RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2019 – 2020

ELECTRICAL AND ELECTRONICS ENGINEERING

V & VI SEMESTER B.E

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

About the Institute:

Ramaiah Institute of Technology (RIT) (formerly known as M. S. Ramaiah Institute of Technology) is a self-financing institution established in Bangalore in the year 1962 by the industrialist and philanthropist, Late Dr. M S Ramaiah. The institute is accredited with "A" grade by NAAC in 2014 and all engineering departments offering bachelor degree programs have been accredited by NBA. RIT is one of the few institutes with prescribed faculty student ratio and achieves excellent academic results. The institute was a participant of the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. All the departments have competent faculty, with 100% of them being postgraduates or doctorates. Some of the distinguished features of RIT are: State of the art laboratories, individual computing facility to all faculty members. All research departments are active with sponsored projects and more than 304 scholars are pursuing PhD. The Centre for Advanced Training and Continuing Education (CATCE), and Entrepreneurship Development Cell (EDC) have been set up on campus. RIT 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 over 1,35,427 books with subscription to more than 300 International and National Journals. The Digital Library subscribes to several online e-journals like IEEE, JET etc. RIT is a member of DELNET, and AICTE INDEST Consortium. RIT has a modern auditorium, several hi-tech conference halls and all are air-conditioned with video conferencing facilities. It has excellent hostel facilities for boys and girls. RIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association. RIT obtained Academic Autonomy for all its UG and PG programs in the year 2007. As per the National Institutional Ranking Framework, MHRD, Government of India, Ramaiah Institute of Technology has achieved 64th rank in 2019 among the top 100 engineering colleges across India.

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 18 well-qualified faculty members. The entire faculty holds postgraduate degree in either Power Systems / Power Electronics. Five of the faculty members are doctorates. Dr. Premila Manohar is Ph.D in HVDC transmission (from HVE, IISc, 1991), 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) and Dr. Kodeeswara Kumaran is specialized in Power Electronics for Renewable Energy Applications (Ph.D from NITK, Surathkal, 2018). In addition, Dr. G. R. Nagabhushana, with a long record of service (Retired Professor from HVE, IISc) is with the department as Professor Emeritus.

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

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

QUALITY POLICY

We at MS 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.

Curriculum Course Credits Distribution

Batch 2017-21

Semester	Humanities & Social Sciences (HSS)	Basic Sciences / Lab (BS)	Engineering Sciences/ Lab (ES)	Professional Courses- Core (Hard core, soft core, Lab) (PC-C)	Professional Courses - Electives (PC-E)	Other Electives (OE)	Project Work (PW)	Internship/ other activities (IS/ECA)	Total semester load
First	2	09	14						**25**
Second	2	09	14						**25**
Third		4		21					**25**
Fourth		4		21					**25**
Fifth	2			19	4				**25**
Sixth				15	4		6		**25**
Seventh				14	12				**26**
Eighth						4	14	6	**24**
Total	**06**	**26**	**28**	**90**	**20**	**4**	**20**	**6**	**200**

SCHEME OF TEACHING
V SEMESTER

Sl. No.	Course Code	Course Name	Category	Credits					Contact Hours
				L	T	P	S	Total	
1	EE51	Digital Signal Processing	PC-C	3	1	0	0	4	5
2	EE52	Control Systems	PC-C	4	0	0	0	4	4
3	EE53	Transmission & Distribution	PC-C	3	0	0	1	4	3
4	EE54	Linear Integrated Circuits	PC-C	3	0	0	1	4	3
5	EE55	Intellectual Property Rights	GN	2	0	0	0	2	2
6	EEExx	Department Elective – A	Elective	4	0	0	0	4	4
7	EEL56	Control Systems Lab.	Lab	0	0	1	0	1	2
8	EEL57	Circuits & Measurements Lab.	Lab	0	0	1	0	1	2
9	EEL58	Electrical Machines – II Lab.	Lab	0	0	1	0	1	2
			Total	**19**	**1**	**3**	**2**	**25**	**27**

Elective Code	Elective Title
EEE03	Digital System Design
EEE16	Renewable Energy Sources
EEE25	Virtual Instrumentation
EEE12	Object Oriented Programming with C++ Laboratory

SCHEME OF TEACHING
VI SEMESTER

Sl. No.	Course Code	Course Name	Category	Credits					Contact Hours
				L	T	P	S	Total	
1	EE61	Power Systems-I	PC-C	3	0	0	1	4	3
2	EE62	Power Electronics	PC-C	3	0	0	1	4	3
3	EE63	Modern Control Theory	PC-C	3	1	0	0	4	5
4	EE64	Mini-Project (optional: Interdisciplinary projects)	Project	0	0	6	0	6	6
5	EEExx	Department Elective – B	Elective	4	0	0	0	4	4
6	EEL66	Power Electronics Lab.	Lab	0	0	1	0	1	2
7	EEL67	Linear Integrated Circuits Lab.	Lab	0	0	1	0	1	2
8	EEL68	DSP Lab.	Lab	0	0	1	0	1	2
			Total	**13**	**1**	**9**	**2**	**25**	**27**

Elective Code	**Elective Title**
EEE06	Electrical AC Machine Design and Cad
EEE08	HVDC Transmission Systems
EEE21	Nano Fabrication and Characterization
EEE26	Advanced Industrial Automation

V SEMESTER

DIGITAL SIGNAL PROCESSING

Subject Code: EE51 **Credit: 3:1:0:0**
Prerequisites: Nil **Contact Hours: 70**
Course Coordinator/s: Sri. Victor George/ Smt. Kusumika Krori Dutta

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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, students will 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. (PO1) (PSO 1)
3. Apply various transform techniques in linear filtering. (PO1) (PSO 1)
4. Apply fundamental principles, methodologies and techniques of the digital signal processing to analyze and design various filter circuits. (PO1) (PSO 1)
5. Explain the basic functional blocks available in a digital signal processor. (PO1) (PSO1)

CONTROL SYSTEMS

Subject Code: EE52 **Credit: 4:0:0:0**
Prerequisites: Nil **Contact Hours: 56**
Course Coordinator/s: Sri. Gurunayk Nayak

Course Content:

Unit I

Modeling 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.

