RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2020 – 2021

ELECTRICAL AND ELECTRONICS ENGINEERING

V & VI SEMESTER B.E

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

About the Institute:

Dr. M. S. Ramaiah a philanthropist, founded 'Gokula Education Foundation' in 1962 with an objective of serving the society. M S Ramaiah Institute of Technology (MSRIT) was established under the aegis of this foundation in the same year, creating a landmark in technical education in India. MSRIT offers 13 UG programs and 15 PG programs. All these programs are approved by AICTE. All the UG programs & 09 PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with 'A' grade by NAAC in 2014. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs till the year 2029. The institute is a participant to the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. The institute has 380 competent faculty out of which 60% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility to all faculty members, all research departments active with sponsored funded projects and more than 300 scholars pursuing Ph.D. To promote research culture, the institute has established Centre of Excellence for Imaging Technologies, Centre for Advanced Materials Technology & Schneider Centre of Excellence. **M S Ramaiah Institute of Technology has obtained "Scimago Institutions Rankings" All India Rank 65 & world ranking 578 for the year 2020.**

The Centre for Advanced Training and Continuing Education (CATCE), and Entrepreneurship Development Cell (EDC) have been set up on campus to incubate startups. **M S Ramaiah Institute of Technology secured All India Rank 8th for the year 2020 for Atal Ranking of Institutions on Innovation Achievements (ARIIA), an initiative of Ministry of Human Resource Development (MHRD), Govt. of India.** MSRIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with good collection of book volumes and subscription to International and National Journals. The Digital Library subscribes to online e-journals from Elsevier Science Direct, IEEE, Taylor & Francis, Springer Link, etc. MSRIT is a member of DELNET, CMTI and VTU E-Library Consortium. MSRIT has a modern auditorium and several hi-tech conference halls with video conferencing facilities. It has excellent hostel facilities for boys and girls. MSRIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association.

As per the National Institutional Ranking Framework, MHRD, Government of India, M S Ramaiah Institute of Technology has achieved 59th rank among 1071 top Engineering institutions of India for the year 2020 and 1st rank amongst Engineering colleges (VTU) in Karnataka.

About the Department:

The department was started in the year 1962 along with the establishment of the college. In 2003, the Department was recognized as a Research Centre by Visvesvaraya Technological University, Belagavi and offers Ph.D and MSc.(Engg.) by research programs. The Department also started a PG program in Computer Applications in Industrial Drives, in 2004. Our UG programme is accredited **by NBA for five years with effect from July 2015.**

The department has 17 well-qualified faculty members. The entire faculty holds postgraduate degree in either Power Systems / Power Electronics. Six of the faculty members are doctorates. Dr. Pradipkumar Dixit is specialized in High Voltage Engineering (Ph.D from Visvesvaraya Technological University, Belagavi, 2009), Dr. Chandrashekhar Badachi is specialized in High Voltage Engineering (Ph.D from Jain University, Bengaluru, 2016), Dr. Kodeeswara Kumaran is specialized in Power Electronics for Renewable Energy Applications (Ph.D from NITK, Surathkal, 2018), Dr. Sridhar S holds doctoral degree with specialization in Power Systems(from Visvesvaraya Technological University, Belagavi, 2018), Dr Janamejaya B C holds doctoral degree with specialization in fast charging (from, University of Ontario Institute of Technology (UOIT), Ontario, Canada, 2018), Dr.Chethan Raj D is specialized in Distributed Generation and Microgrid Control (Ph.D from NITK, Surathkal, 2020), Dr.Ratna Rajul Tupakula is specialized in Control Strategies Application to Power Systems and Power Electronics (Ph.D from NIT, Warangal, 2019) and Dr. G. R. Nagabhushana, Formerly Chairman, Department of High Voltage Engineering, Indian Institute of Science, Bangalore is with the department as Professor Emeritus. In addition, Sri. K V Jayaram, Retired JM-DGM, Bokaro Steel Plant / SAIL has joined the department as Co-ordinator for Schneider Electric Centre of Excellence.

VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio economic needs.

MISSION OF THE INSTITUTE

MSRIT shall meet the global socio-economic needs through

1. Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization.
2. Establishing research clusters in emerging areas in collaboration with globally reputed organizations.
3. Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs.

QUALITY POLICY

We at M S Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

VISION OF THE DEPARTMENT

To excel in engineering education and research, inculcating professional ethics in students and emerge as leaders globally in the field of electrical & electronics engineering.

MISSION OF THE DEPARTMENT

The mission of the department is to produce graduates who will

1. Be able to apply their knowledge to identify and solve problems arising in any industry.
2. Be able to contribute to research and developmental activities in frontier areas.
3. Master innovative skills to be entrepreneurs and/or consultants.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: Produce graduates who will have the ability to apply the knowledge of basic Sciences engineering sciences and electrical engineering to excel in professional career.

PEO 2: Produce graduates who will continue to enhance their knowledge.

PEO 3: Produce graduates who are confident to take up diverse career paths.

PEO 4: Produce graduates who will provide leadership and demonstrate the importance of professional integrity.

PROGRAM OUTCOMES (POs):

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: 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.

PO4: 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 conclusions.

PO5: 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.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: 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.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: 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 leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1: Identify, formulate, analyze, design and implement—electrical and electronics circuits, control systems, drives, power systems and power electronic systems.

PSO2: Use modern tools to solve problems in diverse and multidisciplinary environment.

PSO3: Understand the impact of engineering solutions in societal and environmental context, commit to professional ethics, lifelong learning and communicate effectively.

PSO4: Apply project management techniques to electrical/electronic(s) systems, exhibiting team work.

Semester wise Credit Breakdown for B.E Degree Curriculum

Batch 2018-22

Semester / Course Category	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Total Credits
Basic Sciences (BSC)	9	8	4	4					**25**
Engineering Sciences (ESC)	11	10							**21**
Humanities, Social Sciences and Management (HSMC)		2			3		3		**8**
Professional Courses – Core (PCC)			21	21	15	11	10		**78**
Professional Courses– Elective (PEC)					3	6	6	3	**18**
Other Open Elective Courses (OEC)					3	3			**6**
Project Work (PROJ), Internship (IN)						4	1	14	**19**
Total Credits	**20**	**20**	**25**	**25**	**24**	**24**	**20**	**17**	**175**

SCHEME OF TEACHING V SEMESTER

Sl. No.	Course Code	Course Name	Category	Credits				Contact Hours
				L	T	P	Total	
1	EE51	Signals and Systems	PCC	3	1	0	4	5
2	EE52	Control Systems	PCC	3	1	0	4	5
3	EE53	Power System Engineering- I	PCC	4	0	0	4	4
4	EE54	Intellectual Property Rights	HSMC	3	0	0	3	3
5	EEExxx	Department Elective – 1	PEC	3	0	0	3	3
6	xxOExx	Open Elective-1	OEC	3	0	0	3	3
7	EEL56	Electrical Machines – II Lab	Lab	0	0	1	1	2
8	EEL57	Power Electronics Lab	Lab	0	0	1	1	2
9	EEL58	Electronic Devices & Circuits Lab	Lab	0	0	1	1	2
			Total	**19**	**2**	**3**	**24**	

Elective Code	Department Elective-1
EEE551	Introduction to Deep Learning
EEE552	Solar and Wind Energy Systems
EEE553	Advanced Industrial Automation

SCHEME OF TEACHING VI SEMESTER

Sl. No.	Course Code	Course Name	Category	Credits				Contact Hours
				L	T	P	Total	
1	EE61	Digital Signal Processing	PCC	3	1	0	4	5
2	EE62	Power System Engineering- II	PCC	3	1	0	4	5
3	EEExxx	Department Elective – 2	PEC	3	0	0	3	3
4	EEExxx	Department Elective – 3	PEC	3	0	0	3	3
5	xxOExx	Open Elective-2	OEC	3	0	0	3	3
6	EE65	Mini project	Lab	0	0	4	4	4
7	EEL66	Digital Signal Processing Lab	Lab	0	0	1	1	2
8	EEL67	Building Automation Lab	Lab	0	0	1	1	2
9	EEL68	Control Systems Lab	Lab	0	0	1	1	2
			Total	**15**	**2**	**7**	**24**	

Elective Code	Elective Title	Elective Code	Elective Title
EEE631	Modern Control Theory	EEE641	Nanofabrication and Characteristics
EEE632	Energy Audit	EEE642	Machine Learning
EEE633	Electric Vehicle Technology	EEE643	Virtual Instrumentation

V SEMESTER

SIGNALS AND SYSTEMS

Subject code: **EE51** **Credits: 3:1:0**
Prerequisites: Nil **Contact Hours: 70**
Course Coordinator/s: Sri. Victor George

Course content:

Unit I

Introduction: Definitions of signals and a system, Classification of signals, Basic operations on signals, Elementary signals viewed as interconnections of operations. Relation between the elementary signals, specific systems, Properties of systems

Unit II

Time – domain representations for LTI systems: Convolution Integral and Convolution sum, Impulse response representation, Properties of impulse response representation, step response.

