presentations and reports on the work carried out and communicate effectively to an audience.

UNIT-I **07 Hrs**

Modern view of power systems, Power Quality: Interest in power quality, definition of power quality, events and variation, Power quality monitoring. Overview of power quality standards, compatibility between equipment and supply, normal events, abnormal events, Distributed generation, impact of distributed generation on current and voltage quality,

tripping of generator units, Power Quality issues and concerns of the country, Summary.

UNIT-II **08 Hrs**

Origin of power quality variations: Voltage frequency variations, power balance, power-frequency control, spinning reserve, choice of power set-point, sharing of load, behaviour consequences of frequency variations, time deviation of clocks, variations in motor speed, variations in flux, risk of under frequency tripping, rate of change of frequency, measurement examples, Summary

UNIT-III **08 Hrs**

Classification of power quality issues: transients, long duration voltage variations, short duration voltage variations, voltage imbalance, waveform distortion, consequences of waveform distortion, harmonic distortion, voltage versus current distortion, harmonics versus transients, power system quantities under non sinusoidal conditions, active reactive and apparent power, displacement power factor and true power factor, harmonic phase sequences, triplen harmonics, harmonic indices, total harmonic distortion and total demand distortion. Summary

UNIT-IV **08 Hrs**

Effects of harmonic distortion: Effect on capacitors, Effect on transformers, impact on motors, Harmonic sources from commercial loads, single phase power supplies, fluorescent lighting, adjustable -speed drives for HVAC and elevators, Wiring and grounding, reasons for grounding, typical wiring and grounding problems, solutions to a few wiring and grounding problems, Summary.

UNIT-V **08 Hrs**

Loads that cause power quality problems, modelling and simulation of nonlinear loads, Classification of Mitigation Techniques for Power Quality Problems: Passive and Active power filters (qualitative approach only). Power quality measurement equipment: types, wiring and grounding testers, Multimeters, digital cameras, oscilloscopes, disturbance analyser's spectrum and harmonic analysers, flicker meters, smart power quality monitors, transducer requirements. Summary.

Unit choice: Unit III and Unit IV

Text books:

1. Electrical Power Systems Quality, Roger C. Dugan, Surya Santoso, MarkF.McGranaghan, H. Wayne Beaty, Paperback, ,McGraw Hill, Professional,

Technology, 7th June 2012 .

2. Power Quality: Problems and Mitigation Techniques, Bhim Singh, Ambrish Chandra, Kamal Al- Haddad, First Edition, © 2015 John Wiley & Sons, Ltd. Published
3. Understanding Power Quality Disturbances, Math H. Bollen, Irene Gu, , Wiley-IEEE Press, July 2006. by John Wiley & Sons, Ltd,2015.

Reference books:

1. Signal Processing of Power Quality Disturbances,Math H. Bollen, Irene Gu, , Wiley-IEEE Press, July 2006.
2. Power Quality,C. Sankaran,by CRC Press,December 21, 2001.
3. Power Quality Enhancement Using Custom Power Devices, by ArindamGhosh , Gerard Ledwich,Paperback – 2009.
4. Power Quality in Power Systems and Electrical Machines ,SecondEdition,Ewald Fuchs and Mohammad A. S. Masoum,Elsevier Inc,2015.

E-Learning :

1. http://nptel.ac.in/courses/108106025/ Power quality in power distribution systems, Dr. Mahesh Kumar, Professor Department of Electrical Engineering Indian Institute of Technology Madras IIT Madras.

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

(OPEN ELECTIVE-II)

Course Code	19EE7OE2EC	Course Name	**ELECTRICAL POWER AND ENERGY CONSERVATION
Credits	03	L – T - P	3-0-0

**** Excluding those EEE students who have taken Electrical Energy Conservation and Auditing - 19EE5PE1EA as Program Elective – I**

In the 5th Semester

Prerequisites: Basic electrical engineering

Course Description: Objective: Energy studies and Energy management concerns the issues regarding optimal use of our present and future energy sources. This course is intended to address economic and environmental problems due to energy use, by considering the technical, economic and social factors that affect the demand for energy. On completing the course, one would have a good knowledge of how economic analysis can help understanding problems related to energy supply and use ; be able to analyze alternative energy policy options in terms of benefits and costs; have a good understanding of energy markets; be able to analyze the risks associated with energy options. Will also have acquired the skills needed to structure, analyse and evaluate energy related problems.