Unit II

Block diagram and signal flow graph: To find overall transfer function.
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.

Unit III

Stability Analysis: Concepts of stability, necessary conditions for stability, Routh-Hurwitz criterion, relative stability.
Root Locus Technique: Introduction, Root locus concepts, construction of root loci.

Unit IV

Stability in Frequency Domain: Nyquist stability criterion, Polar plot, Correlation between time and frequency responses

Unit V

Frequency Domain Analysis: Introduction, Bode plot, determination of transfer function, Compensators-lag, lead, lag-lead networks.

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

Course Outcomes (COs):

At the end of the course, the students are 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. (PO-1,2) (PSO-1)
5. Identify the need of compensation. (PO-1,2) (PSO-1)

TRANSMISSION AND DISTRIBUTION

Subject Code: EE53 **Credit: 3:0:0:1**
Prerequisites: Nil **Contact Hours:42**
Course Coordinator/s: Sri.Ramakrishna Murthy K

Course Content:

Unit I

Electrical Power Transmission and Distribution: Standard Voltages for transmission, a typical transmission and distribution system, feeders, distributors, and service mains, Overhead line conductors. Classification of power transmission systems, advantages of high voltages for transmission, limitations of AC transmission.
Mechanical Design of Overhead Lines: Derivation of sag and tension for overhead lines with level supports, derivation of sag and tension for overhead lines with unequal supports, effect of wind pressure and ice, numerical problems.
Self-Study: *Introduction to HVDC transmission, main components of overhead lines, properties of line conductors, various kinds of line supports*

Unit II

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 a conductor due to internal flux, inductance of a conductor due to external flux, inductance of single phase two wire line, flux linkages of a single conductor in a group, inductance of composite conductor lines, inductance of three phase lines with equilateral and unsymmetrical spacing and transposition, numerical problems.
Capacitance of transmission lines, electric field of a long straight conductor, potential difference between two points due to a charge, capacitance of single phase system, potential difference between two conductors in a group of conductors, capacitance of three phase symmetrically spaced and un-symmetrically spaced conductors, problems
Self-Study: *Effect of earth on the capacitance of transmission lines, bundled conductors, numerical problems.*

Unit III

Characteristics and performance of power transmission lines: Classification of transmission lines, definitions of voltage regulation and efficiency, analysis of short transmission lines, analysis of medium transmission lines - nominal T method, nominal Π model and end condenser method, analysis of long transmission lines (rigorous method), ABCD constants for short, medium and long transmission lines, numerical problems.
Self-Study: *Ferranti effect*

Unit IV

Insulators: Voltage distribution over a string of insulators, string efficiency, calculation of string efficiency, methods of improving string efficiency - expression for line to pin capacitor with static shielding, numerical problems.

Underground cables: 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.

Self-Study: *Properties of materials used for insulators, types of insulators, advantages of underground cables over overhead lines, cable construction*

Unit V

DC distribution; types, calculations, uniformly loaded fed at one end, fed at both ends with equal and unequal voltages; fed at both ends - concentrated loading with equal and unequal voltages, ring main distributors.

AC Distribution:, AC distribution calculations - concentrated loads with pf referred to RE voltage and pf referred to respective load voltages, numerical problems.

Self-Study: *Classification of distribution systems, connection schemes - radial, ring main, requirements and design considerations for distribution system.*

Text books

1. Soni, Gupta & Bhatnagar, '*A course in Electrical Power*', Dhanapat and Sons, 2001.
2. J.B.Gupta, '*A text book of Transmission and Distribution'*, S.K.Kataria and Sons, 1998.

Reference Books

1. W.D Stevenson, '*Elements of Power System Analysis*', McGraw Hill International, 1992.
2. S.M.Singh, '*Electric Power Generation, Transmission and Distribution*', Prentice Hall of India Private Ltd., 2003.

Course Outcomes (COs):

After completion of this course, the students will be able to -

1. Have in depth knowledge of transmission and distribution systems and will be able to analyze the DC & AC distributors with different types of loads.(PO-1) (PSO 1)
2. Will be able to do the calculations for the mechanical design of OH lines (PO-3) (PSO 1,3)
3. Understand the importance of electrical transmission line constants and be able to calculate those values for the representation of transmission line (PO-3) (PSO 1)
4. Are able to evaluate the performance of electrical transmission lines from regulation and efficiency (PO-2) (PSO 1)
5. Understand the types of insulators and underground cables with structure and be able to do the design parameter calculations. (PO-3) (PSO 1)

LINEAR INTEGRATED CIRCUITS

Subject Code: EE54 **Credit: 3:0:0:1**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator/s: Sri. Ramakrishna Murthy/ Smt.Mamatha G M

Course Content:

Unit I

Introduction to Operational Amplifier: Operational amplifier description – Circuit symbol and terminals, current, impedance and voltage level, block diagram. Basic OP-AMP parameters: Input and output voltage range, offset voltage and current, offset nulling, CMRR, PSRR, input and output impedance, slew rate and frequency limitation.
OP-AMP as D.C. Amplifier: Biasing operational amplifier, D.C. coupled voltage follower, D.C. Coupled non-inverting amplifier, D.C. Coupled inverting amplifier, differential amplifier.
Self-Study: *IC Package*, *Summing amplifiers*

Unit II

OP-AMP as A.C. Amplifier: Capacitor coupled voltage followers, high Zin capacitor coupled voltage follower, Capacitor coupled non-inverting amplifier, high Zin capacitor non-inverting amplifier, capacitor coupled differential amplifier, use of single polarity supply.
Precision Rectifiers: Introduction, precision half wave rectifier: saturating precision rectifier, non-saturating precision rectifier, precision full wave rectifiers: half wave rectifier and summing circuit, high input impedance full wave precision rectifier,
Self-Study: *Setting upper cut off frequency*, *Capacitor coupled inverting amplifier,*

Unit III

Signal Processing Circuits: Dead zone circuit, precision clipper, precision clamping circuit, precision rectifier peak detector, sample and hold circuit.
Active Filters: Introduction, First order low and high pass Butterworth filter, second order low and high pass Butterworth filter, band pass filter.
Signal Generators: Basic principle of oscillator, phase shift oscillator, Wein bridge oscillator, Square wave generator, triangular wave generator.
Self-Study: *Peak clipper, Voltage follower peak detector, Band reject filter, Saw tooth wave generator,*

Unit IV

Op-Amp Frequency Response and Compensation: OPAMP circuit stability, frequency and phase response, frequency compensating methods, manufacturers recommended compensation, OPAMP circuit bandwidth, slew rate effects, stray capacitance effects, load capacitance effect.