Unit III

Block diagram representation, direct form I and direct form II. Differential and difference equation representation, Solution of differential and difference equation. Sampling theorem, quantization.

Unit IV

Concept of Fourier Series and Fourier transform. Fourier representation of discrete-time periodic signals, Properties of discrete time Fourier series (DTFS)
The Discrete-Time Fourier Transform: Representations of non-periodic signals: The discrete-time Fourier transform (DTFT), Properties of DTFT.

Unit V

Z- Transforms: Introduction, Z-transform, Properties of ROC, Properties of Z transforms, inversion of Z-transforms, Transforms analysis of LTI systems, Transfer function, Stability and causality, Unilateral Z-transform and its application to solve difference equations.

Text Books

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

Reference Books

1. Michel J Roberts, *Signals and Systems Analysis of signals through linear systems,* Tata McGraw Hill, 2003.

Course Outcomes (COs)

At the end of the course the student will be able to

1. Perform various operations on elementary signals used in systems and identify its properties. (PO-1) (PSO-1)
2. Represent Linear Time Invariant (LTI) system through different techniques. (PO-1) (PSO-1)
3. Analyze the relation between the input and output of an LTI system through its impulse response. (PO-1) (PSO-1)
4. Determine the various responses of an LTI system using different techniques. (PO-1) (PSO-1)
5. Apply various properties of transform techniques in the analysis of signals and systems. (PO-1) (PSO-1)

CONTROL SYSTEMS

Subject code: **EE52** **Credits: 3:1:0**
Prerequisites: Nil **Contact Hours: 70**
Course Coordinator/s: Sri. Gurunayk Nayak

Course content:

UNIT -I

Modelling of Systems: The control system, mathematical models of physical systems-introduction, differential equations of physical systems, Mechanical systems, Friction, Translational systems, Rotational systems, Electrical systems, Analogous systems.
(Numerical only on finding transfer function, No numerical on analogous systems)
Block diagram and signal flow graph: To find overall transfer function. **(No numerical)**

UNIT -II

Time response analysis: Standard test signal, unit step response of first and second order system, time response specifications, time response specifications of second order systems, steady state errors and error constants.
Stability Analysis: Concepts of stability, necessary conditions for stability, Routh-Hurwitz criterion, relative stability. **(Numerical only with max. 2-Poles, 2-Zeros)**

UNIT -III

Root Locus Technique: Introduction, Root locus concepts, construction of root loci. (Numerical only with max. 2-Poles, 2-Zeros)
Frequency Domain Analysis: Frequency Domain Specifications, Correlation between time and frequency responses, Polar plot.

UNIT -IV

Stability in Frequency Domain: Nyquist stability criterion. (Numerical only with max. 2-Poles, 2-Zeros), Bode plot (Numerical only with max. 2-Poles, 2-Zeros), Determination of transfer function from Bode plot, Compensators- RC lag, RC lead, RC lag-lead networks.

UNIT -V

Controllers: Introduction to Controllers**,** Necessity of Controllers, Block diagram representation of of feedforward and feedback controller, Effects of Addition of Poles

and zeros in plant transfer function (With respect to stability), Introduction to PID Control: Effect of Proportional, Integral, and Differential controller on time domain behavior of the system, Introduction to Zeigler-Nichols Method for designing PID controller (No Numerical).

Text Books

1. J. Nagrath and M. Gopal, '*Control Systems Engineering*', New Age International (P) Ltd, 4th Edition.

Reference Books

1. K. Ogata, '*Modern Control Engineering*', Pearson Education Asia / PHI, 4th Edition.
2. Benjamin Kuo, '*Automatic Control Systems*', PHI, 7th Edition.
3. MATLAB Documentation on SIMIAM Package.

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Derive the transfer function and mathematical model of variety of mechanical, electromechanical systems. (PO- 1, 2) (PSO-1)
2. Find the time domain specifications and time response of the system for various inputs. (PO-1, 2) (PSO-1, 2)
3. Analyze the stability of the system using graphical and algebraic techniques. (PO-1, 2) (PSO-1)
4. Find the frequency domain specifications and identify the need of compensation. (PO-1, 2) (PSO-1)
5. Understand the need of PID control in mobile robotics. (PO-1, 4) (PSO-1, 2)

POWER SYSTEM ENGINEERING - I

Subject Code: EE53 **Credits: 4:0:0**
Prerequisites: Nil **Contact Hours: 56**
Course Coordinator/s: Sri. Ramakrishna Murthy K / Sri. Victor George

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Course content:

Unit I

Introduction to Electrical Power Transmission and Distribution: Standard Voltages for transmission, a typical transmission and distribution system, feeders, distributors, and service mains, classification of power transmission systems, advantages of high voltages for transmission, classification of distribution systems, connection schemes - radial, ring main, requirements and design considerations for distribution system.

AC Distribution: AC distribution calculations -concentrated loads with power factor referred to receiving end voltage and power factor referred to respective load voltages, numerical problems.

Sag Calculations: Main components of overhead lines, Sag and tension for overhead lines with equal and unequal supports, **(no derivations, only concepts and problems).**

Unit-II

Transmission Line Parameters: Transmission line constants, resistance of transmission line and skin effect. Inductance of transmission line, magnetic field intensity inside and outside the conductor, inductance of single phase two wire line, inductance of three phase lines with equilateral and unsymmetrical spacing and transposition, Capacitance of transmission lines, electric field of a long straight conductor, capacitance of single phase system, capacitance of three phase symmetrically spaced and un-symmetrically spaced conductors, effect of earth on the capacitance of transmission lines. (**No derivation, concepts and problems only**)

Insulators: Properties of materials used for insulators, types of insulators, voltage distribution over a string of insulators, calculation of string efficiency, methods of improving string efficiency - expression for line to pin capacitor with static shielding, numerical problems. Introduction to composite insulators.

Unit III

Performance of power transmission lines: Classification of Transmission Lines, ABCD constants for short, medium and long transmission lines, Ferranti effect.

Underground cables: Advantages of underground cables over overhead lines, cable construction, Insulation resistance of single core sheathed cable, capacitance of single core cable, dielectric stress in single core cable, most economical size of a cable, grading of cables - capacitance grading and inter sheath grading, capacitance of 3 core cable, numerical problems **(only concepts and problems, no derivation).**

Representation of Power System Components: Introduction, circuit models of power system components, one - line diagram, Impedance and reactance diagrams, per-unit system, change in base quantities, per-unit impedance and reactance diagrams.

Unit IV

Symmetrical Components: Resolution of unbalanced phasors, the 'a' operator, expression for phase voltage in terms of symmetrical components, expression for symmetrical components in terms of phase voltages relation between sequence components of phase and line voltages in star of equivalent star connected systems, relation between sequence components of phase and line currents in delta connected systems, symmetrical components in star-delta, transformer banks.

Sequence Impedances and Sequence Networks: Introduction, sequence impedances of a symmetrical circuit, sequence networks of power systems elements, sequences impedances and network of three-phase transformers, sequence impedance and networks of transmission lines, construction of sequence networks of a power system.

