RAMAIAH
Institute of Technology

CURRICULUM

Outcome Based Education

Academic year 2023 – 2024

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 17 UG programs and 11 PG programs. All these programs are approved by AICTE. All eligible UG and PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with **'A+' grade by NAAC in March 2021** for 5 years. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs since 2007. The institute has also been conferred autonomous status for Ph.D. program since 2021. 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 67% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility for 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, Centre for Antennas and Radio Frequency systems (CARFS), Center for Cyber Physical Systems, Schneider Centre of Excellence & Centre for Bio and Energy Materials Innovation. **Ramaiah Institute of Technology has obtained "Scimago Institutions Rankings" All India Rank 107 & world ranking 600 for the year 2022.**

The Entrepreneurship Development Cell (EDC) and Section 8 company "Ramaiah Evolute" have been set up on campus to incubate startups. **M S Ramaiah Institute of Technology is recognized by Atal Ranking of Institutions on Innovation Achievements (ARIIA), MoE, 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. The Institute is a member of DELNET, CMTI and VTU E-Library Consortium. The Institute has a modern auditorium, recording studio, and several hi-tech conference halls with video conferencing facilities. The institute 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 (NIRF), MoE, Government of India, Ramaiah Institute of Technology has achieved 78th rank among 1314 top Engineering Institutions & 23rd Rank for School of Architecture in India for the year 2023.

About the Department:

The department was started in the year 1962 along with the establishment of the Institute. In 2003, the Department has been recognized as a Research Centre by Visvesvaraya Technological University, Belagavi and offers Ph.D and MS(by Research) programs. UG programme has been accredited by NBA since 2001. The department has 17 well-qualified faculty members. The entire faculty holds postgraduate degree specialized in diversified areas of Electrical Engineering like Power Systems, Power Electronics, Control Systems, Electrical Machines, etc. 13 of the faculty members are doctorates from various esteemed institutions like IISc, Bangalore, IIT-Dhanbad, NITK, Surathkal, Vellore Institute of Technology, Vellore, Visvesvaraya Technological University, Belagavi, Pondicherry University, Pondicherry and Jain University, Bengaluru. In addition, the department is actively involved in research, testing and consultancy in the area of high voltage applications under the able guidance of Dr. G. R. Nagabhushana, Formerly Chairman, Dept. of High Voltage Engineering, Indian Institute of Science, Bangalore, and is presently with the department as Professor Emeritus. The main focus of the department is to impart quality technical education to students in UG, PG and Ph.D levels based on OBE. Many technical activities are in place to enhance both technical and communication skills for students and staff.

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 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.

Semester wise Credit Breakdown for B.E Degree Curriculum
Batch 2021-25

Semester / Course Category	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Total Credits
Basic Sciences (BSC)	08	08	03	03	--	--	--	--	22
Engineering Sciences (ESC)	11	09	--	--	--	--	--	--	20
Humanities, Social Sciences and Management (HSMC)	--	02	01	01	03	03	--	--	10
Ability Enhancement Course (AEC)	01	01	01	01	01	--	03	--	08
Universal Human Values (UHV)	--	--	02	--	--	--	--	--	02
Professional Core Courses (PCC)	--	--	11	12	11	05	04	--	43
Integrated Professional Core Course (IPCC)	--	--	03	03	03	--	04	--	13
Professional Elective Courses (PEC)	--	--	--	--	03	06	03	--	12
Institutional Open Elective Courses (IOE)	--	--	--	--	--	03	03	--	06
Internship (INT)	--	--	--	02	--	02	--	05	09
Mini Project / Project Work (PW)	--	--	--	--	--	03	03	09	15
Non Credit Mandatory Courses (NCMC)	--	--	Yes	--	Yes	--	--	--	--
Total Credits	20	20	21	22	21	22	20	14	160

SCHEME OF TEACHING

V SEMESTER

Sl. No.	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours /week
					L	T	P	Total	
1	EE51	Digital Signal Processing	EEE	PCC	2	1	0	3	3
2	EE52	Advanced Industrial Automation	EEE	IPCC	2	0	1	3	4
3	EE53	Power Electronics	EEE	PCC	3	0	0	3	3
4	EE54	Control Systems	EEE	PCC	2	1	0	3	3
5	EEE55x	Program Elective Course – 1	EEE	PEC	3	0	0	3	3
6	EEL56	Power Electronics Lab	EEE	PCC	0	0	1	1	2
7	EEL57	Control Systems Lab	EEE	PCC	0	0	1	1	2
8	AL58	Research Methodology & Intellectual property rights	EEE	HSMC	3	0	0	3	3
9	AEC510	Ability Enhancement Course - V	Any department	AEC	1	0	0	1	1
Total					**17**	**1**	**3**	**21**	**25**
10	HS59	Environmental Studies *		NCMC	0	0	0	0	1

* Environmental Studies is under the category of NCMC, 1 hour teaching per week has to be allocated in the time table.

Elective Code	Department Elective-1
EEE551	Virtual Instrumentation
EEE552	Solar and Wind Energy Systems
EEE553	Data Structures Using C++

Nomenclature: IPCC: Integrated Professional Core Course**, PCC:** Professional Core Course**, HSMC:** Humanity and Social Science & Management Courses**, PEC:** Professional Elective Courses **, AEC–**Ability Enhancement Courses, **NCMC**: Non-credit Mandatory Course

L –Lecture, T – Tutorial, P- Practical/ Drawing

Note: XXE55x, where x=1,2,3,4,5

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with practical of the same course. Credit for IPCC is 03 and its Teaching–Learning hours (L : T : P) can be considered as (2 : 0 : 1). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated only by CIE (no SEE). However, questions from the practical part of IPCC can be included in the SEE question paper.

Professional Elective Courses: A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course out of five courses. The minimum student's strength for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Innovation/ Societal/ Entrepreneurship based Internship: At the End of fourth Semester four - weeks Summer Internship Shall Be Carried Out – Based On industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship. Credited in fifth Semester. All the students admitted shall have to undergo mandatory internship of 04 weeks during the vacation of IV semester. A Viva-Voce examination shall be conducted during VI semester and the prescribed credit shall be included in VI semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent examination after satisfying the internship requirements.

AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):

Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years' degree program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students 8^{th} semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points; 8^{th} semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the 8^{th} semester grade card.