Comparators: Positive feedback, upper threshold voltage, lower threshold voltage, zero crossing detector with hysteresis, inverting voltage level detectors with hysteresis, voltage level detector with independent adjustment of hysteresis and center voltage.
Self-Study: *Circuit stability precautions, Non-inverting voltage level detectors with hysteresis.*

Unit V

Selected Applications of Op-Amps: Voltage to current converters with floating load, voltage to current converters with grounded load, integrator and differentiator.
Specialized IC Applications: 555 timer, 555 timer as a monostable multivibrator, monostable multivibrator applications, 555 timer as an astable multivibrator, astable multivibrator applications, fixed voltage regulator.
Self-Study: *Current to voltage converter, Adjustable voltage regulators.*

Text Books

1. David A Bell, "*Operational amplifiers and Linear IC's*", Prentice Hall, 2nd Edition. (For the following topics: **Introduction to Operational amplifier, OP-AMP as D.C. Amplifier, OP-AMP as A.C. Amplifier, Signal Processing circuits, OP-AMP Frequency Response and Compensation**)
2. Ramakant A Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Prentice Hall, 4th Edition. (For the following topics: **Active Filters, Signal Generators, Selected Applications of OP-AMP and Specialized IC Applications,**)
3. Robert F Couglin, Frederick F Driscoll, "*Operational Amplifiers and Linear Integrated Circuits*", Prentice Hall, 6th Edition. (For the topic: **Comparators**)

References

1. Sergio Franco, "*Design with Operational Amplifiers and Analog Integrated Circuits*", TMC, 2008.
2. Roy Choudhary, "*Linear Integrated Circuits*", New Age International, 2003.

Course Outcomes (COs):

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

1. Analyze various electrical characteristics of different IC's through interpretation of their data sheets. (PO 1)(PSO 1)
2. Design and analyze linear and non-linear circuits for different functionality using op-amp. (PO 1,3)(PSO 1)
3. Analyze an Op-Amp circuit for stability and design a suitable compensation method. (PO 1,3)(PSO 1)
4. Design and analyze converter for selected applications. (PO 1,3)(PSO 1)
5. Illustrate the functionality 555 timer and voltage regulators. (PO 2)(PSO 1)

INTELLECTUAL PROPERTY RIGHTS

Subject Code: EE55 **Credit: 2: 0: 0: 0**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Sri. Vinayaka V Rao/ Sri. Ravindra Kumar C

Course content:

Unit I

Basic principles of IP laws: 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, non – patentable inventions. Patent cooperation treaty, TRIPS,WIPO.

Unit II

Patents: Introduction, origin and meaning of the term patent, objective of a patent law, the legislative provisions regulating patents, principles underlying the patent law in India, patentable invention. Inventions which are not patentable, patent of addition, process patent.
Procedure for obtaining patent: Submission of application, filing provisional and complete specification, publication and examination of the application, communication to the applicant , opposition proceedings to the grant of the patent, grant and term of patent,
Provisional and complete specification: Definition of Specification, kinds of specification, provisional specification, complete specification, claims, conditions for amendment.

Unit III

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, revocation and surrender of patents.
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, drafting of the products, case studies.

Unit IV

Copy Right: Meaning and characteristics of copy right, features of copyright law of 1957,historical overview, justification for copyright law, subject matter of copyright, concepts, principles, values and interests of the copyright protection, 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, assignment of copy right, licensing by owners, license in published and unpublished works, License to reproduce certain works.
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, registration of copyright, case studies.

Unit V

Trade Marks: Introduction, Trademark act 1999,meaning,descritpions,functions,need and essentials of trademark, some other marks, procedure of registration of trademarks, principles of registration of trademarks, grounds of refusal, distinctiveness, descriptive and non-descriptive words, forms of infringement, remedies against infringement of trademarks, case studies, Introduction to Trade secrets.
Industrial Design: Introduction, design act 2000, procedure of registration of a design, piracy of a registered design, case studies.
Geographical Indicators: salient features of the 1999bill, meaning of GI, prohibited geographical indicators, grounds of refusal for registration.

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., 5th edition , 2012.

References

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.

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 criteria's, opposition procedures and rights 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 and remedial action in IPR domain. (PO-1,6,8) (PSO-3)
5. Familiarize with latest legal cases in the field of IPR. (PO-1,6,8,10) (PSO-3)

CONTROL SYSTEMS LAB.

Subject Code: EEL56 **Credit: 0: 0: 1:0**
Prerequisites: Nil **Contact Hours:28**
Course Coordinator/s: Sri. Gurunayk Nayak

List of Experiments

1. Obtain Time response of second order system (RLC circuit) and find time domain specifications of the same. And simulate the same using MATLAB. Frequency response
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 and DC servo motor.
7. Simulate DC position control System for PI, PD, PID Controller.
8. To draw root loci for different transfer functions using MATLAB and verification by theoretical method.
9. Obtain phase margin, gain margin for different transfer function by drawing Bode plot and Nyquist plot using MATLAB and verification by theoretical method.
10. i) To solve 2^{nd} order differential equations by numerical technique and obtain time response of the system using MATLAB.
    ii) Mathematical modelling and Simulink simulation of inverted Pendulum.
11. Introduction to SISO toolbox and analyzing of step, frequency responses for different pole, zero locations.
12. Data acquisition example using MATLAB for real time applications.

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) (PSO1,2,4)
3. Analyze the behavior and stability of the systems for addition of poles and zeroes. (PO 1,2,5) (PSO1,2,4)
4. Distinguish the performance of Servo motors. (PO 1,2)(PSO 1)
5. Design the appropriate compensator. (PO 1,3,5) (PSO1,2,4)

CIRCUITS & MEASUREMENTS LAB.