Unit V

Symmetrical and Unsymmetrical Faults: Introduction, analysis of three -phase symmetrical faults, fault calculations of a synchronous generator, single line-to-ground fault on an unloaded generator, line-to-line fault on an unloaded generator, double line-to-ground fault on an unloaded generator. Unsymmetrical Faults on Power System, single line-to-ground fault, line-to line fault, double line-to-ground fault, single line-to-ground fault on an unloaded generator through a fault impedance, series types of faults

Text Books

1. J.B Gupta, '*Transmission and Distribution of Electrical Power*', Katson Books, 10th Edition.
2. W.D.Stevenson Jr., '*Elements of Power System Analysis*', McGraw Hill, 4th Edition.
3. C.L.Wadhwa, '*Electrical Power Systems*', Wiley Eastern Ltd., 3rd Edition.

Reference Books

1. Soni, Gupta & Bhatnagar, '*A course in Electrical Power*', Dhanapat and Sons, 2001.
2. S.M.Singh, '*Electric Power Generation, Transmission and Distribution*', Prentice Hall of India Private Ltd., 2003.

Course Outcomes (COs):

At the end of the course, the student will be able to:

1. Identify different components of transmission and distribution systems and calculate sag in over-head transmission lines. (PO-1) (PSO-1)
2. Compute the parameters of the transmission line and evaluate performance of the line. (PO-1) (PSO-1)
3. Determine voltage drop in AC distributors. (PO-1) (PSO-1)
4. Select the configurations of line insulators / underground cables and evaluate their performance. (PO-1) (PSO-1)
5. Analyze symmetrical faults by representing components of power system on per unit basis. (PO-1) (PSO-1)
6. Construct sequence networks to determine short-circuit currents and phase voltages for unbalanced faults. (PO-1) (PSO-1)

INTELLECTUAL PROPERTY RIGHTS

Subject Code: EE54 **Credits: 3:0:0**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator/s: Sri. Vinayak V Rao

Course content:

Unit-I

Basic concepts of Intellectual property [IP] law, Introduction, concept of property, need for a holistic approach, constitutional aspects of IP, evolution of the patent system in UK, US and India, basis for protection, invention, criteria for patentability, Nature of IP, Commercial exploitation of IP, Enforcement of rights and remedies against infringement, Intellectual property and economic development, International character of IP, New acts affecting IP, Importance and need of world intellectual property organizations [WIPO], Trade related intellectual property rights [TRIPS].

Unit-II

Patent: Principles underlaying patent law in India, object of patent law, value of patent system, advantages of patent to inventor, Patentable inventions, non-patentable inventions.

Procedure for obtaining the patent, Specification, Provisional and complete specification, construction and amendment of specification, Opposition proceedings to grant patents, register of patents and patent office.

Rights and obligations of a patentee, transfer of patent rights, government use of inventions, revocation and surrender of patents, infringements of patents, action for infringement, drafting of patent, Case studies.

Trade secrets: Introduction, Factors, Trade secrets v/s Patents

Unit-III

Copyrights: Nature, characteristics, subject matter of copyright, term, author, ownership, rights conferred by copyright, registration, regulatory authorities, assignment/licensees, infringement, remedies, International copyright, Case studies.

Unit-IV

Trademarks: Meaning, function, essentials of trademarks, Principles of registration, rights conferred by registration, Infringement and action against infringement, Case studies.

Industrial design: registration, procedure, piracy and remedies of industrial designs, Case studies.
Geographical indicators: Meaning, registration, rights, infringements, remedies, Case studies. Discussion on defence and obscure publication about IPR.

Unit-V

Cyber Law: Need and role of law in the cyber world, concept of property in cyberspace, protection, infringement and remedies for the copyrights in cyberspace, Implications on intellectual property rights, relevance of domain names in intellectual property rights, software copyrights, Information technology act 2000-siginificance, objectives and offenses, case studies

Text Books

1. P.Narayanan, "*Intellectual Property Law*", Eastern Law house, 3rd edition, 2018**.**
2. Dr.B.L.Wadehra, "*Intellectual Property Law Handbook*", Universal Law Publishing Co. Ltd., 5th edition , 2012.
3. Pawan Duggal "Textbook on Cyber Law", Universal law publishing house, 2nd edition.
4. Harish Chander, "Cyber Laws and IT Protection", PHI publication, 4th edition, 2012.

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.
4. "*The Patents Act, 1970 (Bare Act with short comments), as amended by Patents (Amendment) Rules 2006 w.e.f. 5-5-2006*". Commercial law publishers (India) Pvt. Ltd., 2006.
5. Thomas T Gordon and Arthur S Cookfair, "*Patent Fundamentals for Scientist and Engineers*", CRC Press 1995.
6. Prabuddha Ganguli, "*Intellectual Property Rights*", TMH Publishing Co. Ltd, 2001

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Access the need, criteria and legal aspects of IPR. (PO-1, 6, 8) (PSO-3)
2. Understand registration, opposition and amendments procedures in the IPR domain. (PO-1, 6, 8) (PSO-3)
3. Apply the drafting concepts for any product of electrical domain. (PO-1, 6, 8) (PSO-3)
4. Gain awareness on different infringements scenarios, remedial action and latest case studies in the IPR domain. (PO-1, 6, 8, 10) (PSO-3)
5. Familiarize with cyber law in IPR domain (PO-1, 6, 8) (PSO-3)

ELECTRICAL MACHINES – II LAB

Subject Code: EEL56 **Credit: 0: 0: 1**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Dr. Chandrashekhar Badachi/ Smt. Mamatha G M

List of Experiments:

1. Open circuit and short circuit tests on a single phase transformer.
2. Load test on single phase transformer direct loading
3. Scott connection of two single phase transformers.
4. Load characteristics of a single phase induction motor.
5. Sumpner's test or back to back test on a pair of single phase transformers.
6. Equivalent circuit & Circle diagram of three phase induction motor.
7. Parallel operation and load sharing of single phase transformers.
8. Load test on three phase induction motor.
9. Separation of iron losses of 1 phase transformer
10. Speed control of induction motor
11. Experiment on induction generator.
12. Three phase transformer connections

Text Books

1. A Langsdorf, '*Theory of alternating current machines'*, TMH, 2nd Edition.
2. M. G. Say, '*performance and design of AC machines'*, CBS Publications, 2005.

Reference Books

1. J. Nagarath and Kothari, '*Electrical Machines'*, TMH, 2nd Edition.
2. Ashafaq Hussaim, '*Electric Machines'*, Dhanpat Rai & Co., 1999.

Course Outcomes (COs)

At the end of the course the students will be able to:

1. Predetermine the % efficiency, regulation of single phase transformer. (PO-1, 4) (PSO-1)
2. Determine the performance of single phase and three phase induction motor. (PO-1,4) (PSO-1)
3. Determine the performance of three phase induction machine (PO-1,4) (PSO-1)

POWER ELECTRONICS LAB

Subject code: **EEL57** **Credits: 0:0:1**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Sri. Omsekhar Indela

List of experiments:

1. Static characteristics of Power MOSFET
2. Static characteristics of IGBT
3. Static characteristics of SCR
4. Static characteristics of TRIAC
5. RC half-wave and full-wave triggering circuit for a thyristor
6. Single phase fully controlled rectifier (R, RL Load, RL Load with FWD)
7. AC voltage controller using Triac-Diac combination
8. SCR firing circuit using synchronized UJT relaxation circuit
9. Commutation circuits for thyristor-LC circuit and Impulse commutation circuit
10. Digital firing circuit for thyristor, TRIAC
11. Voltage impulse commutated chopper
12. Study of the working of series inverter

Text Books

1. M. H. Rashid, "*Power Electronics: Circuits, Devices and Applications*", Third Edition, PHI, 2005.
2. Vedam Subrahmanyam, "*Power Electronics*", Revised Second Edition, New Age International Publishers, 2006.

Reference Books

1. G. K. Dubey, S. R. Doradla, A. Joshi and R. M. K. Sinha, "*Thyristorised Power Controller*", New Age International Publishers.
2. M. D. Singh and Khanchandhani K.B, "*Power Electronics"*, TMH, 2001.