Course outcomes:

At the end of the course, the student will have the ability:

CO 1	Ability to apply the knowledge and try to solve the problems of power crisis in India by analyzing different load availability with respect to requirements and demand.
CO 2	Ability to select and apply different methods of tariffs used in practice so as to motivate and apply the energy conservation methods in various sectors of energy use.
CO 3	Ability to analyze various energy auditing methods to conserve energy in various sectors
CO 4	Ability to analyze different load curves of various energy sectors and apply load control methods for optimal use of electricity.

UNIT-I **07 Hrs**

Introduction: Electrical Energy demand, Electrical Energy growth in India, Growth of Electrical Energy consumption, Electrical Energy losses, Electrical Energy sources, conventional and nonconventional energy sources, power crisis in India, future Energy demand in India.

UNIT-II **08 Hrs**

Load and Load curves: Energy requirements, Maximum Demand, Group Diversity factor, Peak Diversity factor, type of load, load factor, capacity factor, utilization factor, base load and peak load plant. Numerical. Tariff: Objective, General Tariff forms, Types of Tariff, Numerical.

UNIT-III **08 Hrs**

Energy conservation: Introduction, motivation for Energy conservation, principles of Energy conservation, Energy conservation planning, Energy conservation in Industries, Energy conservation in Generation, Transmission and Distribution, Energy conservation in household and commercial sectors, Transport and Agriculture.

UNIT-IV **08 Hrs**

Energy Audit: Aim of Energy Audit, Energy flow diagram, Energy management team, Considerations in implementing Energy conservation programs, Periodic progress review, Instruments for Energy Audit, Energy Audit for illumination system, Energy Audit for heating, Ventilation, Air-condition systems, Energy Audit for compressed air systems and Energy Audit of Buildings.

UNIT-V **08 Hrs**

Concept of Demand Side Management (DSM), Load management as a DSM Strategy, Applications of Load control, End use Energy Conservation, Tariff options for DSM, DSM & Environment.

Unit Choice: Unit-II and Unit-IV

Text books:

1. Generation of Electrical Energy: B.R.Gupta, Chand & Company, 5th Edition
2. Energy Management: Umesh Rathore, S.K.Kataria & Sons, 2nd edition, 2004

Reference books:

1. Energy Management Handbook

E-Learning :

1. https://books.google.co.in/books?isbn=0881735434, Steve Doty – 2007
2. https://books.google.co.in/books?isbn=1315356619, D. Yogi Goswami – 201

BMS COLLEGE OF ENGINEERING, BANGALORE-19
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Course Code	22EE7OE2EV	Course Name	ELECTRIC AND HYBRID VEHICLES
Credits	03	L – T - P	3-0-0

Course outcomes:
At the end of the course, the student will have the ability:

CO 1	Acquire in depth knowledge of the electric vehicle system and its components and various modes of operation.
CO 2	Estimate and analyse the performance parameters of an electric vehicle under different conditions of operation.
CO 3	Analyse various energy storage technologies used in electric vehicles
CO 4	Develop the electric propulsion unit and its control for application of electric vehicles.
CO 5	Design converters for battery charging and explain transformer less topology.
CO 6	Present a technical report on modelling and operation of Electric vehicles.

UNIT-I **04 Hrs**

Environmental impact and history of modern transportation: Air pollution, global warming, importance of different transportation, history of electric vehicles.

UNIT-II **08 Hrs**

Electric and Hybrid Electric Vehicles: Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.

UNIT-III **08 Hrs**

Electric Propulsion: EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor drives for Electric Vehicles, Configuration and control of Drives.

UNIT-IV **08 Hrs**

Energy storage for EV and HEV: Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of

Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors. Basic converters for battery charging.

UNIT-V **08 Hrs**

Design of Electric and Hybrid Electric Vehicles: Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy Storage design.