The Non-Credit Mandatory Course The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. In case, any student fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured **'F'** grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

SCHEME OF TEACHING

VI SEMESTER

Sl. No.	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours /week
					L	T	P	Total	
1	AL61	Management & Entrepreneurship	EEE	HSMC	3	0	0	3	3
2	EE62	Power System Engineering-I	EEE	PCC	2	1	0	3	3
3	EEE63x	Program Elective Course – 2	EEE	PEC	3	0	0	3	3
4	EEE64x	Program Elective Course – 3	EEE	PEC	3	0	0	3	3
5	EEL65	Digital Signal Processing Lab	EEE	PCC	0	0	1	1	2
6	EEL66	Building Automation Lab	EEE	PCC	0	0	1	1	2
7	EEOE0x	Institutional Open Elective - 1	EEE	IOE	3	0	0	3	3
8	EEP67	Mini Project	EEE	PW	0	0	3	3	-
9	INT68	Innovation/Societal/ Entrepreneurship based Internship	EEE	INT	0	0	2	2	-
Total					**14**	**1**	**7**	**22**	**19**

Elective Code	Program Elective Course – 2	Elective Code	Program Elective Course – 3
EEE631	Modern Control Theory	EEE641	Nanofabrication and Characteristics
EEE632	Energy Audit	EEE642	Machine Learning
EEE633	Electric Vehicle Technology	EEE643	Fundamentals of Data Communication Networks
EEE634	Digital Image Processing	EEE644	Electromagnetic Compatibility

Nomenclature, PCC: Professional Core Course**, PEC:** Professional Elective Courses, **IOE:** Institutional Open Elective, **PW:** Mini Project, **INT –** Internship

L –Lecture, T – Tutorial, P- Practical/ Drawing

Note: XXE63x , where x=1,2,3,4,5
XXE64x , where x=1,2,3,4,5
XXOE0x*, where x=1,2,..,… continued from previous

L –Lecture, T – Tutorial, P- Practical/ Drawing/ Project work

Professional Elective Courses: A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course out of five courses. The minimum student's strength for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Institutional Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled for the open electives offered by their parent department. However, they can take an elective offered by other departments, provided they satisfy the prerequisite condition, if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an open elective shall not be allowed if,

1. The candidate has studied the same course during the previous semesters of the program.
2. The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.
3. A similar course, under any category, is prescribed in the higher semesters of the program.
4. The minimum students' strength for offering open electives is 10. However, this condition shall not be applicable to cases where the admission to the program is less than 10.

Mini-project work: Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications.

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report,

project presentation skill, and question and answer session as per the rubrics defined by the department.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project. The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill, and question and answer session as per the rubrics defined by the parent department.

SEE component for Mini-Project: SEE will be conducted by the two examiners appointed by the Institute. SEE marks awarded for the mini project shall be based on the evaluation of project work report, project presentation skill and question and answer session.

Research/Industrial Internship - At the end of sixth / seventh semester (in two cycles to accommodate all the students of the) Research/Industrial Internship shall be carried out – Based on Industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship. All the students admitted shall have to undergo mandatory internship of 24 weeks during the vacation of VI/VII semesters. A Viva-Voce examination shall be conducted during VII semester and the prescribed credit shall be included in VII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent examination after satisfying the internship requirements.

Research internship Students have to take up research internship at Centers of Excellence (CoE) / Study Centers established in the same institute and /or out of the institute at reputed research organization / Institutes. Research internship is basically intended to give you the flavor of current research going on in a particular topic/s. The internships serve this purpose. They help students get familiarized with the field, the skill needed the effort amount and kind of effort required for carrying out research in that field.

Industry internships: Is an extended period of work experience undertaken by /Institute students looking to supplement their degree with professional development. The students are allowed to prepare themselves for the workplace and develop practical skills as well as academic ones. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with "unexpected contingencies" helps students recognize, appreciate, and adapt to organization realities by tempering knowledge with practical constraints.

AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):

Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years' degree program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students 8^{th} semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points; 8^{th} semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the 8^{th} semester grade card.

V SEMESTER

DIGITAL SIGNAL PROCESSING	
Course Code: EE51	**Credits: 2:1:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator/s: Sri. Victor George/ Smt. Kusumika Krori Dutta/ Dr. R. Subha	

Course content

Unit I

Introduction: Basic elements of digital signal processing, Advantages, Sampling and Quantization, Definitions of signal and system, Classification of signals, Elementary discrete time signals, Basic operations on discrete time signals, Properties of systems, Impulse response representation of discrete time systems, Linear convolution.

Unit II

Z-Transforms: Introduction to Z-transform, Properties of ROC, Properties of Z transforms (Proof excluded), inversion of Z-transforms by partial fraction method, Introduction to Discrete Time Fourier Transform (only definition).

Discrete Fourier Transform: Definition, Properties (Proof excluded), Circular Convolution, Use of DFT in linear filtering, overlap add and overlap save methods.

Unit III

Fast Fourier Transform Algorithms: Radix2 FFT Algorithm, Decimation in time, Decimation in frequency algorithms, Inverse FFT algorithms

Structure of Digital systems: Direct form I, Direct form II and Cascade structure of IIR Systems, Direct form and Linear Phase structure of FIR systems.

Unit IV

Design of IIR Filters: Introduction to filters, Characteristics and design of analog filters -Butterworth and Chebyshev, design of IIR digital Filter using bilinear transformation technique, applications of IIR filter.

Unit V

Design of FIR Filters: Introduction to FIR filter design using windowing technique, Design of linear phase FIR filters using rectangular, Hamming and Hanning windows, FIR filter design by frequency sampling method, applications of FIR filter.

Text Books

1. John G Proakis and Dimitris G Manolakis, "*Digital Signal Processing–Principles, Algorithms, and Application*", PHI, 3rdEdition, 1996.
2. Sanjit K Mitra, "*Digital Signal Processing using MATLAB*", TMH, 2001.

Reference Books

1. Alan V Oppenheim, Ronald W Schafer and John R Buck, "*Discrete-Time Signal Processing*", PHI, 2nd edition, 2009.
2. Jhonny R. Jhonson, "*Introduction to Digital Signal Processing*", Pearson, 1st Edition, 2016.

Course Outcomes (COs):

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

1. Identify the need for digital signal processing in various engineering problems. (PO-1) (PSO-1)
2. Perform basic operations on elementary signals and identify the properties of a given system and represent Linear Time Invariant (LTI) system using its impulse response. (PO-1) (PSO-1)
3. Apply various transform techniques in the analysis of signals and systems and represent them using block diagrams. (PO-1,2) (PSO-1)
4. Apply fundamental principles, and techniques of the digitalsignal processing to design IIR filters to meet the given specifications. (PO-1,3) (PSO-1)
5. Apply fundamental principles, and techniques of the digitalsignal processing to design FIR filters to meet the given specifications. (PO-1,3) (PSO-1)

Course assessment and evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO4, CO5
Quiz	10	CO1, CO2
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

ADVANCED INDUSTRIAL AUTOMATION	
Course Code: EE52	**Credits: 2:0:1**
Pre – requisites: Nil	**Contact Hours: 28L+14L**
Course Coordinator/s: Smt. Kusumika Krori Dutta/Smt. Mamatha G M	

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

List of Experiments

1. Develop a Ladder logic programming for Logic Gates
2. Develop a ladder program for starting an electrical motor using DOL starter.
3. Development of circuits using Timer and Counter blocks.
4. Simulation and emulation of Traffic Light Control using PLC.
5. Emulation of I/Os using switch and LED boards using PLC.
6. Implementation of PID controller using PLC.
7. Simulation and Emulation of Elevator Control using PLC.
8. Simulation and Emulation of Batch Process using PLC.
9. Simulation and Emulation of Conveyor control using PLC.
10. Simulation and Emulation of Process Control problem

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, PO-5) (PSO-1)
3. Create a PLC project using PLC software and configure the I/O for a PLC project. (PO-1, PO-2, PO-4, PO-5) (PSO-1, PSO3)
4. Design HMI layout. (PO-1, PO-4) (PSO-1)
5. Develop the knowledge of the SCADA system. (PO-1) (PSO-1)

Course assessment and evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO3, CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Lab Test	10	CO1, CO2, CO3, CO4, CO5
Assignment/ Quiz	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

POWER ELECTRONICS	
Course Code: EE53	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator/s: Dr. R. Subha/ Dr. Kodeeswara Kumaran. G	

Course content

Unit I

Devices: Structure, steady statecharacteristics and switching characteristics of Power MOSFET, IGBT and BJT, Static and dynamic characteristics of SCR (only theory) and TRIAC, Snubber circuits (simple numericals).