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Gain knowledge about the working of power electronic switches like MOSFET, IGBT, SCR and Triac. (PO-4, 5) (PSO-1, 2)
2. Design, build and test firing circuits for thyristors. (PO-3, 4) (PSO-1, 2)
3. Design, build and test commutation circuits for thyristors. (PO-3, 4) (PSO-1, 2)
4. Design, build and test power electronic circuits. (PO-4, 5) (PSO-1, 2)

ELECTRONIC DEVICES AND CIRCUITS LAB

Subject Code: EEL58 **Credits: 0:0:1**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Sri. Ramakrishna Murthy K / Sri. Victor George

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List of Experiments:

Sl. No.	Laboratory Experiments
1.	Design and implementation of Clippers and clampers using i) Diodes ii) Op-Amp
2.	Design and implementation of full wave rectifier using i) Diodes ii) Op-Amp and also to demonstrate the concept of regulated output using voltage regulator
3.	Design and implementation of RC phase shift oscillator using i) FET/BJT ii) Op-amp
4.	Design of BJT emitter follower, Darlington emitter follower (with & without bootstrap) and determination of the gain, input & output impedance. Implementation of Voltage follower and its comparison with emitter follower
5.	Design, build and test RC coupled single stage FET/BJT amplifier and determination of the frequency response, input & output impedances
6.	Design and implementation of inverting amplifier, non - inverting amplifier and inverting summing amplifier using Op-amp
7.	Design and implementation of the following Active filters i. First order low pass filter ii. Second order low pass filter
8.	Design and implementation of the following Active filters i. First order high pass filter ii. Second order high pass filter
9.	Design and implementation of zero crossing detector, inverting and non-inverting voltage level detector using Op-Amp
10.	Design and implementation of i. Differentiator and Integrator using op-Amp ii. Monostable and Astable Multivibrator using 555 timer
11.	Design and simulation of Amplifier circuits and clippers.
12.	Design and simulation of clampers and oscillators

Text Books

1. Robert L Boylestad & Louis Nashelsky, *"Electronic Devices & Circuit Theory"*, 6th Edition, PHI, 2002.
2. David A Bell, "*Operational amplifiers and Linear IC's*", Prentice Hall, 2nd Edition.
3. Ramakant A Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Prentice Hall, 4th Edition.
4. Robert F Couglin, Frederick F Driscoll, "*Operational Amplifiers and Linear Integrated Circuits*", Prentice Hall, 6th Edition.

Reference Books

1. Jacob Millman & Christos C Halkias, "*Integrated Electronics*", Tata McGraw-Hill, 1991.
2. Albert Malvino & David J Bates, *"Electronic Principles"*, 7th Edition, TMH, 2007.
3. Sergio Franco, "*Design with Operational Amplifiers and Analog Integrated Circuits*", TMC, 2008.
4. Roy Choudhary, "*Linear Integrated Circuits*", New Age International, 2003.
5. J. Nagarath, "*Electronic Devices & Circuits*", PHI, 2007.
6. Sudhaker Samuel, "*Electronic Circuits*", 2nd Edition, Tata McGraw Hill, 2010.

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Design the biasing circuits for establishing the Q point of a transistor amplifier. (PO-1, 4) (PSO-1)
2. Design, Simulate (using PSpice), build and test clipper, clamper, rectifiers, voltage regulator, oscillators and RC coupled amplifier. (PO-1, 4) (PSO-1)
3. Design and analyze the performance of various linear circuits and non-linear circuits using Op-Amp. (PO-1, 4) (PSO-1)
4. Evaluate the performance of different active filters using Op-Amps. (PO-1, 4) (PSO-1)
5. Design and analyze the performance different multivibrators using 555 timer. (PO-1, 4) (PSO-1)

DIGITAL SIGNAL PROCESSING

Subject code: **EE61** **Credits: 3:1:0**
Prerequisites: Nil **Contact Hours: 70**
Course Coordinator/s: Sri. Victor George

Course content:

Unit I

Basic elements of digital signal processing, Advantages of digital signal processing over analog signal processing.

Discrete Fourier Transform: Frequency domain sampling, DFT as a linear transformation, circular convolution, Use of DFT in linear filtering.

Unit II

Filtering of Long Data Sequence: Overlap-save method, Overlap-add method.

Fast Fourier Transform Algorithms: Radix-2 FFT Algorithm, Decimation in time, Decimation in frequency algorithms.

Unit III

Structure for FIR systems: Direct form, Linear phase and cascade form structure.

Structure of IIR systems: Direct form I, Direct form II, Cascade and parallel structure.

Unit IV

Design of FIR Filters: Introduction to filters**,** Design of linear phase FIR Filters using rectangular, hamming and hanning windows, FIR filter design by frequency sampling method.

Unit V

Design of IIR Filters from Analog Filters: IIR Filter design by impulse invariance, Bilinear transformation. Characteristics of analog filters -Butterworth and Chebyshev, frequency transformation in analog domain. Introduction to the TMS320LF2407 digital signal controller, C2xx DSP CPU architecture (block diagram level explanation).

Text Books

1. John G Prokis & Dimitris G Manolakis, '*Digital Signal Processing*', PHI, 3rd Ed,.
2. Hamid Toliyat and Steven Campbell, '*DSP- Based Electro Mechanical Motion Control'*, CRC Press, 2011.

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Identify different engineering problems where digital signal processing is involved (PO-1) (PSO-1)
2. Analyze the various techniques to obtain the transformation of discrete signals (PO-1) (PSO-1)
3. Apply various transform techniques in linear filtering (PO-1) (PSO-1)
4. Apply fundamental principles, methodologies and techniques of the digital signal processing to design various filter circuits (PO-1) (PSO-1)
5. Understand the basic functional blocks available in a digital signal processor (PO-1) (PSO-1)

POWER SYSTEM ENGINEERING- II

Subject code: **EE62** **Credits: 3:1:0**
Prerequisites: Nil **Contact Hours: 70**
Course Coordinator/s: Dr. Sridhar. S

Course content:

UNIT -I

Modeling of transmission lines, off nominal transformer, loads and generator. Formation of Y_{BUS} by method of inspection. Basic definitions of Elementary graph theory. Formation of Incidence Matrices. Primitive network- Impedance form and admittance form. Formation of Y_{BUS} by method of singular transformation. Z_{BUS} formation by inverting Y_{BUS} and Z_{BUS} building Algorithm (Without mutual coupling). Computation of 3phase fault current using Z_{BUS} (derivation excluded).

UNIT -II

Load Flow Studies: Introduction, review of numerical solutions of algebraic equations by iterative methods, power flow equations, and classification of buses, operating constraints and data for load flow study. Load flow solution using Gauss–Seidal method, (numerical problem for not more than 2 iteration), acceleration of convergence. Load flow solution using Newton–Raphson method in polar co-ordinates (numerical problem for 1 iteration only). Fast Decoupled load flow method.

UNIT -III

Economic Operation of Power System: Introduction, economic generation scheduling neglecting losses and, iterative techniques. Derivation of transmission loss formula. Economic dispatch including transmission losses. Approximate penalty factor. Iterative technique for solution of economic dispatch with losses. Introduction to unit commitment (problem formulation).

UNIT -IV

Stability Studies: Introduction, steady state stability, power angle equation of synchronous machines, methods of improving SSSL, dynamics of a synchronous machine, Swing equations, Swing curve, Equal Area Criterion (EAC), applications of Equal Area Criterion, critical clearing angle. Transient stability, Numerical solution of swing equation by Point-by-Point method and Runge–Kutta method.

UNIT -V

Load Frequency Control: Schematic diagram of automatic load frequency control and automatic voltage control. Generator model, turbine model and governor model. Block diagram representation of single area ALFC.

Compensation in Power Systems: Introduction, load compensation, line compensation, series compensation and shunt compensators. Principle and operation of converters. Introduction to FACTS Controllers.