Unit choice: Unit IV and Unit V

Text books:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles; Fundamentals Theory and Design", Second Edition, CRC Press 2005.
2. Iqbal Husain, "Electric and Hybrid Vehicles; Design Fundamentals", CRC Press 2003.

Reference books:

1. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Springer 2013.
2. C.C. Chan and K.T. Chau, Modern Electric Vehicle Technology Oxford University, 2001
3. Chris Mi M. Abul Masrur, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives. Wiley publication, Second Edition, 2011.

E-Learning :

1. Introduction to Hybrid and Electric Vehicles:
   https://nptel.ac.in/courses/108/103/108103009/

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19EE7PWMPJ	Course Name	MAJOR PROJECT WORK-1 Course
Credits	03	L – T - P	0 -0-3

Course outcomes:

At the end of the course, the student will have the ability:

CO 1	Ability to research literature, and formulate a complex engineering problem.
CO 2	Apply the fundamental knowledge of mathematics, science and engineering principles in design of solutions of system components.
CO 3	Identify, select, and apply a suitable engineering/IT tool in modeling /data interpretation /analytical studies, conduct experiments leading to a logical solution.
CO 4	Design a system/ system component/process, build it and test its functioning as a solution to a complex engineering problem.
CO 5	Communicate effectively to a diverse audience and develop technical reports and publication

Student groups can take up project work on a fresh topic /continue the work taken up in Mini project-I& II in any of the domains of either Electrical or Electronics or interdisciplinary where the preliminary idea is already conceived and relevant designs arrived at and implemented through simulations/hardware.

BMS COLLEGE OF ENGINEERING, BANGALORE-19
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Course Code	19ES7HSPMF	Course Name	PROJECT MANAGEMENT AND FINANCE
Credits	03	L – T - P	3 -0- 0

Prerequisites: Personality development course, soft skills

Course Description:

This course provides an insight into the basic principles of project management, including concepts, principles, and formulation of projects such as initiating, planning, executing, monitoring & controlling, and closing process groups. Introduces fundamentals from the project management knowledge areas such as integration, scope, time, cost, quality, human resources, communications, risk, procurement, and stakeholder management.

Provides students with the opportunity to apply project management principles to real-world situations. It offers techniques to evaluate projects which could be successfully used for improving the quality of managerial decisions and also the importance of financial management in managing projects and programs.

Course outcomes:

At the end of the course, the student will have the ability:

CO 1	Apply the Knowledge of project management principles and to study the current market trends
CO 2	Implement project management methodologies ethically for successful project completion
CO 3	Identify the investment opportunities and to formulate the projects.
CO 4	Choose projects which benefit the society and organization and apply project phases and document them for future reference

UNIT-I **07 Hrs**

Concepts of Project Management - Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects

Concepts of project, Categories of project, Project life cycle phases, Project management concepts, Tools and techniques for project management, the project manager, Basic education for a project manager, Roles and responsibilities of project manager, Project manager as profession, Summary

UNIT-II **08 Hrs**

Establishing the Project - Scope, Time, Cost and performance goals, Feasibility report, Financing Arrangements, Preparation of cost estimates, Finalization of project implementation schedule, Evaluation of the project profitability, appointing a project manager, Fixing the Zero date, Summary

UNIT-III **08 Hrs**

Organizing Human Resources and Contracting - Delegation , Project managers authority, Project organization, Accountability in Project Execution , Contracts , R's of contracting, Tendering and Selection of Contractors, Team building, Summary.

UNIT-IV **08 Hrs**

Organizing Systems and Procedures for Project Implementation -Working of systems, Design of Systems, Project work system design , Work breakdown structure, Project execution plan, Project procedure manual, Project control system, Planning, Scheduling and Monitoring, Monitoring contracts, Project diary , Summary.

UNIT-V **08 Hrs**

Financing of Projects - Capital structure, Menu of financing , Internal accruals , Equity capital, Preference capital , Debentures (or bonds) , Methods of offering term loans , Working capital advances, Miscellaneous sources , Raising venture capital, Project financing structures, Financial closure, Financial institutions, Summary.