Unit II

Gate Drive/Triggering Circuits: MOSFET gate drive circuits, BJT base Drive circuits, Isolation of gate and base drives, UJT triggering circuit for thyristor (simple numericals).

DC Choppers: Introduction, Performance parameters, principle of step-up and step-down operation (simple numericals), classification of choppers.

Unit III

Controlled Rectifiers: Introduction, single phase semi converter and single phase full converter with R & RL load (simple numericals), single phase dual converter, (only theory) three phase full converter with RL load (simple numericals).

AC Voltage Controllers: Introduction, performance parameters, single phase and three phase full wave AC voltage controller with R load (simple numericals), single phase cycloconverter (only theory).

Unit IV

Inverters: Introduction, Performance parameters, single phase Full-bridge inverter, three phase inverter - 180 degree conduction (simple numericals), voltage control of single phase inverter - multiple pulse width modulation and sinusoidal pulse width modulation, three phase current source inverter (only theory).

Unit V

WBG Devices: An overview of Wide Band Gap devices, Silicon Carbibe (SiC) and Gallium Nitride (GaN) based semiconductors, Silicon Carbide MOSFETs, BJTs and IGBTs, benefits of WBG devices for power converters, Applications of WBG devices.

Text Books

1. M. H. Rashid, "*Power Electronics: Circuits, Devices and Applications*", FourthEdition, Pearson, 2021.
2. M. D. Singh, Khanchandhani K. B, "*Power Electronics"*, TMH, 2001.

Reference Books

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

Course Outcomes (COs):

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

1. Understand the fundamental principles and characteristics of various power electronic devices in terms of structure, steady-state behavior, and switching dynamics. (PO1) (PSO1).
2. Design and analyze gate drive circuits for semiconductor devices, ensuring efficient switching and isolation. (PO2, PO3) (PSO1).
3. Demonstrate proficiency in the operation and application of DC choppers, controlled rectifiers, AC voltage controllers, and inverters, considering performance parameters and practical constraints. (PO2, PO3) (PSO1).
4. Evaluate the benefits and applications of Wide Band Gap (WBG) semiconductor devices in power converters and related systems, recognizing their advantages in terms of efficiency and power density (PO2, PO3) (PSO1).

Course assessment and evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO3, CO4
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO3
Quiz	10	CO1, CO2
Semester End Examination (SEE)	100	CO1, CO2,CO3,CO4

CONTROL SYSTEMS	
Course Code: EE54	**Credits: 2:1:0**
Pre – requisites: Nil	**Contact Hours: 28L+14T**
Course Coordinator/s: Dr. B. V. Sumangala/ Dr. S. Dawnee	

Course content

Unit I

Modelling of Systems:

Control system, mathematical models of physical systems introduction, differential equations of physical systems, Mechanical systems - Translational systems and 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 signals, unit step response of first and second order systems, time response specifications for second order systems, steady state errors and error constants.

Stability Analysis:

Concept of stability, necessary conditions for stability, Routh-Hurwitz criterion, relative stability. (Numerical only with a max. of 4 numbers of Poles + Zeros)

Unit III

Root Locus Technique:

Introduction, Root locus concepts, construction of root loci. (Numerical only with a max. of 4 numbers of Poles + 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 a max. of 4 numbers of Poles + Zeros), Bode plots (Numerical only with a max. of 4 numbers of Poles + Zeros), Determination of transfer function from Bode magnitude plot, Compensators- RC lag, RC lead, RC lag-lead networks.

Unit V

Controllers:

Introduction to Controllers, Necessity of Controllers, Block diagram representation of feedforward and feedback controller, Effects of Addition of Poles and Zeros in transfer function (With respect to stability),

Introduction to PID Controller: 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 Book:

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, student will be able to:

1. Derive the transfer function and mathematical model for 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, 5) (PSO-1, 2)
3. Analyze the stability of the system using graphical and algebraic techniques. (PO- 1, 2, 5) (PSO-1, 2)
4. Find the frequency domain specifications and identify the need of compensation. (PO- 1, 2, 5) (PSO-1, 2)
5. Understand the need for compensators and different controllers. (PO- 1, 2, 5) (PSO-1)

Course assessment and evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO3, CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO1, CO2,CO3
Simulation	10	CO1, CO2,CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2,CO3, CO4, CO5

POWER ELECTRONICS LAB	
Course Code: EEL56	**Credits: 0:0:1**
Pre – requisites: Nil	**Contact Hours: 14P**
Course Coordinator: Dr. R. Subha/ Dr. Kodeeswara Kumaran. G	

List of experiments:

1. Static characteristics of Power MOSFET
2. Static characteristics of IGBT
3. Static characteristics of SCR
4. SCR firing circuit using synchronized UJT relaxation oscillator
5. Gate drive circuit for MOSFET
6. SCR digital triggering circuit for a single phase controlled rectifier with R load
7. Speed control of DC motor using controlled rectifier
8. Speed control of universal motor using AC voltage controller
9. Design and implementation of DC-DC converter
10. Design and implementation of PWM control for single phase inverter
11. Switching characteristics of WBG devices using simulation tool
12. Simulation of three phase converters and inverters.

Text Books

1. M. H. Rashid, "*Power Electronics: Circuits, Devices and Applications*", Third Edition, Pearson, 2021.
2. Vedam Subrahmanyam, "*Power Electronics*", Revised Second Edition, NewAge 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, 2007.
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 and SCR. (PO 4, 5) (PSO 1, 2)
2. Design, build and test firing circuits / gate driver circuits for power electronic devices. (PO 3, 4) (PSO 1, 2)
3. Design, build and test power electronic converters. (PO 4, 5) (PSO 1, 2)
4. Design and implementation of speed control of motors. (PO 4, 5) (PSO 1, 2)

Course assessment and evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test	20	CO1, CO2, CO3, CO4
Other components		
Record+ Observation	15	CO1, CO2, CO3, CO4
Viva	05	CO1, CO2, CO3, CO4
Assignment	10	CO2,CO3
Semester End Examination (SEE)	50	CO1, CO2, CO3, CO4

CONTROL SYSTEMS LAB	
Course Code: EEL57	**Credits: 0:0:1**
Pre – requisites: Nil	**Contact Hours: 14P**
Course Coordinator/s: Dr. B V Sumangala/ Dr. S Dawnee	

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.
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)

Course assessment and evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test	20	CO1, CO2, CO3, CO4, CO5
Other components		
Record+ Observation	20	CO1, CO2, CO3, CO4, CO5
Quiz	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	50	CO1, CO2, CO3, CO4, CO5

RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	
Course Code: AL58	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. S. Sridhar	

Course Content

Unit I

Research Methodology

Introduction: Meaning of Research, Objectives of Research, Types of Research, Ethics in Research, Types of Research Misconduct.

Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art, Bibliographic Databases, Conceptualizing Research, Critical and Creative Reading.

Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge flow through Citations, Acknowledgments, and Attributions.

Pedagogy: Chalk and Talk, PowerPoint Presentations

Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit II

Research Design: Need for Research Design, Important Concepts Related to Research Design: Dependent and Independent Variables, Extraneous Variable, Variable, Common Control, Confounded Relationship, Research Hypothesis, Experimental and Control Groups, Treatments.

Experimental Designs: Introduction to Randomised Block Design, Complete Randomised Design, Latin Square Design, and Factorial Design.

Pedagogy: Chalk and Talk, PowerPoint Presentations

Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit III

Method of Data Collection: Primary and Secondary Data Collection.

Sampling Design: Sampling fundamentals, Measurement, and Scaling Techniques, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, and Types of Sample Design.

Data Analysis: Testing of Hypotheses: Null Hypothesis, Alternative Hypothesis, Type I and Type II Errors, Level of Significance. Procedure for Hypothesis Testing: Mean, Variance, Proportions. Chi-square Test, Analysis of Variance (One Way ANOVA), and Covariance (ANOCOVA)

Pedagogy: Chalk and Talk, PowerPoint Presentations
Links: https://onlinecourses.nptel.ac.in/noc23_ge36/preview

Unit IV

Intellectual Property Rights

Introduction to IPR: Different forms of IPR, Role of IPR in Research and Development. TRIPS Agreement, Patent Cooperation Treaty (PCT).

Patents: Brief history of Patents-Indian and Global Scenario, Principles Underlying Patent Law, Types of Patent Applications in India, Procedure for Obtaining a Patent. Non Patentable Inventions. Rights Conferred to a Patentee, Basmati Rice Patent Case.

Pedagogy: Chalk and Talk, PowerPoint Presentations
Links: https://archive.nptel.ac.in/courses/110/105/110105139/

Unit V

Design: What is a Design? Essential Requirements for a Registrable Design, Procedure of Registration of a Design,

Trademarks: Essentials of a Trademark, Registration, and Protection of Trademarks, Rights Conferred by Registration of Trademarks, Infringements, Types of Reliefs, Case Studies.

Copyrights: Characteristics of Copyrights, Rights Conferred by Registration of Copyrights, Registration of Copyrights, Infringements, Remedies against Infringement of Copyrights, Case studies

Pedagogy: Chalk and Talk, PowerPoint Presentations
Links: https://archive.nptel.ac.in/courses/110/105/110105139/

Text books:

1. C. R Kothari, Gourav Garg, Research Methodology – Methods and Techniques. New Age International Publishers.
2. Dr. B L Wadehra – Law relating to Intellectual property. Universal Law Publishing Co.
3. Dipankar Deb, Rajeeb Dey, Valentina E. Balas "Engineering Research Methodology", ISSN 1868-4394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13-2946-3 ISBN 978-981-13-2947-0 (eBook), https://doi.org/10.1007/978-981-13-2947-0.

Reference Books:

1. David V. Thiel "Research Methods for Engineers" Cambridge University Press, 978-1-107-03488-4

Course Outcomes (COs):

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

1. Possess the knowledge of research and conduct a literature review**.** (PO-8, PO-10, PO-12)**.**
2. Apply the knowledge of research design and design of experiments. (PO-4, PO-8, PO 10, PO-12).
3. Analyse data collection methods, analysis, and sampling design. (PO-4, PO-8, PO-10, PO-12).
4. Understand the global and Indian scenarios of patents and patent applications. (PO-8, PO-10, PO-12).
5. Acquire the requirements of registration and infringements related to trademarks, copyrights, and designs. (PO-8, PO-10, PO-12)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO1, CO2
Quiz	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

ABILITY ENHANCEMENT COURSE - V	
Course Code: AEC510	**Credits: 1:0:0**
Pre – requisites: Nil	**Contact Hours: 14L**
Course Coordinator: Any Department	

Ability Enhancement Courses (AEC) are the generic skill courses which are basic and needed by all to pursue any career. These courses are designed to help students enhance their skills in communication, language, and personality development. They also promote a deeper understanding of subjects like social sciences and ethics, culture and human behaviour, human rights and the law.

Every student shall register for AEC course under the supervision of his/her proctor. For III, IV & V semester, the student shall select the Ability Enhancement Course online such that the selected course does not overlap with any professional core/ elective course offered by the parent department of the student. After selection, the registration of the course has to be done by the student at his/her parent department.

ENVIRONMENTAL STUDIES	
Course Code: HS59	**Credits: 0:0:0**
Pre – requisites: -	**Contact Hours: 14L**
Course Coordinator: -	

Course Content

Unit I

Environment, Ecology and Biodiversity

Definition, scope, and importance. Multidisciplinary nature of Environmental studies. Food chain and food web. Energy flow and material cycling in the ecosystem. Biodiversity and threats to biodiversity. Concept of sustainable development: Definition, objectives, and applications.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos, Models
- Link: https://youtu.be/I_bnGkviWOU
  https://youtu.be/Ar04qG1P8Es

Unit II

Natural resources

Forest resources: Ecological importance of forests. Water resources: Global water resources distribution. Mineral resources: Environmental effects of extracting and processing Mineral resources. Food resources: Effects of modern agriculture. Land resources: Soil erosion and Desertification.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos
- Link: https://youtu.be/vsXv3anIBSU
  https://youtu.be/1rOVPqaUyv8

Unit III

Energy sources

Growing energy needs. Conventional and non-conventional / Renewable and Non-renewable energy sources. Bio Energy-Ethanol and Bio mass energy. Energy of the future – Hydrogen fuel cells and Nuclear energy. Environmental Impact Assessment (EIA): Definition, Objectives and benefits. Step by step procedure of conducting EIA.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Animations, Models
- Link: https://youtu.be/mh51mAUexK4
  https://youtu.be/XS-eXqppf_w

Unit IV

Environmental pollution

Definition, Causes, Effects and control measures of Water pollution, Air pollution and Soil/ land pollution. Management of Municipal Solid Waste and treatment

methods of municipal solid waste.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos
- Link: https://youtu.be/NRoFvz8Ugeo
  https://youtu.be/DAQapF-F4Vw

Unit V

Environmental protection

Global warming and Climate change, Acid rain, Ozone layer depletion. Salient features of Environmental Protection Act, Air & Water Acts. Functions of Central and State Pollution Control Boards.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos, Open source softwares
- Link: https://youtu.be/iV-BvYwl4Y8
  https://youtu.be/BYqLRGawoH0

Text Books:

1. Dr. S M Prakash – Environmental Studies, Elite Publishers, 2007.

Reference Books:

1. P. Venugopala Rao – Principles of Environmental Science & Engineering Prentice Hall of India, 1st edition, 2006.

Web links and video Lectures (e- Resources):

1. https://youtu.be/I_bnGkviWOU
2. https://youtu.be/vsXv3anIBSU
3. https://youtu.be/mh51mAUexK4
4. https://youtu.be/NRoFvz8Ugeo
5. https://youtu.be/iV-BvYwl4Y8

Course Outcomes (COs):

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

1. Describe the importance of environmental studies, sustainable development and biodiversity (PO-1, 7)
2. Explain the importance and conservation of impacts of natural resources (PO-1, 7)
3. Distinguish the energy sources and identify the alternative energy sources for sustainable development (PO-1, 7)
4. Identify the causes, effects and control measures of pollution in developmental activities (PO-1, 7)
5. Outline the current environmental issues and the role of the agencies for environmental protection (PO-1, 7)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO4, CO5
Average of the two internal test shall be taken for 30 marks		
Other components		
Assignment – MCQ, Objectives	10	CO1, CO2
Assignment – Quiz, Group presentation	10	CO3, CO4
Semester End Examination (SEE)	50	CO1, CO2, CO3, CO4, CO5

VI Semester

MANAGEMENT & ENTREPRENEURSHIP	
Course Code: AL61	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. M Rajesh/ Dr. Siddhartha kar	

Course content

Unit I

Introduction to Management: Definition of Management, Its nature and purpose, Contributions of F.W. Taylor and Henry Fayol to management theory, Functions of managers.

Planning: Types of plans, Steps in planning, the planning process, Management By Objectives (MBO)

Organizing: The nature and purpose of organizing, Formal and informal organization. Organization levels and Span of management, Principle of span of management, the structure and process of organizing

- Pedagogy: Chalk board, power point presentations
- Link: https://onlinecourses.nptel.ac.in/noc23_mg33/preview
  https://www.digimat.in/nptel/courses/video/110107150/L01.html

Unit II

Staffing: Situational factors affecting staffing.

Leading: Human factors in managing, definition of leadership, Ingredients of leadership

Controlling: Basic control process, Critical control points and standards, Control as a feedback system, Feed forward control, Requirements for effective controls.

- Pedagogy: Chalk board, power point presentations
- Link: https://nptel.ac.in/courses/110107150

Unit III

Introduction to Entrepreneurship: The Foundations of Entrepreneurship: What is an Entrepreneurship?, The benefits of Entrepreneurship, The potential drawbacks of Entrepreneurship; Inside the Entrepreneurial Mind: From Ideas to Reality: Creativity, Innovation and Entrepreneurship, Creative Thinking, Barriers to Creativity

- Pedagogy: Chalk board, power point presentations
- Link:https://www.youtube.com/watch?v=Hgj_kRrvbhQ&list=PL7oBzLzHZ1wXW3mtolxV5nIGn48NLKwrb

Unit IV

The Entrepreneurial Journey: Crafting a Business Plan: The benefits of creating a business plan, The elements of a business plan; Forms of Business Ownership and Buying an Existing Business: Sole proprietorships and partnership.

- Pedagogy: Chalk board, power point presentations
- Link:https://www.youtube.com/watch?v=Tzzfd6168jk&list=PLyqSpQzTE6M8EGZbmNUuUM7Vh2GkdbB1R

Unit V

Launching the Business: Franchising and the Entrepreneur: Types of Franchising, The benefits of buying a Franchise; E-Commerce and the Entrepreneur: Factors to consider before launching into E-commerce, Ten Myths of E-Commerce.

- Pedagogy: Chalk board, power point presentations
- Link:https://www.youtube.com/watch?v=5RMqxtMwejM&list=PLyqSpQzTE6M9zMKj_PSm81k9U8NjaVJkR

Textbooks

1. Harold Koontz, H. Weihrich, and A.R. Aryasri, Principles of Management, Tata McGraw-Hill, New Delhi, 2004.
2. Essentials of Entrepreneurship and Small Business Management – Norman Scarborough & Jeffrey Cornwall (Pearson, 2016)

References

1. Innovation & Entrepreneurship – Peter Drucker (Harper, 2006)
2. Entrepreneurship: The Art, Science, and Process for Success – Charles Bamford & Garry Bruton (McGraw-Hill, 2015)
3. Managent and Enterpreneuship-NVR Naidu, T Krishna Rao, I.K. International Publishing House Pvt. Ltd.@ 2008
4. Poornima M Charantimath, Entrepreneurship Development and Small Business Enterprises, Pearson Education, 2006.

Course Outcomes (COs):

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

1. Plan and organize for the manpower in the given type of organization (PO: 6,9,11)
2. Use staffing Leading and controlling function for the given organization. (PO: 6,8,9,10)
3. Understand the fundamentals of entrepreneurship with the goal of fulfilling the requirements of the industries and holding the responsibilities towards the society. (PO-6,7,8)

4. Design a basic business plan by considering case studies and show the involvement of ownership in Business. (PO-3,7,8,11).
5. Start a new small business with the help of E-Commerce and the current available technologies. (PO-5,11)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1,CO2
Internal Test-II	30	CO3,CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO3
Quiz/ Presentation	10	CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

POWER SYSTEM ENGINEERING- I	
Course Code: EE62	**Credits: 2:1:0**
Pre – requisites: Nil	**Contact Hours: 28L+14T**
Course Coordinator: Dr. S. Poornima / Dr. N. Kiran Kumar	

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)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2,CO3
Internal Test-II	30	CO4, CO5, CO6
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO6
Quiz	10	CO3, CO4
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5, CO6

DIGITAL SIGNAL PROCESSING LAB	
Course Code: EEL65	**Credits: 0:0:1**
Pre – requisites: Nil	**Contact Hours: 14P**
Course Coordinator: Dr. Victor George/ Smt. Kusumika Krori Dutta/ Dr. R. Subha	

LIST OF EXPERIMENTS

1. Verification of sampling theorem.
2. Frequency domain analysis using FFT.
3. Linear Convolution of given sequences.
4. Circular Convolution of given sequences.
5. Analysis of an audio signal.
6. Processing of image signal.
7. Generation of PWM signal.
8. Noise reduction in signals.
9. DTMF generation and filtering.
10. Design of FIR filter to meet given specifications.
11. Design of IIR filter to meet given specifications.
12. Implementation of digital filters

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. Analyze a given signal in frequency domain using FFT algorithm. (PO – 2, 6) (PSO-1, 2).
3. Process various signals using a simulation package. (PO – 1,2, 6) (PSO-1, 2).
4. Understand the practical application of digital signal processing. (PO – 6) (PSO-1, 2).
5. Design IIR and FIR filters to meet the given specifications. (PO – 2, 3, 4, 6) (PSO-1, 2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test	20	CO1, CO2, CO3, CO4, CO5
Other components		
Record+ Observation	20	CO1, CO2, CO3, CO4, CO5
Assignment	10	CO5
Semester End Examination (SEE)	50	CO1, CO2, CO3, CO4, CO5