Power System Security: Introduction, Factors affecting power system security, Contingency Analysis, Contingency Selection and Ranking.

Text books

1. Nagrath, I. J., and Kothari, D. P., '*Modern Power System Analysis*', TMH, 2003.
2. K.Uma Rao, '*Computer Techniques and Models in Power Systems*', I.K. International, 2007.

Reference books

1. Allen J Wood et al, '*Power Generation, Operation and Control*', Wiley, 2003.
2. Stag G. W., and El Abiad, A. H. '*Computer Methods in Power System Analysis*', McGraw Hill International Student Edition, 1968.
3. Pai, M.A, '*Computer Techniques in Power System Analysis*', TMH, 2nd Edition.
4. John Grainger, Jr. William Stevenson, '*Power System Analysis*', McGraw Hill, 1994.
5. Singh L. P., '*Advanced Power System Analysis and Dynamics*', New Age International (P) Ltd, New Delhi, 2001.
6. Haadi Sadat, '*Power System Analysis*', TMH, 2nd Edition, 12th Reprint.

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Formulate the Y_{BUS} and Z_{Bus}. (PO-1) (PSO-1)
2. Obtain load flow solution by Gauss Siedel method, Newton Raphson Method and FDLF Method. (PO-1) (PSO-1)
3. Obtain economic load dispatch of a thermal power plant. (PO-1) (PSO-1)
4. Analyze the stability aspects of power system. (PO-1) (PSO-1)
5. Develop the block diagram of ALFC, evaluate load sharing. (PO-1) (PSO-1)

MINI PROJECT

Subject Code: EE65 **Credits: 0:0:4**
Prerequisites: Nil **Contact Hours: 84**
Course Coordinator/s: Sri. Gurunayk Nayak

Course content:

This course will provide an introduction to mini-project. Students will work in a group of 3/4 to solve a problem of current concern requiring an engineering solution. They are required to follow a systematic approach towards developing the solution by considering technical and non-technical factors. The working model of the solution along with the design documentation will be considered for final evaluation.

Course Outcomes (COs):

At the end of the course Students will be able to:

1. Perform sufficient literature survey on existing methods in the area of selected topic. (POs – 1, 2, 3, 4, PSO– 1)
2. Describe the proposed design method in terms of technical block diagram or flowchart. (POs – 2, 3, 10, PSO– 2, 3)
3. Implement the proposed design method using appropriate software or/and hardware tools (POs – 2, 3, 4, 5, PSO– 2, 3).
4. Analyze the complexity at various stages of building project involving multiple hardware or/and software technologies. (POs – 2, 3, 4, 5, PSO– 2, 3)
5. Present and prepare technical details of the project at regular intervals using oral, written and visual aids for effective communication. (POs – 9, 10, PSO– 2, 3)

DIGITAL SIGNAL PROCESSING LAB

Subject Code: EEL66 **Credit: 0: 0: 1**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Sri. Victor George

LIST OF EXPERIMENTS

1. Verification of sampling theorem.
2. Frequency domain analysis using FFT.
3. Convolution of given sequence.
4. Analysis of an audio file.
5. Pulse Width Modulation.
6. Noise reduction of signals.
7. DTMF generation and filtering.
8. Design of LP & HP FIR filter to meet given specifications.
9. Design of BP & BS FIR filter to meet given specifications.
10. Hardware implementation of FIR filter to meet given specifications.
11. Design of IIR filter to meet given specifications.
12. Hardware implementation of IIR filter to meet given specifications.

Text Books

1. J. G. Proakis, Ingle, "*Digital Signal Processing using MATLAB*", MGH, 2000.
2. B. Venkataramani and Bhaskar, "*Digital Signal Processors*", TMH, 2002.

Reference Books

1. Sanjit K Mitra, "*Digital Signal Processing using MATLAB*", TMH, 2001.

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand the basic operations in digital signal processing. (PO-1, 2, 6) (PSO-1, 2)
2. Understand the use of the FFT algorithm in signal analysis. (PO-2, 6) (PSO-1, 2)
3. Design FIR/IIR filters for practical applications. (PO-2, 3, 4, 6) (PSO-1, 2)
4. Understand the handling of digital signals using a simulation package. (PO-1, 2, 6) (PSO-1, 2)
5. Understand the handling of digital signals using hardware circuits. (PO-2, 6) (PSO-1, 2)

BUILDING AUTOMATION LAB

Subject code: **EEL67** **Credits: 0:0:1**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Sri. Narasimpur Tushar Suresh

List of experiments:

1. Installing and Testing KNX Bus Line, Create a project and add devices to the project.
2. Develop an application to program a switch and a switch actuator.
3. Develop an application to program a switch, a dimming control and a blind actuator.
4. Develop an application to configure touch Pro to control blind actuator, switch actuator, and dimming
5. Develop an application for Lighting control using the occupancy sensor Using 4 gang, create the following
    a. Rocker – 1: operate dimming at 0% - 50% - 100%
    b. Rocker – 2 : operate "All On" and "All Off"
6. Develop a mobile wiser application to control the given installation.
7. To operate and control HVAC using PID controller and BMS controller
8. To configure the field instruments in the BMS-"Ecostuxure Building Expert"
9. Configuration of DI and DO modules
    a. Switching on Heating, when humidity is high
    b. Open Damper when CO2 level is high
1. Switch off AHU, when fire is activated
10. Configuration of AI and AO modules
    a. Configure a pressure sensor & pressure transmitter
    b. Configure a temperature sensor & temperature transmitter
11. Creating Graphics of the given HVAC system and Binding of variables to Graphical representation
12. Create logic for the AHU operation
    a. Using Humidity inputs
    b. Using CO_2 level
    c. Input from Fire alarm System
    d. Using flow switch

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Develop a program to control loads of a smart home. (PO-1,3)(PSO-2,3)
2. Develop a program to control HVAC system. (PO-1,3)(PSO-2,3)

CONTROL SYSTEMS LAB

Subject Code: EEL68 **Credits: 0:0:1**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Sri. Gurunayak Nayak

List of Experiment

1. Obtain Time response of second order system (RLC circuit) and find time domain specifications of the same. And simulate the same using MATLAB.
2. Obtain frequency response of second order system (RLC circuit) and find time domain specifications of the same. And simulate the same using MATLAB.
3. Design and implementation of RC lead compensator. And verify the results using MATLAB.
4. Design and implementation of RC lag compensator. And verify the results using MATLAB.
5. Implementation of RC Lag-Lead compensator.
6. Experiment to draw speed torque characteristics of a AC servo motor.
7. Experiment to draw speed torque characteristics of a DC servo motor.
8. Simulate DC position control System for PI, PD and PID Controller.
9. To draw root loci for different transfer functions using MATLAB and verification by theoretical method, Obtain phase margin, gain margin for different transfer function by drawing Bode plot using MATLAB and verification by theoretical method
10. Introduction to SISO toolbox and analyzing of step, frequency responses for different pole, zero locations.
11. Introduction to SIMIAM package for Mobile robotics.
    i) Implementation of PID Control for GoToGoal application.
    ii) Implementation of PID Control for obstacle avoidance application.

Text Books

1. J. Nagrath and M. Gopal,' Control Systems Engineering', 4th edition

Reference Books

1. K. Ogata,' Modern Control engineering ', 4th edition.
2. Benjamin Kuo, 'Automatic Control Systems', PHI, 7th Edition.

Course Outcomes (COs):

At the end of the course Students are able to:

1. Analyze time domain response for different damping ratio. (PO-1,2,5) (PSO-1,2,4)
2. Analyze the stability of the system by various methods. (PO-1,2,5) (PSO-1,2,4)
3. Analyze the behavior of mobile robots for different PID co-efficients. (PO-1,2,5) (PSO-1,2,4)
4. Distinguish the performance of Servo motors. (PO-1,2) (PSO-1)
5. Design the appropriate compensator. (PO-1,3,5) (PSO-1,2,4)

Department Elective- 1

Introduction to Deep Learning

Subject Code: EEE551 **Credits: 2:1:0**
Prerequisites: Nil **Contact Hours: 56**
Course Coordinator/s: Smt. Kusumika Krori Dutta

Course content:

Unit I

Introduction: Human brain, neuron models, neural nets as directed graphs, feedback, neural architectures, knowledge representation, connection to artificial intelligence.