UNIT Choice: Unit-II and Unit-IV

Text books:

1. Project Management – S Choudary, Tata McGRAW Hill Publishing Company Limited
2. Projects- Planning , Analysis , Selection, Financing ,Implementation and Review –Dr. Prasanna Chandra McGRAW Hill Publishing Company Limited
3. Project Management Institute A Guide to the Project Management Body of Knowledge PMBOK Guide (Sixth Edition), Sept 2017

Reference books:

1. Fundamentals of Project Management by Dr.Vijay Kanabar
2. Project Management – David I Cleland – Mcgraw Hill International edition
3. Project Management – Gopalakrishnan – Mcmillan India Ltd
4. Project Management – harry – Maylor- Peason Publication

E-Learning :

1. https://www.youtube.com/watch?v=5d16JwWwjKo
2. Nptel lecture on Introduction to project management by prof. Arun Kanda https://www.youtube.com/watch?v=5pwc2DYlKQU

VIII SEMESTER SYLLABUS

BMS COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College under VTU)

Course Code	19ES8HSIPL	Course Name	INTELLECTUAL PROPERTY RIGHTS AND CYBER LAW
Credits	02	L – T - P	2-0-0

Course Description:

This course develops contextual knowledge to access societal health, safety, legal and consequent responsibilities relevant to the professional engineering practice. The course also emphasizes the laws governing the protection of individuals, organizations, institutions, society and countries against Infringements on social, emotional and economic lines. It also gives awareness about the punishments to wrong doings by misuse of cyber space on information technology platform.

Course outcomes:

At the end of the course, the student will have the ability:

CO 1	Ability to understand and commit to professional ethics and responsibilities to obtain Intellectual Property Rights like Patents, Copyright &Trademarks.
CO 2	Understand the impact of Patents, Copyrights & Trademarks and demonstrate the knowledge of cyber law for the societal and environmental context.
CO 3	Ability to use IPRs and cyber law to access, societal, health, safety & Cultural issues.
CO 4	Ability to work in multiple teams to effectively communicate IP & Cyber Law.

UNIT-I **04 Hrs**

Basic principles of IP laws & Patents: Introduction, Concept of property, Constitutional aspects of IP, Evolution of the patent system in UK, US and India, Basis for protection, Origin and meaning of the term patent, Objective of a patent law, principles underlying the patent law in India, the legislative provisions regulating patents, Non – patentableinventions.

UNIT-II **06 Hrs**

Procedure for obtaining patent: Submission of application, Filing provisional and complete specification, Examination of the application, advertisement of the acceptance, opposition, Grant and sealing of patent, Term of the patent, compulsory license.

Provisional and complete specification: Definition of Specification, Kinds of specification, provisional specification, complete specification, Claims, Conditions for amendment.

Rights conferred on a patentee: Patent rights, Exception and limitations, Duties of a Patentee. Transfer of patent: Forms of transfer of Patent rights, Assignment, kinds of assignment, License, kinds of license, Rights conferred on a licensee, Transmission of patent by operation of law.

Infringement of patents: Construction of claims and infringement, patents held to be infringed, patents held to be not infringed.

Action for Infringement: Where a suit is to be instituted, procedure followed in the suit, Onus of establishment infringement, Defence by the defendant, The Relief's, Injunction, Damages or account of profits, patent agents, patent drafting, database searching, and Case studies.

UNIT-III **06 Hrs**

Copy Right: Meaning and characteristics of copy right, Indian copy right law, requirement of copy right, Illustrations copy right in literary work, Musical work, Artistic work, work of architecture, Cinematograph film, sound recording.

Author and Ownership of copy right: Ownership of copy right, Contract of service, Contract for service, rights conferred by copy right, terms of copy right, license of copy right.

Infringement of copy right: Acts which constitute infringement, general principle, direct and indirect evidence of copying, Acts not constituting infringements, Infringements in literary, dramatic and musical works, Remedies against infringement of copy right, Case studies

Trade Marks: Introduction, Statutory authorities, procedure of registration of trademarks, rights conferred by registration of trademarks, licensing in trade mark, infringement of trade mark and action against infringement.