Subject Code: EEL57 **Credit: 0: 0: 1: 0**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Sri. Victor George/ Sri. Narasimpur Suresh Tushar

List of Experiments

1. Measurement of low resistance using Kelvin's Double Bridge.
2. Measurement of resistance using Wheatstone 's bridge.
3. Verification of Superposition and Reciprocity Theorem.
4. Two/Three way control of Fluorescent lamp and power factor improvement.
5. Measurement of Inductances and coefficient of coupling of a transformer using Maxwell's Bridge.
6. Analysis of Series and Parallel Resonant Circuits.
7. Verification of Kirchoff's Laws.
8. Verification of Thevenin's Theorem.
9. Verification of Maximum Power Transfer Theorem.
10. Determination of Ratio and Phase angle error of Current Transformer.
11. Filter Design
12. Measurement of earth resistance

Course Outcomes (COs):

At the end of the course students are able to:
1. Perform Experiments to (i) Verify Kirchoff's laws, network theorems, Resonant phenomenon (ii)Measure low & high resistance using Kelvin's Bridge and Wheatstone's bridge (iii) Inductance using Maxwell's Bridge. (PO-1,4) (PSO-1)
2. Use software package to design and analyse resonant circuits and network theorems. (PO-1,4) (PSO-1,2)
3. Control fluorescent lamp from 2/3 points and power factor improvement. (PO-1,4) (PSO-1)
4. Determine errors in CT. (PO-1,4) (PSO-1)

ELECTRICAL MACHINES – II LAB

Subject Code: EEL58 **Credit: 0: 0: 1:0**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Dr.Chandrashekhar Badachi & Sri. Ravindra Kumar C

List of Experiment

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

Course Outcomes (COs):

At the end of the course students are able to:
1. Predetermine the % efficiency, regulation of single phase transformer. (PO1, 4) (PSO-1)
2. Determine the performance of single phase and three phase induction motor. (PO1,4) (PSO-1)
3. Determine the performance of three phase induction motor from circle diagram. (PO1,4) (PSO-1)

VI Semester

POWER SYSTEMS – I

Subject Code: EE61 **Credit: 3: 0: 0: 1**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator/s: Sri.Victor George

Course content:

Unit I

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
Symmetrical Three -Phase Faults: Introduction, symmetrical short of asynchronous generator, short circuit of a loaded synchronous generator, analysis of three-phase symmetrical faults.
Self-study: *Structure of general power system, advantages of per-unit computations.*

Unit-II

Symmetrical Components: Introduction, 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.
Self-study: *Complex power in terms of symmetrical components.*

Unit III

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, construction of sequence networks of a power system.
Self-study: *Sequence impedance and networks of transmission lines.*

Unit IV

Unsymmetrical Faults: Introduction, 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, series types of faults.
Self-study: *Fault through impedance, single line-to-ground fault on an unloaded generator through a fault impedance, line-to-line fault on an unloaded generator through a fault impedance, double line -to-ground fault on an unloaded generator through a fault impedance.*

Unit V

Stability Studies: Introduction, steady state stability, power angle equation of synchronous machines, steady state stability of a two machine system, Clarke's diagram, methods of improving SSSL, Transient stability, dynamics of a synchronous machine, Swing equations, Swing curve, Equal Area Criterion(EAC), applications of Equal Area Criterion, critical clearing angle.
Self-study: *Methods of improving transient stability.*

Text Books

1. W.D.Stevenson Jr., Elements of Power System Analysis , McGraw Hill, 3rd Ed.,
2. E.W.Kimbark, Power System Stability, Vol-I, Wiley International, 2003.
3. I.J.Nagrath and D.P.Kothari, Modern Power System Analysis ,TMC, 2nd Edition

Reference Books

1. C.F.Wagner, R.D.Evans, Symmetrical Components , McGraw Hill, 1993.
2. P.N.Reddy, Symmetrical Components and Short Circuit Studies , Khanna Publishers, 2002.

Course Outcomes (COs):

At the end of the course, Students are able to:

1. Describe the general structure of power system and represent its various components on per unit basis. (PO-1) (PSO-1)
2. Analyze the symmetrical faults in power system. (PO-1) (PSO-1)
3. Determine the symmetrical components of unsymmetrical phasors. (PO-1) (PSO-1)
4. Identify different techniques to analyze unsymmetrical faults in power system (PO-1) (PSO-1,3)
5. Analyze the stability aspects of a power system. (PO-1) (PSO-1,3)

POWER ELECTRONICS

Subject Code: EE62 **Credit: 3: 0: 0: 1**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator/s: Smt. Archana Diwakar/Sri. Omsekhar Indella

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Course content:

Unit I

INTRODUCTION
Application of power electronics, power semiconductor devices, control characteristics of power devices
POWER TRANSISTORS
Power MOSFET: Structure, operation, concept of pinch-off, steady state characteristics, switching characteristics
IGBT: Structure, operation, steady state characteristics, switching characteristics.

Unit II

THYRISTORS
Introduction, static characteristics, two- transistor model, dynamic characteristics – turn-on and turn-off, di/dt and dv/dt protection
Thyristor firing circuits – R, R-C and UJT triggering circuit.

Unit III

THYRISTOR COMMUTATION TECHNIQUES
Introduction, natural commutation, Forced commutation – self commutation, resonant pulse commutation complementary commutation, impulse commutation
AC VOLTAGE CONTROLLERS
Introduction, principle of on-off and phase control, single phase unidirectional controller with R load, Single-phase bi-directional controllers with resistive and inductive loads.

Unit IV

CONTROLLED RECTIFIERS
Introduction, single phase single pulse and two pulse converters with R& RL load, three phase three pulse and six pulse converter with R & RL load, single phase and three-phase semi-converters

Unit V

DC CHOPPERS
Introduction, principle of step-up and step-down chopper, classification of choppers

INVERTERS

Introduction, principle of operation, performance parameters, single phase half and full- bridge inverter with R and RL load, voltage control of single phase inverter – single pulse width, multiple pulse width, sinusoidal pulse width, modified sinusoidal pulse-width modulation and phase displacement control techniques.

Self-study: Types of power electronic circuits, Isolation of gate and base drives. Simple design of gate and base drives. Series and parallel operation of thyristors**,** Triac: structure, characteristics, external pulse (class E) commutation. effect of free-wheeling diode for inductive loads.