Unit II

Learning Process: Error-correction learning, memory based learning, Hebbian learning, competitive learning, Boltzmann learning, credit assignment, learning with and without a teacher, learning tasks, memory, statistical learning theory.

Unit III

Modern practical deep neural networks: Deep feed forward networks, regularization for deep learning, optimization for training deep models, convolutional Networks.

Unit IV

Sequence Modelling: Recurrent and recursive nets, practical Methodology, applications.

Unit V

Deep Learning Research: Linear factor models, auto encoders, variation auto encoders, restricted Boltzmann machine, generative adversarial networks.

Text Books

1. Simon Haykin, '*Neural networks: A comprehensive foundation'*, Second Edition, Prentice Hall, New Delhi, 1999, ISBN-81-203-2373-4.
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, '*Deep Learning*', MIT Press, 2016.

Course Outcomes (COs):

At the end of the course, the student will be able to:

1. Understand the concepts of neural networks and deep learning. (PO-1,2) (PSO-1)
2. Analyze various types of learning and their usage. (PO-1,2) (PSO-1)
3. Apply deep feedforward networks and convolutional to solve practical problems. (PO-2,5) (PSO-2)
4. Demonstrate recurrent and recursive nets function and implementation in practical problems solving. (PO-2,5) (PSO-2)
5. Design end-to-end deep learning architectures for practical applications. (PO-2,3,5) (PSO-1, 2)

SOLAR AND WIND ENERGY SYSTEMS

Subject code: **EEE552** **Credits: 3:0:0**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator: Dr. Sridhar. S

Course content:

Unit- I

Fundamentals of Energy Science and Technology: Introduction, Energy, Economy and Social Development, Classification of Energy Sources, Importance of Non - conventional Energy Sources, Salient features of Non-conventional Energy Sources, World Energy Status, Energy Status in India.

Energy Conservation and Efficiency: Introduction, Important Terms and Definitions, Important Aspects of Energy Conservation, Global Efforts, Achievements and Future Planning, Energy Conservation/Efficiency Scenario in India, Energy Audit, Energy Conservation Opportunities.

Energy Storage: Introduction, Necessity of Energy Storage, Specifications of Energy Storage Devices.

Solar Energy-Basic Concepts: Introduction, The Sun as Source of Energy, The Earth, Sun, Earth Radiation Spectrum, Extraterrestrial and Terrestrial Radiations, Spectral Power Distribution of Solar Radiation, Depletion of Solar Radiation.

Unit- II

Solar Energy-Basic Concepts (continued): Measurement of Solar Radiation, Solar Radiation Data, Solar Time, Solar Radiation Geometry, Solar Day Length, Extraterrestrial Radiation on Horizontal Surface, Empirical Equations for Estimating Terrestrial Solar Radiation on Horizontal Surface, Solar Radiation on Inclined Plane Surface.

Solar Thermal Systems: Introduction, Solar Collectors, Solar Water Heater, Solar Passive Space Heating and Cooling Systems, Solar Industrial Heating Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers

Unit- III

Solar Photovoltaic Systems: Introduction, Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell Technologies, Solar Cell, Module, and Array Construction, Maximizing the Solar PV Output and Load Matching. Maximum Power Point Tracker. Balance of System Components, Solar PV Systems, Solar PV Applications

Unit- IV

Wind Energy: Introduction, Basic Principles of Wind Energy Conversion, History of Wind Energy, Wind Energy Scenario – World and India. The Nature of the Wind, the Power in the Wind, Forces on the Blades, Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations

Wind energy systems: Environment and Economics Environmental benefits and problems of wind energy, Economics of wind energy, Factors influence the cost of energy generation, machine parameters, Life cycle cost analysis

Unit- V

Basic Components of a Wind Energy Conversion (WEC) System: Classification of WEC systems, Advantages and Disadvantages of WECS, Types of Wind Machines (Wind Energy Collectors), Analysis of Aerodynamic Forces Acting on the Blade, Performance of Wind- machines, Generating Systems, Energy Storage, Applications of Wind Energy, Environmental Aspects.

Text Books

1. G.D. Rai, '*Non-conventional Sources of Energy*', Khanna Publishers, 4th Edition
2. B.H. Khan, 'Non-conventional energy sources', TMH, 2nd Edition

Reference Books:

1. ShobhNath Singh, '*Non-Conventional Energy Resources*', Pearson, 2015.
2. S.P. Sukhatme J.K.Nayak, '*Solar Energy – Principles of Thermal Collections and Storage*', McGraw Hill, 2008.
3. Ahmad Hemami, '*Wind Turbine Technology*', Cengage, 2012.

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Discuss the importance of the role of renewable energy, the concept of energy storage and the principles of energy storage devices. (PO-1)(PSO-1)
2. Discuss the concept of solar radiation data and solar PV system fabrication, operation of solar cell, sizing and design of PV system. (PO-1) (PSO-1)
3. Describe the process of harnessing solar energy and its applications in heating and cooling. (PO-1) (PSO-1)
4. Explain basic Principles of Wind Energy Conversion, collection of wind data, energy estimation and site selection. (PO-1) (PSO-1)
5. Discuss the performance of Wind-machines, energy storage, applications of Wind Energy and environmental aspects. (PO-1) (PSO-1)

ADVANCED INDUSTRIAL AUTOMATION

Subject Code: EEE553 **Credits: 2:0:1**
Prerequisites: Nil **Contact Hours: 56**
Course Coordinator/s: Sri. Narsimpur Tushar Suresh

Course content:

UNIT I

Programmable Logic Controllers: Introduction, Comparison with other types of controllers, Architecture, Processor scan, Memory, Brief coverage of various Digital, Analog and Special I/O modules, Factors to consider while selecting I/O modules.
PLC Programming: Brief of various languages, IEC-61131 standard

UNIT II

Ladder Language Programming: Ladder structure, basic ladder elements, enhanced ladder elements, Scan cycle, speeding up PLC scan time, Developing Ladder program for given specification.
Functional Block Diagram (FBD) Programming: Overview, commonly available functional blocks, creating function blocks, Developing FBD for given specification.

UNIT III

PLC Installation: Panel Layout, Heating, Wiring, Grounding, Ringing the I/O Wiring
Safety: Failsafe wiring of STOP switch, Emergency stop, Safety interlocks
Maintenance Practices: Visual Inspection, Continuity Check, Input/Output Wiring Check, Operational Testing, Troubleshooting, Hardware Failures, Software Errors
Designing Systems: Program development, Commissioning, System Documentation, PLC and PLC components selection for an application

UNIT IV

Introduction to Human Machine Interface (HMI): Overview, Graphics and controls, HMI hierarchy design, displays and navigation, Trending: historical data collection and presentation of live data, Alarms: alarm information, event data, alarm logger, alarm summary display. Reports: alarm, events and historical process data reports.

UNIT V

SCADA Systems: Overview of concepts, definitions, applications and architecture. Remote terminal Units (RTU), Master terminal Units (MTU).

Text books

1. L. A. Bryan & E. A. Bryan, '*Programmable Controllers Theory and Implementation*', Second Edition, published by an industrial text company, 1997
2. W Bolton, '*Programmable Logic Controllers'*, Fourth Edition, Elsevier newnes, 2006

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Understand the purpose, functions, and operations of a PLC. (PO-1) (PSO-1)
2. Identify the basic components of the PLC and how they function. (PO-1,5) (PSO-1)
3. Create a PLC project using PLC software and configure the I/O for a PLC project. (PO-1,2,4,5) (PSO-1,3)
4. Design HMI layout. (PO-1,4) (PSO-1)
5. Develop the knowledge of SCADA system. (PO-1) (PSO-1)

Department Electives-2&3

MODERN CONTROL THEORY

Subject code: **EEE631** **Credits: 2:1:0**
Prerequisites: Control Systems **Contact Hours: 56**
Course Coordinator/s: Sri. Gurunayk Nayak

Course content:

UNIT -1

State Variable Analysis and Design: Introduction, Concept of State, State Variables and State Model, State Modeling of Linear systems, Linearization of state equation. State space representation using Physical variables, Phase variables and Canonical variables. Derivation of Transfer Function from State Model.