BUILDING AUTOMATION LAB	
Course Code: EEL66	**Credits: 0:0:1**
Pre – requisites: Nil	**Contact Hours: 14P**
Course Coordinator: Smt. Mamatha G M/ Dr. Hemachandra Gudimindla	

List of experiments:

1. Testing of KNX Bus and project creation on ETS platform.
2. Develop an application to program a push button (switch) and a switch actuator.
3. Develop an application to program a push button (switch) and dimming actuator.
4. Develop an application to program a push button (switch) and a blind actuator.
5. Develop an application to program occupancy sensor and switch actuator.
6. Develop an application to configure multi touch Pro (switch) to control switch, dimming and blind actuator.
7. Develop an application to configure multi touch Pro (switch) using scenes to control switch, dimming and blind actuator.
8. Develop a mobile wiser application to control the switch, dimming and blind actuator.
9. Configuration of AI, DI and DO modules in the HVAC BMS system.
10. Configuration of DI and DO modules for the following logic operations.
    a. Switching on Heating when humidity is high.
    b. Open Damper when CO2 level is high.
    c. Switch off the AHU, when fire is activated.
11. Create logic for the AHU operation.
    a. Using Humidity inputs
    b. Using CO2 level
    c. Input from Fire alarm System
    d. Using flow switch
12. Create Graphics for the AHU logic on HVAC system.

Course Outcomes (COs):

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

1. Understand the operation of ETS and BMS operation workstation software. (PO1, PO5) (PSO1, PSO2)
2. Develop a program to control loads of a smart home. (PO1, PO5) (PSO1, PSO2)
3. Develop a program to control loads using mobile wiser application. (PO1, PO5) (PSO1, PSO2)
4. Develop a program to control AHU of HVAC system. (PO1, PO5) (PSO1, PSO2).
5. Create graphics for AHU on BMS workstation. (PO1, PO5) (PSO1, PSO2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test	20	CO1, CO2, CO3, CO4, CO5
Other components		
Record+ Observation	15	CO1, CO2, CO3, CO4, CO5
Viva	05	CO1, CO2, CO3, CO4, CO5
Assignment	10	CO3
Semester End Examination (SEE)	50	CO1, CO2, CO3, CO4, CO5

MINI PROJECT	
Course Code: EEP67	**Credits: 0:0:3**
Pre – requisites: Nil	**Contact Hours: 42P**
Course Coordinator: Dr. Hemachandra Gudimindla	

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. (PO – 1, 2, 3, 4), (PSO– 1)
2. Describe the proposed design method in terms of technical block diagram or flowchart. (PO – 2, 3, 10), (PSO– 2, 3)
3. Implement the proposed design method using appropriate software or/and hardware tools (PO – 2, 3, 4, 5), (PSO– 2, 3).
4. Analyze the complexity at various stages of building project involving multiple hardware or/and software technologies. (PO – 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. (PO – 9, 10), (PSO– 2, 3)

Program Elective Courses- 1

VIRTUAL INSTRUMENTATION	
Course Code: EEE551	**Credits: 0:1:2**
Pre – requisites: Nil	**Contact Hours: 42P**
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)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test	20	CO1, CO2, CO3, CO4, CO5
Other components		
Record	10	CO1, CO2, CO3, CO4, CO5
Capstone Project	20	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	50	CO1, CO2, CO3, CO4, CO5

SOLAR AND WIND ENERGY SYSTEMS	
Course Code: EEE552	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Hemachandra Gudimindla/ Dr. S. Poornima	

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 Scenario 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.

Unit II

Solar Energy-Basic Concepts: Introduction, The Sun as Source of Energy, Extraterrestrial and Terrestrial Radiations, Spectral Power Distribution of Solar Radiation, Depletion of Solar Radiation. Measurement of Solar Radiation, Solar Time, Solar Radiation Geometry, Solar Day Length, Extraterrestrial Radiation on Horizontal Surface and 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. Shobh Nath 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. Describe the significance of renewable energy, and the principles of energy storage devices. (PO-1, PSO-1)
2. Explain 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. Describe the performance of Wind-machines, energy storage, applications of Wind Energy and environmental aspects. (PO-1, PSO-1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2
Internal Test-II	30	CO3, CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO4, CO5
Quiz	10	CO2, CO3
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

DATA STRUCTURES USING C++	
Course Code: EEE553	**Credits: 2:0:1**
Pre – requisites: Nil	**Contact Hours: 28L+14P**
Course Coordinator: Dr. Hemachandra Gudimindla	

Course content

Unit I

Classes and Objects: Introduction to OOPs, Objects as data types, Abstraction, Encapsulation, Constructors, Destructors. Operator Overloading.

Friend Functions: Overloading of unary operators, binary operators, Friend functions.

Unit II

Inheritance and Polymorphism: Inheritance, Types of Inheritances, Derived Class and Base Class, Overriding member functions, Scope resolution, Virtual Functions, Pure Virtual Functions

Stacks: Definition, representation, basic operations of stack (PUSH and POP) and its implementation, Applications of Stack: Conversion from Infix to Postfix, Evaluation of Postfix expression.

Unit III

Queues: Definition, representation, primitive operations of queue and its implementation, Circular queues and Priority queues.

Linked Lists: Representation and implementation of operations (Insertion, Deletion and Search) of Singly, Doubly and Circular Linked Lists. Applications: Implementation of stack and queue using linked lists.

Unit IV

Trees: Basic terminologies of binary trees, Binary tree traversal and its operations, Binary search trees (Inorder, Preorder and Postorder Traversal).

Graphs: Basic concepts, operations (insert and delete vertex, add and delete edge), traverse graph (Depth-first traversal), Graph storage structures (Adjacency matrix)

Unit V

Algorithm analysis: Time and space complexity, Asymptotic analysis, Worst case and average case analysis

Algorithm design: Divide-and-conquer (Quick sort, Merge sort, searching and binary

search), Greedy (Dijkstra's shortest path algorithm), Dynamic Programming (insertion sort)

Text Books:

1. D.S.Malik, "Data Structures using C++", Indian Edition, Cengage Learning, 2003
2. Robert Lafore, "Introduction to OOPs with C++", 4th Edition, Sams Publishing, 2001
3. E. Balaguruswamy, "Object Oriented Programming with C++", Tata McGraw Hill,4th Edition, 2011

Reference Books:

1. Sourav Sahay, "Object Oriented Programming Using C++", 2nd Edition, Oxford University Press, 2013.

List of experiments

1. Write a C++ Program to understand the concept of classes and objects in C++ and how to use them to create basic data structures.
2. Write a C++ Program to demonstrate Operator Overloading and Friend Functions
3. Write a C++ Program to demonstrate Inheritance and Polymorphism
4. Write a C++ Program to implement a stack data structure.
5. Write a C++ Program to convert infix expressions to postfix notation, followed by evaluating the postfix expression of a stack data structure.
6. Write a C++ Program to implement a queue data structure in C++ and extend it to create a circular queue
7. Write a C++ Program to implement basic operations (Insertion, Deletion, and Search) for Singly, Doubly, and Circular Linked Lists.
8. Write a C++ Program to implement traversal operations (Inorder, Preorder, and Postorder) in binary search trees (BSTs)
9. Write a C++ Program to sort an array of elements using merge sort. Use divide and conquer approach.
10. Write a C++ Program to search for an element in an array using binary search technique.
11. Write a C++ Program to sort array of elements by applying Dynamic programming concept to insertion sort.
12. Using Greedy Technique identify the shortest path in a given network using Dijkstra's shortest path algorithm.