Text Books

1. M.H. Rashid, " *Power Electronics: Circuits, Devices and Applications*", Third Edition, PHI, 2005
2. M.D.Singh, Khanchandhani K.B, "*Power Electronics"*, TMH, 2001

Reference Books

1. Ned Mohan, Tore M. Undeland , William P. Riobbins, "*Power Electronics-converters, applications and design*", Third edition, Wiley 2009.
2. Vedam Subramanyam, "*Power Electronics*", Revised Second Edition, New Age International Publishers, 2006.

Course Outcomes (COs):

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

1. Familiar with the structure, characteristics and operation of power semiconductor devices like Thyristor, MOSFET and IGBT. (PO 1) (PSO 1)
2. Analyze and synthesize the detailed operation of thyristors. (PO 1,2) (PSO 1, 2)
3. Design suitable firing circuits and commutation circuits for thyristors. (PO 2,3) (PSO 1, 2)
4. Analyze various converter circuits. (PO 2,3) (PSO 1)
5. Design simple power electronic circuits. (PO 3,5,9) (PSO 1, 2,3)

MODERN CONTROL THEORY

Subject Code: EE63 **Credit: 3:1:0:0**
Prerequisites: Nil **Contact Hours: 70**
Course Coordinator/s: Smt. S. Dawnee/ Sri. Gurunayk Nayak

Course content:

Unit I

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 II

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 III

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 IV

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, behaviour of non-linear system, Common Physical non-linearity – saturation, friction, backlash, dead zone, relay, multi variable non- linearity.

Unit V

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, 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) (PSO 1, 2)
3. Analyze controllability of the system and design the controller. (PO 1,2) (PSO 1)
4. Analyze observability of the system and design the observer. (PO 1,2) (PSO 1)
5. Evaluate the stability of nonlinear systems. (PO 1,2) (PSO 1)

MINI-PROJECT

Subject Code: EE64 **Credit: 0:0:6:0**
Prerequisites: Nil **Contact Hours: 84**
Course Coordinator: 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. Define the problem to be solved in a clear and unambiguous terms. (POs – 1, 2, 3, 4, PSO – 1)
2. Identify and establish the need to solve the problem by gathering relevant literature. (POs – 1, 2, 3, 4, PSO – 1)
3. Describe the proposed design method in terms of technical block diagram or flowchart. (POs – 2, 3, 10, PSOs – 2, 3)
4. Implement and demonstrate the proposed design method using software/hardware tools. (POs – 2, 3, 4, 5, PSOs – 2, 3)
5. Document and present the solution to the peer group. (POs – 9, 10, PSOs – 2)

POWER ELECTRONICS LAB

Subject Code: EEL66 **Credit: 0: 0: 1: 0**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Smt. Archana Diwakar/ Sri. Narasimpur Tushar Suresh

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, students will have 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)

LINEAR INTEGRATED CIRCUITS LAB

Subject Code: EEL67 **Credit: 0: 0: 1: 0**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Sri. Ramakrishna Murthy. K /Smt. Mamatha G M

List of experiments:

1. Design and implementation of voltage follower, inverting amplifier, non- inverting amplifier and inverting summing amplifier using 741 OP – AMP
2. Design and implementation of capacitor coupled inverting and non- inverting amplifier with single polarity supply using 741 OP – AMP
3. Design and implementation of Non-saturating Precision half wave rectifier and high impedance precision full wave rectifier, using 741 OP – AMP
4. Design and implementation of positive clipper, negative clipper and precision clamper using 741 OP – AMP
5. Determination of OP-AMP parameters
6. Design and implementation of the following filters using 741 OP – AMP
   - First order low pass filter
   - Second order low pass filter
   - First order high pass filter
   - Second order high pass filter
7. Design and implementation of square wave generator, triangular wave generator and RC phase shift oscillator using 741 OP-AMP
8. Design and implementation of zero crossing detector, inverting and non- inverting voltage level detector using 741 OP-AMP
9. Design and implementation of
   - Differentiator and Integrator using 741 OP – AMP
   - Monostable and Astable Multivibrator using 555 timer
10. Design and implementation of Voltage Regulators
    - Fixed Voltage Regulator
    - Adjustable Voltage Regulator
11. Demonstration of ± 5V & ± 15V Power Supply
12. Demonstration of thyristor based triggering circuit using OP-AMP

Text Books

1. David A Bell, "*Operational amplifiers and Linear IC's*", Prentice Hall, 2nd Edition.
2. Ramakant A Gayakwad, "Op-Amps and Linear Integrated Circuits", Prentice Hall, 4th Edition.
3. Robert F Couglin, Frederick F Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Prentice Hall, 6th Edition.

References

1. Sergio Franco, "*Design with Operational Amplifiers and Analog Integrated Circuits*", TMC, 2008.
2. Roy Choudhary, "*Linear Integrated Circuits*", New Age International, 2003.

Course Outcomes (COs):

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

1. Design and analyze the performance of various linear circuits using op-amp. (PO 3, 4, 9) (PSO 1)
2. Design and analyze the performance of various nonlinear circuits using op-amp. (PO 3,4, 9) (PSO 1)
3. Evaluate the performance of different active filters using Op-Amps. (PO 1, 4, 9) (PSO 1)
4. Design and analyze the performance of different multivibrators using 555 timer. (PO 3, 4, 9) (PSO 1)
5. Analyze different op-amp parameters. (PO 1, 4, 9)(PSO 1)

DSP LAB

Subject Code: EEL68 **Credit: 0:0:1:0**
Prerequisites: Nil **Contact Hours: 28**
Course Coordinator/s: Smt. Kusumika Krori Dutta

A. LIST OF EXPERIMENTS

1. Perform the following operation on a given sequence (Time shifting, Up and down sampling, Folding)
2. Verification of sampling theorem.
3. Convolution of given sequence
a) Linear b) Circular
4. Solving a given difference equation with and without initial conditions
5. Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum, and verify using built in function
6. Given a causal system H(z), obtain pole-zero plot, magnitude and phase response.
7. Linear convolution of two sequences using DFT and IDFT.
8. Circular convolution of two given sequences using DFT and IDFT
9. Design and implementation of FIR filter to meet given specifications. (Window, frequency sampling method)
10. Design and implementation of IIR filter to meet given specifications (Impulse Invariant, Bilinear Transform)

B. LIST OF EXPERIMENTS USING DSP PROCESSOR

1. Linear convolution of two given sequences.
2. Circular convolution of two given sequences.
3. Solving a given difference equation
4. Computation of N- Point DFT of a given sequence
5. Realization of an FIR filter (any type) to meet given specifications. The input can be a signal from function generator / speech signal.