UNIT-IV **04 Hrs**

Cyber Law: An introduction, Definition, why cyber law in India, Evolving cyber law practices- for corporates, privacy in Indian cyber space. Terrorism & Cyber Crime. Cyber theft and Indian telegraph act, Cyber Stalking

UNIT-V **04 Hrs**

Indian Cyber law: Protecting Indian children online, Spam, contempt in cyber space,

Indian consumers & cyber space, E-courts of India.

UNIT Choice: Unit-II and Unit-III

Text books:

1. Dr. T Ramakrishna, "Basic principles and acquisition of Intellectual Property Rights", CIPRA, NSLIU -2005.
2. Dr.B.L.Wadehhra, "Intellectual Property Law Handbook", Universal Law Publishing Co. Ltd., 2002.
3. Cyberlaw-The Indian perspective by Pavan Duggal, 2009 Edition.

Reference books:

1. Dr. T Ramakrishna, "Ownership and Enforcement of Intellectual Property Rights", CIPRA, NSLIU -2005.
2. "Intellectual Property Law (Bare Act with short comments)", Universal Law Publishing Co. Ltd. 2007
3. "The Trade marks Act 1999 (Bare Act with short comments)", Universal Law Publishing Co. Ltd., 2005.

BMS COLLEGE OF ENGINEERING, BANGALORE-19

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(OPEN ELECTIVE-III)

Course Code	19MD8OE3OR	Course Name	OPERATIONS RESEARCH
Credits	03	L – T - P	3-0-0

Prerequisites: Matrix computations, Statistics and Probability

Course Description: To acquaint the students with quantitative methods and different techniques for effective decision making; model formulation and applications that is used in solving business decision problems in various environments. The course includes linear programing, transportation, assignment problems, CPM/PERT techniques, Game theory.

Course outcomes:

At the end of the course, the student will have the ability:

CO 1	Formulate a real-world problem as a mathematical programming model.
CO 2	Formulate and solve transportation models by applying cost cutting strategies.
CO 3	Formulate and solve assignment models and travelling salesmen problems.
CO 4	Construct a project network and apply program evaluation review technique and critical path management.
CO 5	Employ Game theory for strategic decision making.

UNIT-I **07 Hrs**

INTRODUCTION: Evolution, definition, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, Linear Programming Problems (LPP) - Formulation of LPP-Graphical solution. Use of slack, surplus and artificial variables, Canonical and Standard forms, Solution of LPPs using Simplex method, Big- M method.

UNIT-II **08 Hrs**

TRANSPORTATION PROBLEM: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner method, least cost method, Vogel approximation method, Degeneracy in transportation problems, optimal solutions by MODI method.

UNIT-III **08 Hrs**

ASSIGNMENT PROBLEM- Formulation, types, Hungarian method for assignment

problem, unbalanced assignment problem, application to maximization cases and travelling salesmen problem

UNIT-IV **09 Hrs**

PERT-CPM TECHNIQUES: Introduction, network construction-AON & AOA diagrams, Fulkerson's rule for numbering the events, Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project. Predicting the completion time of project; crashing of simple projects.

UNIT-V **08 Hrs**

GAME THEORY: Formulation of games, types, solution of games with saddle point, Solution of games without saddle point, 2x2 games without saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games.

UNIT Choice : Unit-I and Unit-IV

Text books:

1. S.D. Sharma-Operations Research, KedarnathRamanath& Co.2002
2. R. Panneerselvam-Operations Research, second edition, PHI Learning Private Limited 2011
3. Richard Bronson, GovindasamiNaadimuthu: Schaumn Outline series-second edition, Tata McGraw Hill edition 2004, Eleventh reprint 2011

Reference books:

1. Hiller and Liberman -Introduction to Operations Research, Ninth edition Mc Graw Hill Publications
2. Hamdy A Taha H A- Operations Research, eighth edition, Pearson Prentice Hall.
3. KantiSwarup, P K Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, 2010.