Course Outcomes (COs):

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

1. Demonstrate proficiency in Object-Oriented Programming (OOP) principles by utilizing classes and objects, operator overloading, friend functions, inheritance, and polymorphism.
2. Understand the data structures and their applications, particularly in the context of Stacks, Queues, and Linked Lists.
3. Implement the concept of binary search trees and the various traversal methods (Inorder, Preorder, and Postorder) and graphs, including graph operations like vertex insertion and deletion, edge addition and deletion, and depth-first traversal.
4. Excel in algorithm analysis and design, proficiently analyzing algorithm efficiency, and implementing key paradigms such as divide-and-conquer, greedy algorithms, and dynamic programming.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2
Internal Test-II	30	CO3, CO4
Average of the two internal test will be taken for 30 marks		
Other components		
Lab test	10	CO1, CO2, CO3, CO4
Observation and Viva	10	CO1, CO2, CO3, CO4
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4

Program Elective Course- 2

MODERN CONTROL THEORY	
Course Code: EEE631	**Credits: 3:0:0**
Pre – requisites: Control Systems	**Contact Hours: 42L**
Course Coordinator: Dr. B V Sumangala/Dr. S. Dawnee	

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 improvements 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 K_e. Determination of value of K_e 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.

Lyapunov Stability Analysis: Lyapunov Function, direct method of Lyapunov for linear systems, construction of Lyapunov Functions for non-linear systems 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 electro-mechanical systems. (PO 1, 2) (PSO - 1)
2. Solve the state equations by different methods. (PO 1, 2, 3) (PSO – 1, 2)
3. Analyze and predict the controllability and observability of any system. (PO 1, 2, 3) (PSO – 1, 2)
4. Design controller and observer for any given system. (PO 1, 2, 3) (PSO – 1, 2)
5. Evaluate the stability of nonlinear systems. (PO 1, 2, 3) (PSO - 1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO3, CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO1, CO2, CO3
Simulation	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

ENERGY AUDIT	
Course Code: EEE632	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Sridhar. S/Dr. Binshati Chatterjee	

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 Book

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)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2
Internal Test-II	30	CO3, CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Quiz	10	CO1
Assignment	10	CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

ELECTRIC VEHICLE TECHNOLOGY	
Course Code: EEE633	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Kodeeswara Kumaran G	

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 Books

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. (PO1)(PSO1)
2. Familiarize with Battery Modelling & Management Systems (PO1,2)(PSO1)
3. Explain the fundamentals of EV charging (PO1)(PSO1)
4. Select semiconductors that can be used in EV power converters (PO1)(PSO1)
5. Recognize different aspects of Electrical machines and power electronic devices used in EV. (PO1)(PSO1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO1, CO2, CO3
Term Paper	10	CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

DIGITAL IMAGE PROCESSING	
Course Code: EEE634	**Credits: 2:0:1**
Pre – requisites: Nil	**Contact Hours: 28L+14T**
Course Coordinator: Smt. Kusumika Krori Dutta	

Course content

Unit I

Digital Image Fundamentals:

What is Image Processing? Fundamental steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic relationships between Pixels.

Unit II

Image Enhancement in Spatial Domain:

Image Enhancement in Spatial Domain, some basic Gray level transformations, Histogram processing, Enhancement using arithmetic/logic operations.

Unit III

Spatial Domain Filtering:

Basics of Spatial filtering, smoothing spatial filters, Sharpening spatial filters.

Frequency domain Filtering:

Image Enhancement in frequency domain, smoothing frequency domain filters, Sharpening frequency domain filters. Constrained least squares filtering, Geometric mean filter.

Unit IV

Image Segmentation:

Detection of discontinuities, edge linking and boundary detection, Thresholding region based segmentation. Segmentation using morphological watersheds, Some basic morphological algorithms.

Unit V

Image Transforms:

Two-dimensional orthogonal & unitary transforms, properties of unitary transforms, two dimensional discrete Fourier transform, Discrete cosine transform, Sine transform, Hadamard transform, Haar transform, KL transform.

Lab Experiments:

1. Basic concepts of Images: Read and display, information about the image.
2. Image display: Basics, bit planes, quantization and dithering.
3. Point processing: Arithmetic operation, image negative.
4. Filtering, create filters, high and low pass filters.
5. Image geometry: Scaling smaller, rotation.
6. The Fourier transform: two dimensional DFT.
7. Image segmentation: thresholding, edge detection.
8. Canny edge detection, second derivatives.

Text Book:

1. Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", Pearson Education, I Ed, 2001, ISBN-13:9780131687288

Reference Book:

1. Anil K. Jain, "*Fundamentals of Digital Image Processing*", Pearson Education, PHI, 2001, ISBN-13:9780133361650

Course Outcomes (COs):

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

1. Describe the processes of Image acquisition and Image Processing. (PO-1) (PSO-2)
2. Extract the information from the image through spatial domain enhancement methods. (PO-1, 2) (PSO-2)
3. Enhance the image quality through different filtering and restoration techniques. (PO-2 ,5) (PSO-2)
4. Extract the information from the image through segmentation methods. (PO-2,5) (PSO-2)
5. Apply and analyse different types of Image transforms on conversion of spatial domain to frequency domain and vice versa. (PO-2) (PSO-2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO3, CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Lab test	10	CO1, CO2, CO3, CO4, CO5
Presentation	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

Program Elective Course- 3

NANOFABRICATION AND CHARACTERIZATION	
Course Code: EEE641	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. 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)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2
Internal Test-II	30	CO3, CO4
Average of the two internal test will be taken for 30 marks		
Other components		
Simulation/ Class Assignment	20	CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

MACHINE LEARNING	
Course Code: EEE642	**Credits: 2:1:0**
Pre – requisites: Nil	**Contact Hours: 28L+14T**
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. (PO1) (PSO1)
2. Understand and apply dimensionality reduction method. (PO1,2)(PSO1)
3. Analyze different classifiers. (PO2) (PSO1)
4. Evaluate Bayesian learning algorithm. (PO1,2) (PSO1)
5. Understand and apply neural network based models. (PO1,2) (PSO1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO3, CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO1, CO2, CO3, CO4, CO5
Term Paper	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

FUNDAMENTALS OF DATA COMMUNICATION NETWORKS	
Course Code: EEE643	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Victor George	

Course content

Unit I

Overview of Data Communication Networks: Data Communication Network Model, classification, Transmission method, Network Topology, Transmission medium, Techniques for data transfer, network access and media sharing, OSI protocol reference model, Internet architecture

Physical Layer: Classification of signals, Fourier analysis, Filters, Line coding, Modulation, Sampling theorem, Analog to Digital conversion, Basic Digital Modulation Schemes, Media Sharing Schemes, Modems, Transmission media, Channel impairments