Text Books

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

References

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

Course Outcomes (COs):

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

1. Perform generation of different signal and basic operations on a given signal. (PO – 1,2,5,9) (PSO-1,2)
2. Implement linear convolution and circular convolution. (PO – 1,2,5,9) (PSO-1,2)
3. Implement FIR filter to meet the given specifications. (PO – 2,3,5,9) (PSO-1,2)
4. Implement IIR filters to meet the given specification. (PO – 2,3,5,9) (PSO-1,2)
5. Implement convolution and filtering using DSP processor. (PO – 2,5,9) (PSO-1,2)

ELECTIVES

DIGITAL SYSTEM DESIGN

Subject Code: EEE03 **Credits: 4: 0: 0: 0**
Prerequisites: Nil **Contact Hours: 56**
Course Coordinator/s: Sri. Ramakrishna Murthy K

Course contents:

Unit I

Introduction to Verilog
Verilog as HDL, levels of design description, concurrency, simulation and synthesis, functional verification, system tasks, programming language interface (PLI), module, simulation and synthesis tools, test benches.
Language constructs and conventions
Introduction, keywords, identifiers, white space characters, comments, numbers, strings, logic values, strengths, data types, scalars and vectors, parameters, memory, operators, system tasks.

Unit II

Gate level modeling
Introduction, AND gate primitive, module structure, other gate primitives, illustrative examples: tri-state gates, array of instances of primitives. Additional examples: design of flip-flops with gate primitives, delays, strengths and contention resolution, net types, design of basic circuits.

Unit III

Behavioral modeling
Introduction, operations and assignments, functional bifurcation, initial construct, always construct, examples, assignments with delays, wait construct, multiple always blocks, designs at behavioral level, blocking and non-blocking assignments, the case statement, simulation flow, *if* and *if*-else constructs, assign-design construct, repeat construct, for loop, the disable construct, while loop, forever loop, parallel blocks, force-release construct, event.

Unit IV

Modeling at data flow level
Introduction, continuous assignment structures, delays and continuous assignments, assignment to vectors, operators.

Switch level modeling
Introduction, basic transistor switches, CMOS switch, bi-directional gates, time delays with switch primitives, instantiations with strengths and delays, strength contention with tri-reg nets.

Unit V

System tasks, functions and compiler directives

Introduction, parameters, path delays, module parameters, system tasks and functions, file-based tasks and functions, compiler directives, hierarchical access, general observations.

Basics of synthesis, modeling a finite state machine (mealy and moore machine)

Test Books

1. T.R. Padmanabhan and B. Bala Tripura Sundari, "*Design through Verilog HDL*", WSE, 2004, IEEE Press.
2. J Bhaskar, "*A Verilog HDL Synthesis- A Practical Primer"*, Star Galaxy Publishing, 1st Edition, 1998.

Reference Books

1. Stephen. Brown and Zvonko Vranesic, "*Fundamentals of Logic Design with Verilog*", TMH, 2005.
2. Michael D. Ciletti, "*Advanced Digital Design with Verilog HDL*", PHI, 2005

Course Outcomes (COs):

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

1. Describe various abstraction levels of Verilog HDL in modeling digital hardware. (PO-1)(PSO-1)
2. Model, simulate and synthesise digital systems using the Verilog HDL. (PO-1) (PSO-1)
3. Design simple combinational and sequential circuits using Verilog. (PO-3) (PSO-1)
4. Model logic circuits using system tasks, functions and compiler directives. (PO-3) (PSO-1).
5. Implement combinational and sequential logic using FSM (PO-3,5) (PSO-1,2)

ELECTRICAL AC MACHINE DESIGN AND CAD

Subject Code: EEE06 **Credit: 3: 0: 1:0**
Prerequisites: Nil **Contact Hours: 70**
Course Coordinator/s: Smt. Kusumika Krori Dutta

Course contents:

Unit I

DESIGN OF 1Φ AND 3Φ TRANSFORMERS:
Output equation for single phase and three, choice of specific loadings, expression for volts/ turn, determination of main dimensions of the core transformer, estimation of number of turns and cross sectional area of primary and secondary coil, estimation of no load current, expression for leakage reactance.

Unit II

DESIGN OF SYNCHRONOUS MACHINES:
Output equation, choice of specific loadings, short circuit ratio, number of slots for the stator. Design of main dimensions, armature winding, slot details for the stator of salient and non-salient pole , synchronous machine, design of rotor of salient pole synchronous machine, dimensions of the pole body, estimation of height and number of turns for the field winding, design of rotor of non-salient pole machine

Unit III

DESIGN OF 3Φ INDUCTION MOTORS:
Output equation, choice of specific loadings, main dimensions of 3Φ induction motor, stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of rotor bars and end ring, design of slip ring IM, estimation of no load current of induction motor.

Unit IV

AC MACHINE WINDING DIAGRAM:
Integral slot single layer full pitched lap , Integral slot single layer full pitched wave, Integral slot double layer full pitched lap, Integral slot double layer full pitched wave, Integral slot single layer and double layer fractional pitched and fractional slot of lap and wave winding.

Unit V

AC MACHINE ASSEMBLY DIAGRAM:
Assembly and sectional views of 1Φ and 3Φ core type transformers.
Assembly and sectional views of stator and rotor of synchronous machines.
Assembly and sectional views of stator of induction machines

Text Books

1. A.K.Sawney, “*A course in electrical machine design*”, Dhanpat Rai and Sons .2005
2. V.N. Mittle,” *Design of Electrical Machines*”, 4/e edition, Standard Publishers.
3. S.F. Devalapur, “*Electrical Drafting*”, Eastern Book Promoters, Belgaum,2006

Reference Books

1. R.K Aggarwal , “*Principles of Electrical machine design*”, 4/e, S.K.Kataria & sons.
2. K. L. Narang, ‘*Electrical Engineering Drawing*’, Satya Prakashan, N.D Publications, 1993.