E-Learning :

1. https://books.google.co.in/books?isbn=8131711048,Taha–2008.
2. https://books.google.co.in/books?isbn=8121902819
3. https://books.google.co.in/books?isbn=8131700003,A. M. Natara P. Balasubramani – 2006

BMS COLLEGE OF ENGINEERING, BANGALORE-19
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Course Code	19EE8OE3SG	Course Name	SMART GRID TECHNOLOGIES (OPEN ELECTIVE)
Credits	03	L – T - P	3 -0- 0

Course Description:

The aim of this course is to provide a basic discussion of the Smart Grid concept the technologies that are vital for its successful implementation. The course covers the concepts of smart grid, smart meters and phasor measurement units, various distribution energy resources and their impact, modern communication technologies vital for Smart Grid, data modifications of existing analytical tools to accommodate wide area monitoring and the important aspect of cyber security in Smart Grids. This course is intended to provide guidelines and overview of key aspects of a Smart Grid.

Course outcomes:

Upon completion of the course, the students will be able to

CO 1	Get acquainted with the smart resources, smart meters and other smart devices.
CO 2	Describe how modern power distribution system functions.
CO 3	Identify suitable communication networks for smart grid applications

UNIT-I **04 Hrs**

Introduction – Introduction to Smart Grid and Smart cities, Evolution of Electric Grid, Smart Grid Concept Definitions and Need for Smart Grid – Functions – Opportunities – Benefits and challenges, Difference between conventional & Smart Grid, Technology Drivers.

UNIT-II **8 Hrs**

Energy Management System (EMS) – Smart substations – Substation Automation – Feeder Automation, SCADA – Remote Terminal Unit – Intelligent Electronic Devices – Protocols, WAMS – Phasor Measurement Unit-PMU protocols, case studies.

UNIT-III **8 Hrs**

Renewable Energy Sources and Storage in Smart Grid – Sustainable Energy Options for Smart Grid- Solar Technology, Wind Power Systems, Biomass Energy, Small and

Micro–Hydro power, Penetration and Variability Issues Associated with Sustainable Energy Technology, Energy Storage Technologies, Case Studies

UNIT-IV **08 Hrs**

Introduction to Smart Meters – Advanced Metering infrastructure (AMI), AMI protocols – Standards and initiatives, Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT-V **10 Hrs**

Elements of communication and networking – Architectures, standards, PLC, Zigbee, GSM, BPL, Local Area network (LAN) – House Area Network (HAN) – Wide Area Network (WAN) – Broadband over Power line (BPL) – IP based Protocols – Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

Unit choice: Unit III and Unit IV

Text books:

1. Stuart Bolas' 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. Ekanayake J., Jenkins N., Liyanage K., Wu, J., Yokoyama A., "Smart Grid: Technology and applications", 1st Edition, 2012, Wiley Publications, ISBN 978-0-470-97409-4
3. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014.

Reference books:

1. Nouredine Hadjsaid and Jean-Claude, "Smart Grids", 1st Edition, 2012, Wiley Publications, ISBN – 978-1-84821-261-9
2. Uma Rao K, Prema V. 'Smart Grid-Fundamentals, Design, Technology, Applications, Communications and Security', published by Wiley India Pvt. Ltd. ISBN: 978-93-5425-321-9
3. Bernd M. Buchholz, "Smart Grids – Fundamentals and Technologies in Electricity Networks", 1st Edition, 2016, Springer Vieweg Publisher, ISBN-13: 978-3662525265

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	21EE8OE3ES	Course Name	Holistic Approach to Electrical Safety(Open Elective)
Credits	03	L – T - P	3 -0- 0

Prerequisites: Basic Electrical Engineering

Course Description:

This Course caters to the Electrical safety Operations and Standards. The course helps students to understand the subjects of safety from fundamentals to the as-on-today status and to select and apply hundreds of remedies with respect to personal or equipment safety. Systematic basic approach leading to the details, step by step, reinforced with the statutory provisions, Standards and regulations and case studies will mould the safety professionals to help the industries to fulfil their legal requirements.