UNIT -2

Diagonalization, Eigen values, Eigen Vectors, Generalized Eigen Vectors.
Solution of State Equation, State Transition Matrix and its Properties. Computation of State transition matrix using Laplace Transformation, Power series Method, Cayley Hamilton Method,

UNIT -3

Concept of Controllability and Observability, Methods of determining the same. Derivation of CCF, OCF, DCF, JCF form, transformation to CCF, transformation to OCF,
Pole placement Techniques: Stability improvement by state feedback, Determination of value of K using Ackermann formula, direct substitution method.

UNIT -4

Necessary and sufficient conditions for arbitrary pole placement, State Regulator Design, Design of State Observer. Reduced order observer design, Dual systems, relation between K and Ke. Determination of value of Ke using Ackermann formula, direct substitution method.
Nonlinear Systems: Introduction, behavior of non-linear system, Common Physical non-linearity – saturation, friction, backlash, dead zone, relay, multi variable non-linearity.

UNIT -5

Phase plane method, singular points, stability of non-linear system, limit cycles, construction of phase trajectories.

Liapunov stability Analysis: Liapunov function, direct method of Liapunov and the linear system. Construction of Liapunov functions for non-linear system by Krasovskii‘s method.

Text Books

1. M.Gopal, "*Digital Control and State Variable Methods: Conventional and Intelligent Control Systems*", Tata McGraw-Hill, 2007.
2. I.J.Nagrath, M. Gopal, "*Control Systems Engineering*", New Age International Publishers, 3rd Edition.

Reference Books

1. Katsuhiko Ogata, "*Modern Control Engineering*", PHI, 3rd Edition.

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Determine the state model for electrical, mechanical and electromechanical systems. (PO-1, 2) (PSO-1)
2. Solve the state equations by different methods. (PO-1, 2) (PSO-1)
3. Analyze and predict the controllability and observability of the system. (PO-1, 2) (PSO-1)
4. Design the controller and observer for any given system. (PO-1, 2) (PSO-1)
5. Evaluate the stability of nonlinear systems. (PO-1, 2) (PSO-1)

ENERGY AUDIT

Subject code: **EEE632** **Credits: 3:0:0**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator: Dr. Sridhar. S

Course content:

Unit-I

Energy Scenarios: Energy Conservation, Energy Audit, Energy Scenarios, Energy Consumption, Energy Security, Energy Strategy, Clean Development Mechanism.

Types of Energy Audits and Energy-Audit Methodology: Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training.

Unit-II

Survey Instrumentation: Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data – Acquisition System, Thermal Basis.

Energy Audit of Boilers: Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods.

Unit-III

Energy Audit of Furnaces: Parts of a Furnace, classification of Furnaces, Energy saving Measures in Furnaces, Furnace Efficiency.

Energy Audit of HVAC Systems: Introduction to HVAC, Components of Air – Conditioning System, Types of Air – Conditioning Systems, Human Comfort Zone and Psychrometry, Vapour – Compression Refrigeration Cycle, Energy Use Indices, Impact of Refrigerants on Environment and Global Warming, Energy – Saving Measures in HVAC, Star Rating and Labelling by BEE.

Unit-VI

Electrical-Load Management: Electrical Basics, Electrical Load Management, Variable- Frequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses.

Energy Audit of Motors: Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling.

Unit-V

Energy Audit of Lighting Systems: Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities

Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.

Text Books

1. Sonal Desai, '*Handbook of Energy Audit'*, McGraw Hill, 2015.

Reference Books

1. H.E. Jordan, '*Energy Efficient Electric Motors and Applications'*, Plenum Pub. Corp

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Understand the need of energy audit and energy audit methodology. (PO-1) (PSO-1)
2. Explain audit parameters and working principles of measuring instruments used to measure the parameters. (PO-1) (PSO-1)
3. Conduct energy audit of boilers, furnaces, power plant, steam distribution system and compressed air systems. (PO-8,9,10,11) (PSO-1,3,4)
4. Conduct energy audit HVAC systems, motors, pumps, blowers and cooling towers. (PO-8,9,10,11) (PSO-1,3,4)
5. Explain load management techniques, effects of harmonics, electricity tariff, improvement of power factor and losses in transmission. Conduct energy audit of lighting systems and buildings. (PO-2,8,9,10,11) (PSO-1,3,4)

ELECTRIC VEHICLE TECHNOLOGY

Subject code: **EEE633** **Credits: 3:0:0**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator: Dr. Janamejaya Channegowda

Course content:

Unit- I

Introduction: IC Engines Basics, Energy Consumption for cycles, Limitations with present Technology – Fuel Shortage, Mechanical Efficiency along with hybrid & Electric Vehicle Systems. Introduction to Electric Vehicles: History of Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Social and Environmental Importance of Electric and Hybrid Electric Vehicles.

Unit- II

Battery Technologies: Types of Batteries, Architecture, Battery Charging & Discharging Cycles, Use of Batteries in Powertrain, Battery Modeling & Management Systems (BMS).

Unit- III

Charging Technologies: Standards, Conductive Charging (AC & DC), Inductive Charging – (Static and Dynamic), Battery Swap Technology. Alternate Energy Storage Systems (Ultracapacitor, Solid-state battery), Hybrid Energy Management System.

Unit- IV

Power Electronics: Fundamentals of Wide-bandgap (WBG) semiconductors, Comparing WBG with Si Devices, Efficiency Comparison, Introduction to GaN and SiC devices – Band Gap, Critical Field, On-Resistance, Two-Dimensional Electron Gas Model. single phase and three phase DC-AC converters & AC-DC Converters.

Unit- V

Electric Drivetrain: Series Hybrid Electric Drive Train, Design Principles of a Series Hybrid Drive Train, Parallel Hybrid Electric Drive Train Design. Design of the Traction Motor and Generator for Specific Power Rating. Fundamentals of regenerative braking and dynamic braking in electric vehicles.

Text Book

1. James Larminie, John Lowry, '*Electric Vehicle Technology Explained*', John Wiley & Sons Ltd, 2nd edition, 2012.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, '*Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*', CRC Press Taylor & Francis Group, 2004.

Reference Books:

1. Iqbal Hussein, '*Electric and Hybrid Vehicles: Design Fundamentals*', CRC Press Taylor & Francis Group, 2003.
2. Fred Wang, Zheyu Zhang and Edward A. Jones, '*Characterization of Wide Bandgap Power Semiconductor Devices*', First Edition, Institution of Engineering and Technology Publications, 2018.
3. Alex Lidow, Johan Strydom, Michael de Rooij, David Reusch, '*GaN Transistors for Efficient Power Conversion*', Third Edition, Wiley, 2019.
4. John G Hayes and G Abas Goodarzi, '*Powertrain – Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles*', First Edition, Wiley, 2018.
5. Ali Emadi, '*Handbook of Automotive Power Electronics and Motor Drives*', CRC Press Taylor & Francis Group, 2005

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Recognize the evolution of electric vehicles and explain EV and HEV configurations. (PO-1) (PSO-1)
2. Familiarize with Battery Modelling & Management Systems (PO-1,2) (PSO-1)
3. Learn the fundamentals of EV charging (PO-1) (PSO-1)
4. Select semiconductors that can be used in EV power converters (PO-1) (PSO-1)
5. Recognize different aspects of Electrical machines and power electronic devices used in EV. (PO-1) (PSO-1)

NANOFABRICATION AND CHARACTERIZATION

Subject code: **EEE641** **Credits: 3:0:0**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator: Smt. S. Dawnee

Course content:

Unit- I

Overview of Nanoelectronics devices and materials requirement, MOS capacitor as a building block of FET - MOSFET structure, SiO_2-Si interface quality- RCA cleaning, Oxidation, Gate electrode, Forming gas anneal.