Course Outcomes (COs):

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

1. Draw lap and wave winding for AC machines both using paper and AutoCAD. (PO 1, 2,5) (PSO-1)
2. Draw assembly diagram of transformer both using paper and AutoCAD. (PO 1, 2,5) (PSO-1)
3. Draw assembly diagram of Alternator and Induction motor both using paper and AutoCAD. (PO 1, 2,3,5) (PSO-1)
4. Design a transformer to meet desired needs within realistic constraints such as economic, manufacturability and sustainability. (PO 1, 3) (PSO-1)
5. Design an Alternator and Induction Motor to meet desired needs within realistic constraints such as economic, manufacturability and sustainability. (PO 1, 3) (PSO-1)

HVDC TRANSMISSION SYSTEMS

Subject Code: EEE08 **Credit: 4: 0: 0: 0**
Prerequisites: Nil **Contact Hours: 56**
Course Coordinator/s: Dr.Premila Manohar

Course content:

Unit I

Introduction to HVDC systems, Comparison of AC and DC transmission systems, Advantages and disadvantages of HVDC transmission systems, applications of DC transmission systems, Types of HVDC links, description of a typical HVDC converter station, Planning for HVDC systems, Modern trends in DC transmission. Description of different converter circuits, half wave, full wave, bridge rectifier circuits, 3 phase –1 way and 3 phase 2- way circuits. Analysis of 1 phase full wave rectifier and bridge rectifier.

Unit II

Analysis of converter circuits, Analysis of 3 phase –1 way, 3 phase 2- way rectifier circuits. Choice of converter configuration- valve utilization factor (VUF) and transformer utilization factor (TUF). Analysis of 6P Graetz circuit, calculation of average direct voltage and current without overlap and with overlap less than 60^0. Numerical problems. Equivalent circuit of 6P rectifier circuit. Inverter operation, voltage and current equations, commutation failure.

Unit III

Control strategies, Equivalent circuit of HVDC system, basic means of control and power reversal, Limitation of manual control, constant voltage verses constant current control, desired features of control and actual control characteristics, Modifications of control characteristics, Constant minimum ignition angle control and constant current control , Constant extinction angle control, Tap changer control, power control and current limits, Analog and digital controllers, HVDC link operation and regulation, MTDC operation

Unit IV

Protection, Harmonics and Filter circuits. General introduction to protection, DC smoothing reactor, Prevention of consequent commutation failure, Converter faults, Clearing of line faults and re-energizing the line, Surge arresters, over current and over voltage protection, Characteristic and non-characteristic harmonics, Troubles caused by harmonics, Means of reducing harmonics, Telephone interference, performance indices, Harmonic analysis, Types of filters.

Unit V

VSC–HVDC systems
Introduction, comparison of LCC-HVDC and VSC-HVDC systems, advantages and applications of VSC –HVDC systems, types of VSC converters 2 level, 3 level and MMC, control of VSC-HVDC link.
Simulation of HVDC systems, Introduction, system simulation: philosophy and tools, HVDC system simulation, HVDC simulator (physical model), Dynamic digital simulation, Modeling of HVDC systems for dynamic digital simulation, Valve & Converter model, Transformer and AC system model, DC network model.

Text Books

1. E.W.Kimbark, Direct Current Transmission –Vol. I , Wiley Interscience, 1971
2. K.R.Padiyar, HVDC Power Transmission Systems, New Age International Publishers, 3rd Ed. 2015

Course Outcomes (COs):

At the end of the course the students will be able to:
1. Demonstrate complete knowledge of HVDC technology. (PO 1) (PSO-1)
2. **U**nderstand and analyse converters, the associated controllers, harmonics and filters of HVDC systems. (PO 1, 2) (PSO-1)
3. **A**pply the knowledge to design and develop HVDC systems and the associated controls, with PSCAD/EMTDC. (PO 3, 5) (PSO-2)
4. Familiar with the recent developments in the high voltage dc transmission area. (PO 2) (PSO-1)

OBJECT ORIENTED PROGRAMMING WITH C++ LABORATORY

Subject code: **EEE12** **Credits: 0:2:2:0**
Prerequisites: Nil **Contact Hours: 56**
Course Coordinator/s: Sri. Omsekhar Indela

Course Contents:

Class, inline functions, default arguments, overloading, class implementation, nesting of member functions, class with arrays as data members, static data member, static member function, arrays of objects, objects as function arguments, friend function, class with constructors, overloaded constructors, dynamic initialization of objects, dynamic constructors, destructors, operator overloading, different types of inheritance, virtual functions.

List of experiments

1. Write a C++ program to illustrate the concept of class
2. Write a C++ program to illustrate the concept of inline functions
3. Write a C++ program to illustrate the use of default arguments
4. Write a C++ program to illustrate the concept of function overloading
5. Write a C++ program to illustrate the concept of class implementation
6. Write a C++ program to illustrate the concept of nesting of member functions
7. Write a C++ program to illustrate the concept of class with arrays as data members
8. Write a C++ program to illustrate the concept of static data member
9. Write a C++ program to illustrate the concept of static member function
10. Write a C++ program to illustrate the concept of arrays of objects
11. Write a C++ program to illustrate the concept of objects as function arguments
12. Write a C++ program to illustrate the concept of friend function
13. Write a C++ program to illustrate the concept of class with constructors
14. Write a C++ program to illustrate the concept of overloaded constructors
15. Write a C++ program to illustrate the concept of dynamic initialization of objects
16. Write a C++ program to illustrate the concept of dynamic constructors
17. Write a C++ program to illustrate the concept of destructors
18. Write a C++ program to illustrate the concept of operator overloading
19. Write a C++ program to illustrate the concept of different types of inheritance
20. Write a C++ program to illustrate the concept of virtual functions

Text Books

1. E Balaguruswamy, Object Oriented Programming Using C++, Tata McGraw-Hill, 4th edition 2008.
2. Herbert Schildt, The Complete Reference C++, 4th Edition, Tata McGraw-Hill, 2005.

References

1. SouravSahay , Object Oriented Programming with C++,. Oxford University Press, 2006.
2. Stanley B. Lippmann, Josee Lajoie, C++ Primer, 4th Edition, Addison Wesley, 2012.