Course outcomes:

At the end of the course, the student will have the ability:

CO 1	Understand the importance of safety in an electrical environment
CO 2	To apply the procedures and guidelines for protection and earthing
CO 3	To apply and practice the Safety norms for personnel safety in electrical installations
CO 4	To comprehend Operations, Maintenance and audit related to safety of Electrical systems.
CO 5	Exposure to Standards and Regulations related to electrical safety

UNIT-I **08 Hrs**

Electrical Safety Aspects: Basic Electrical concepts,- stored energy, electrical shocks, Effects of electrical parameters on human body and its severity, Safety measures-general and main, Safety of the self, Safety of the equipment, Safety of the Public

UNIT-II **08 Hrs**

Protection Procedures: Overload and short circuit protection, Protection against surges and voltage fluctuations, Earth fault protection, No load protection, Protection against lightning

UNIT-III **08 Hrs**

Safety Operations and Earthing: Sign boards, Tagging System -Lock out and Tagout,

PPE, Earthing: Necessity of earthing, Earth insulation and continuity tests, Earthing standards, Bonding, Electrical work in hazardous atmosphere, Static electricity – Operations of machines generating static charge

UNIT-IV **08 Hrs**

Safe Operating Procedures, Maintenance of Equipments: Utility and Manufacturers websites, SOPs, Maintenance and Health monitoring of equipments, Tests and Audits, case Studies

UNIT-V **08 Hrs**

Electricity Standards and Regulations: Indian Standards, IEC, IEEE Standards, National Electric Code (NEC), Indian Electricity rules and Regulations

Unit choice: Unit II and Unit III

Text books:

1. Fundamentals of Industrial Safety and Health,2008 Edition, by Dr K.U.Mistry
2. A Practical Guide Vol 1 to 4,National Safety Council , India
3. IS 5216(Part-I- "Recommendations on safety Procedures and Practices in Electrical Work

Reference books:

1. Indian Electricity Rules: IE Rules 2020
2. IS 8437 (Part 1) : 1993 IEC Pub 479-l (1984) Guide On Effects Of Current Passing Through The Human Body – General Aspects
3. IEEE Standard 902
4. Course material and Related Technical Papers, websites of interest

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)

Course Code	19EE8SRSMR	Course Name	INTERNSHIP SEMINAR-II
Credits	02	L – T - P	0 -0- 2

Course Outcomes:

CO 1	Engage in exposure to industrial practices.
CO 2	Analyze and interpret technical information.
CO 3	Select and apply modern engineering tools
CO 4	Communicate Effectively to an Audience, and design documentation (written graphical and visual forms)
CO 5	Engage in independent learning.

Internship seminar-II is the presentation of work carried out by students along with report of the internship carried out during semester breaks at the industry / institution/ through valued add courses provided by the industry/institution attended for a duration of 4-6 weeks.

BMS COLLEGE OF ENGINEERING, BANGALORE-19
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Course Code	19EE8PWMPW	Course Name	MAJOR PROJECT-II
Credits	09	L – T - P	0 -0- 9

Course outcomes:
At the end of the course, the student will have the ability:

CO 1	Ability to apply the knowledge of mathematics, science and engineering concepts to provide solutions to a societal problem or for development of a new technology to meet global challenges.
CO 2	Identify, formulate, review literature and analyze a problem in the above mentioned areas.
CO 3	Design/Develop system components to solve the identified problem.
CO 4	Conduct experiments to analyze the information for valid conclusions.
CO 5	Apply appropriate tools/techniques to analyze the results obtained.
CO 6	Apply reasoning to justify the impact of the solution with respect to health/safety/legal /technological development for the benefit of society.
CO 7	Demonstrate the knowledge gained for sustainable development.
CO 8	Demonstrate the extent of originality of their work and present information to substantiate the adherence to standards available.
CO 9	Complement their efforts to the success of the team.
CO10	Communicate effectively to a diverse audience and develop technical reports and publications.
CO11	Apply the principles of project management and finance.
CO12	Engage in independent learning.

Student groups may continue the work taken up in Major project-I in any of the domains of either Electrical and Electronics or interdisciplinary where the preliminary work and relevant designs arrived at and implemented through simulations/hardware.