CMOS scaling -ideal scaling theory, non-scaling factors, various definitions for channel length, Transistor Design methodology, Short channel Effect-Channel Engineering, Drain Induced barrier Lowering

Unit- II

Energy Bands In Silicon (Review only), Ultrathin SiO2 growth, gate-oxide scaling, electric field calculation (V_{FB},V_{Si}), Analysis with different examples, Flat band voltage Computation, Energy band diagram under thermal equilibrium, V_{Si} calculation under different conditions like accumulation, depletion etc. FN Tunneling, Time Dependent Dielectric Breakdown, Direct tunneling

Unit- III

High-k dielectrics, EOT, High-k dielectric requirements.

Metal gate transistor-Issues, Replacement gate, Fully Silisided gate technology.

Electrical characterization: HFCV and LFCV, Issues on scaling, sub-threshold leakage, Non-idealities in CV Transport enhanced transistor, I-V and reliability measurements.

Unit- IV

Non classical transistor structure, Silicon on Insulator (SOI) –PDSOI and FDSOI Processing and Characterization, Energy band diagram comparisons, SOI MOSFET operation with backchannel biased into Accumulation, Depletion and Inversion.

Unit-V

Introduction to other high performance nanoscale MOSFETs, Nano materials – Making and Characterisation, Introduction to CVD, ALD techniques, core-shell

structures, whiskers, SVS process. Analytical nano-characterization techniques: size, structure, composition, thickness measurement techniques.

References:

1. International Technology Roadmap for Semiconductors (ITRS)
2. Current literature from journals and conference proceedings

Course Outcomes (COs):

After the completion of the course the students will be able to:

1. Describe the different steps in the fabrication of scaled transistors. (PO-1) (PSO-1)
2. Develop a process flow for the fabrication of nano MOSFETs based on a particular specification, compute its threshold voltage. (PO-2) (PSO-1)
3. Implement the methodology for life time estimation and reliability. (PO-2) (PSO-1)
4. Analyze electrical characterization and perform parameter extraction from CV characteristics. (PO-2) (PSO-1)
5. Explain the different electrical and mechanical characterization techniques and making of nano materials. (PO-1) (PSO-1)

MACHINE LEARNING

Subject code: **EEE642** **Credits: 2:1:0**
Prerequisites: Nil **Contact Hours: 56**
Course Coordinator: Smt. Kusumika Krori Dutta

Course content:

Unit- I

Introduction to Machine Learning:
What is machine learning? Examples of machine learning applications –learning associations- classification-regression-unsupervised learning-reinforcement learning.

Probability Theory:
Probability densities, expectations and covariance, Bayesian probabilities, the Gaussian distribution, curve fitting, probability distribution, Decision tree.

Linear algebra for Machine Learning:
Basic Matrix identities, traces and determinants, matrix derivatives, Eigen value, eigen vector equation.

Unit- II

Supervised Learning:
Learning a class from examples, Noise, Learning multiple classes, Regression, Model selection and generalization.

Bayesian Decision Theory:
Classification, Losses and risks, Utility theory. Naïve Bayes Classifier.

Linear Model for Classification:
Discriminant functions, Probabilistic Generative models, Probabilistic Discriminative models, Bayesian Logistic regression

Unit- III

Dimensionality reduction:
Subset selection, Principal Component Analysis (PCA), Fisher's linear discriminant Analysis (LDA).

Parametric Methods:
Maximum likelihood Estimator (MLE), Bayes estimator, parametric classification.

Multivariate methods:
Multivariate data, Parameter Estimation, Estimation of Missing Values, Multivariate Normal Distribution, Multivariate Classification, Tuning Complexity.

Unit- IV

Clustering:

Mixture densities, k-Mean clustering, Expectation-Maximization, Mixtures of Latent variable models, Supervised learning after clustering, Hierarchical clustering, Choosing the Number of Clusters.

Non-parametric methods:

Non-parametric Density Estimation-Nearest Neighbor estimator- kernel estimator, nonparametric classification.

Unit- V

Maximum margin classifiers:

SVM, Introduction to kernel methods, Overlapping class distributions, Relation to logistic regression, Multiclass SVMs, and SVRs.

Multilayer Perceptron:

Understanding the Brain, Neural networks as a paradigm for Parallel Processing, training a perceptron, Back Propagation algorithm.

Text books

1. Ethem Alpaydin, "*Introduction to Machine Learning*", Second Edition, PHI Learning Pvt. Ltd, 2010.
2. Christopher Bishop, "*Pattern Recognition and Machine Learning*", CBS Publishers & Distributors, 2010.

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Understand and apply different machine learning based learning techniques. (PO-1) (PSO-1)
2. Understand and apply dimensionality reduction method. (PO1,2) (PSO1)
3. Analyze different classifiers. (PO-2) (PSO-1)
4. Evaluate Bayesian learning algorithm. (PO-1,2) (PSO-1)
5. Understand and apply neural network based models. (PO-1,2) (PSO-1)

VIRTUAL INSTRUMENTATION

Subject code: **EEE643** **Credits: 0:1:2**
Prerequisites: Nil **Contact Hours: 84**
Course Coordinator: Dr. Kodeeswara Kumaran G

Course content:

TUTORIAL TOPICS

LabVIEW introduction, Navigating LabVIEW, VIs and Functions, Dataflow, LabVIEW data types, Tools for programming, cleaning, and organizing VIs, Building a basic VI, Correction of broken VIs, Debugging techniques, Error handling, Loops review, While loops, For loops, Timing a VI.

Data feedback in loops, Plotting data waveform chart, Arrays, Common array functions, Polymorphism, Auto-indexing, Clusters, Type definitions, Case structures.

Event driven programming, Understanding modularity, Icon, Connector Pane, Documentation, Using SubVIs, Measuring fundamentals with NI DAQ hardware, Accessing files form LabVIEW, High-level and low level file I/O functions, Comparing file formats, Using sequential programming, Using state programming, State machines.

Variables, Using variables appropriately, Race conditions, Communicating data between parallel loops, Implementing simple design patterns and multiple loop design patterns, Functional global variable design pattern, Error handlers, generating error codes and messages, Timing design pattern, VI server architecture, Property nodes.

Controlling user interfaces, File formats, Creating a file and folder paths, Write and read binary files, Working with multichannel text files with headers, Access TDMS files in LabVIEW and Excel, Refactoring codes, Creating and distributing applications.

LIST OF EXPERIMENTS

1. (i) Getting familiar with LabVIEW environment
   (ii) Demonstration of document codes
2. (i) Programs to perform arithmetic operations
   (ii) Programs to understand dataflow
3. (i) Programs using *while* loops and *for* loops
   (ii) Programs to demonstrate data tunnels in loops
4. (i) Program to plot data waveforms
5. (ii) Program using n-dimensional arrays
6. (i) Programs using shift registers

(ii) Programs using case structures

7. Programs to read data from and write data to a binary/ASCII/LVM file
8. (i) Programs to implement state machines
   (ii) Programs to execute sequential tasks
9. Program to acquire data and control processes with myDAQ/myRIO hardware devices
10. Implementation of voltmeter, ammeter and wattmeter functions using myDAQ/myRIO
11. Implementation of DC motor control using myRIO

(12 to 14) Capstone project

References:

1. LabVIEW fundamentals by National Instruments
2. LabVIEW Basics-I course manual by National Instruments
3. LabVIEW Basics-II course manual by National Instruments

Course Outcomes (COs):

At the end of the course the student will be able to:

1. Demonstrate their understanding about the basic concepts of LabVIEW programming (PO-1) (PSO-1)
2. Develop VI programs in LabVIEW to meet given requirements. (PO-2,3,5) (PSO-1,2)
3. Debug and deploy LabVIEW programs on host computer/ myRIO. (PO-4,5) (PSO-1,2)
4. Deploy myDAQ for signal acquisition and processing. (PO-5) (PSO-1,2)
5. Develop a standalone system using myRIO for simple process control requirement. (PO-3,5) (PSO-1,2)