Course Outcomes (COs):

The student will be able to:

1. Design programs using classes and objects for C++. (PO-1, 2, 3, 5) (PSO-2,3)
2. Build programs for automatic initialization of objects and destroy objects that are no longer required. (PO-2, 3, 4, 5) (PSO-2,3)
3. Build programs with different types of constructors. (PO-2, 3, 4, 5) (PSO-2,3)
4. Constructing applications to provide flexible options for the creation of new definitions for some of the operators. (PO-2, 3, 5) (PSO-2,3)
5. Specifying mechanism of deriving a new class from older classes through Inheritance. (PO-2, 3, 4, 5) (PSO-2,3)

RENEWABLE ENERGY SOURCES

Subject Code: EEE16 **Credit: 4: 0: 0: 0**
Prerequisites: Nil **Contact Hours: 56**
Course Coordinator/s: Sri. C. Ravindra Kumar / Smt. Archana Diwakar

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Course content:

Unit I

An Introduction to Energy Sources: Global Energy Consumption, World Energy Futures, Energy scenario in India, Energy Alternatives for the future
Solar Energy: Solar Constants, Solar Radiation on Earth Surface, Solar Radiation Geometry, Solar Radiation Measurements, basic sun-earth angles (beam radiation on an inclined surface, sunrise, sunset and day length, Latitude, Declination angle, Surface azimuth angle, Hour angle, Zenith angle, Solar altitude angle expression for angle between incident beam and the normal to a plane surface), Local apparent time, solar radiation on tilted surface (no derivation for any of these)

Unit II

Solar Energy Collectors: Flat Plate collectors, Concentrating Collectors
Solar thermal energy storage: Storage systems- thermal, electrical, chemical, mechanical, electromagnetic, solar pond.
Applications: water heating, space heating & cooling, solar distillation, solar pumping, solar greenhouses, solar power plants.
Solar photovoltaic system: Photovoltaic effect, solar cell fundamentals, characteristics, solar cell, module, panel and array construction, maximizing the solar PV output and load matching, maximum power point tracker (MPPT), solar photovoltaic system, applications of PV system, PV hybrid system.

Unit III

Wind Energy: Principles of wind energy conversion systems (WECS), nature of wind, power in the wind, lift & drag, site selection, components of WECS, classification of WECS, derivation of power coefficient (Cp) for a horizontal axis wind turbine, power available in the wind.
Energy from Biomass: Types of bio mass fuels, solid, liquid and gas, biomass conversion techniques- wet process, dry process, biogas generation-factors affecting bio-digestion, classification of bio gas plants.

Unit IV

Energy from oceans: Introduction, ocean thermal energy conversion, open cycle OTEC, closed cycle OTEC, hybrid cycle, bio-fouling
Tidal Energy: Energy from tides, components of tidal power plants.
single basin arrangement, double basin arrangement, numericals on energy in simple single basin tidal system

Unit V

Direct energy conversion systems
Magneto-hydro-dynamic (MHD) generation: Principle of MHD power generation, MHD system, materials for MHD generators and future prospects
Fuel cells: Working principle, efficiency, classification and types of fuel cells, application of fuel cells
Hydrogen Energy: Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles

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. S.P.Sukhatme, '*Solar Energy: Principles of Thermal Collection and Storage*', TMH, 2nd Edition.
2. D.P Kothari, '*Renewable Energy sources and Emerging Technologies*', PHI 2008.

Course Outcomes (COs):

At the end of the course, the student will be able to:
1. Determine the main sources of Renewable energy, the origins of those sources, and the means by which the sources can be exploited for energy generation. (PO 1) (PSO-1)
2. Analyze the working of solar thermal energy and solar PV systems. (PO 1)(PSO-1)
3. Analyze working of wind energy systems, biomass plants, ocean thermal energy systems and tidal power plants. (PO 1,2) (PSO-1,3)
4. Comprehend the basics of direct energy conversion techniques like magneto hydro dynamic(MHD) generation, fuel cells and hydrogen energy. (PO 1) (PSO-1,3)
5. Enhance their knowledge about the latest trends in Renewable energy sources by analyzing scholarly articles. (PO 7,12) (PSO-1)

NANO FABRICATION AND CHARACTERIZATION

Subject Code: EEE21 **Credit: 4: 0: 0: 0**
Prerequisites: Nil **Contact Hours:56**
Course Coordinator/s: 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, 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, Parameter extraction, Nano-MOSFET performance metrics.

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 Characterization, Introduction to CVD, ALD techniques, core-shell structures, whiskers, SVS process. Analytical nano-characterization techniques: size, structure.

References

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

Course Outcome (COs):

At the end of the course, the student 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-1,2) (PSO-1)
3. Implement the methodology for life time estimation and reliability. (PO-1)(PSO-1)
4. Analyze electrical characterization and perform parameter extraction from CV characteristics. (PO-1) (PSO-1)
5. Explain the different electrical and mechanical characterization techniques and making of nano materials. (PO-1) (PSO-1)

VIRTUAL INSTRUMENTATION

Subject Code: EEE25 **Credit: 0:2:2:0**
Prerequisites: Nil **Contact Hours:84**
Course Coordinator/s: Dr. Kodeeswara Kumaran G

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. Develop VI program in LabVIEW to meet system design requirements. (PO-2,3) (PSO-1)
2. Debug and deploy LabVIEW programs on host computer/ myRIO. (PO-4)(PSO-1)
3. Deploy myDAQ for signal acquisition and processing. (PO-5)(PSO-2)
4. Develop a standalone system using myRIO for simple process control requirement. (PO-5)(PSO-2)

ADVANCED INDUSTRIAL AUTOMATION

Subject Code: EEE26 **Credit: 3:0:1:0**
Prerequisites: Nil **Contact Hours: 70**
Course Coordinator/s: Sri. Narsimpur Tushar Suresh

Course contents:

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), Communication setups,

Text books

1. L.A. Bryan, E.A. Bryan, Programmable *Controllers Theory and Implementati*on, Second Edition.
2. W Bolton, *Programmable Logic Controllers*.

Course Outcomes (COs):

Students 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. Explain the principles of operation of SCADA system. (PO-1) (PSO-1)