Unit II

Data Link Layer Protocols: Framing, Bit stuffing, Flow control, Error control, Error detection, Error control protocols, Data link control protocols

Multiple Access Schemes: Multiplexing schemes, Orthogonal access schemes, Controlled access schemes, Random access schemes

Unit III

Local Area Networks: Ethernet topologies, LAN switching, Frame forwarding methods, Virtual LANs, Wireless LANs, Token ring network

Network Layer Part I – IP Addressing: IP address, Maximum Transmission Unit, IP Version 4 Addressing, IP Subnetting, Variable Length Subnet Mask Networks, Address Resolution Protocol

Unit IV

Network Layer Part II – Routing: Routing Principle, Routing Algorithms, Routing Metrics, Flooding Algorithm

Transport Layer – TCP and UDP: How TCP Works, TCP Flow Control, UDP, Stream Control Transmission Protocol (SCTP), Datagram Congestion Control Protocol (DCCP)

Unit V

Application Layer Services: Dynamic Host Configuration Protocol, Domain Name System

Introduction to Mobile Communication Networks: Radio Communication Basics, Introduction to Cellular Communication, Introduction to Mobile Cellular Networks, Introduction to the GSM Network

Introduction to Network Security: Data Encryption Terminology, Cryptographic Systems, Digital Signatures

Text book:

1. Fundamentals of Data Communication Networks, Wiley, **2018, Oliver C. Ibe,**

Reference Book:

1. Data Communication and Networking, Behrouz A Forouzan, MGH Higher Education, 4th Edition, 2007

Course Outcomes (COs):

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

1. Identify various aspects of physical layer of communication network.
2. Determine the necessity of various data link layer protocols
3. Identify various aspects of network layer of communication network
4. Determine the role of transport layer in the IoT communication
5. Identify various aspects of application layer and mobile communication network.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO3, CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO1, CO2, CO3, CO4, CO5
Quiz	10	CO1, CO2
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

ELECTROMAGNETIC COMPATIBILITY	
Course Code: EEE644	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Smt. Mamatha G M	

Course content

Unit I

Electrostatic field, their control & Estimation: Electric field intensity, Electric strength, classification of electric fields, Degree of uniformity of electric fields, control of electric filed intensity, estimation of electric field intensity, Basic Equation for potential and field intensity in electrostatic fields, Analysis of electrostatic fields in homogeneous single dielectric medium.

Sources: EMC regulation, typical noise path and use of network theory, Method of noise coupling, miscellaneous noise sources and methods of eliminating interference.

Unit II

Cabling: Capacitive coupling, effect of shield on magnetic coupling, mutual inductance effect, agnatic filed between shield & inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, Shield transfer impedance, Coaxial cable vs shielded twisted pair cables.

Digital circuit radiation: Differential radiation, Common mode radiation, controlling techniques for Differential & common mode radiation, EMC testing procedures.

Unit III

Shielding: Near& Far fields, Characteristics& Wave impedance shielding effectiveness, Absorption loss, Reflection loss, composite absorption& reflection loss, Shielding with magnetic materials, effects of apertures, conductive windows, coatings, cavity resonance.

Intrinsic noise sources: Thermal noise, contact noise, shot noise & popcorn noise, Measuring random noise, Noise factor, Measurement of noise factor. Digital circuit Noise & layout, Power Distribution noise.

Unit IV

Electrostatic Discharge: Static generation, human body mode, Static discharge and ESD protection in equipment design, Software & ESD protection, ESD vs EMC.

Contact Protection: Glow discharge, Arc Discharge, Loads with high inrush currents, contact protection fundamentals Contact protection networks for inductive loads and resistive loads.

Unit V

Balancing & filters: Balancing, Power supply decoupling, Decoupling filters, High frequency decoupling, System bandwidth, Modulation and coding.

Grounding: safety grounds, Signal grounds, Single point ground systems, multipoint ground systems, Functional ground layout, Hardware grounds, ground loops, Grounding of cable shields, Guard shields, Guard meters.

EMC applications: RF& Transient Immunity, PCB layout & stack up

Text books:

1. Henry W. Ott., "*Electromagnetic Compatibility Engineering",* Revised Edition, John Wiley 2009.
2. Ravindra Arora, "*High Voltage insulation engineering"*, New age International Publication 1995.

Reference books:

1. Henry ott., "*Noise reduction techniques in electronic systems",*2nd Edition, John Wiley 1988.

Course Outcomes (COs):

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

1. Interpret on Estimation and Control of Electric Field Intensity. (PO 1, 2, 8, 10) (PSO 1, 2, 3)
2. Analyze the factors affecting EMC. (PO 1, 5, 6, 7, 10) (PSO 1, 2, 3)
3. Design a Cabling and Filtering network for various circuits to mitigate EMC issues. (PO 1, 2, 3, 4, 5, 8, 10) (PSO 1, 2, 3)
4. Recognize Shielding and methods of Grounding for different EMC applications. (PO 1, 2, 3, 4, 5, 8, 10) (PSO 1, 2, 3)
5. Justify the need of protection of equipments against ESD. (PO 1, 5, 6, 7, 10) (PSO 1, 2, 3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2, CO3
Internal Test-II	30	CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO3, CO4
Quiz/ Presentation	10	CO2
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

Open Elective

WIND ENERGY AND DESIGN ASPECTS	
Course Code: EEOE04	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Sridhar. S	

Course content

Unit I

Wind resources Assessment: Introduction, estimation of power production, evaluation of sites, wind data for prospective sites, feasibility study, micro- siting of wind power plants, visual impact, pitfalls.

Components of wind power plants: rotor, Nacelle, Towers, Electric Substation, Tower foundations.

Types of wind power plants: Types of axis, stand – alone and grid connected WPPs, upwind and downwind WPPs, blade count, power ratings of WPPs, aerodynamic power regulation method, types of electrical generators in WPPs, constant speed and variable speed WPPs, geared, direct drive and semi-geared/ hybrid WPPs, WPP with single gearbox and multiple generators.

Unit II

Specifications of wind power plants: General data, rotor, hub, lightning protection, pitching system, breaking system, drive train, electrical generator, electrical system, electronic controller, yaw system, nacelle, tower, specific power of WPP, standards and specifications.

Choice of wind turbines: Wind turbines options, size of wind turbines, types of wind turbines, wind turbines tailored to wind climate, nominal power vs rotor diameter, IEC wind classes, configuration, grid compatibility, suppliers.

Working of wind power plants: physical principle of modern wind turbine, wind turbine rotor blade characteristics, hub and main shaft functions, working of geared WPP, working principle of direct drive WPP, semi-geared/ hybrid WPP working principle, breaking of WPP, yawing, cable untwisting, electric substation and grid

Unit III

Grid integration of wind power plants: Introduction, functions of an electric power system, functional requirements of WPPs in an electric grid, embedded generation, types of WPP and wind farm grid connections, integration issues, operational issues,

siting WPPs for effective grid integration, grid integration issues in India, challenges for grid integration, wind power integration standards, supergrid strategy.

Wind power and environment: Introduction, impact of wind power on environment, benefit of wind power for environment, land demand, local impacts, visual impact on the landscape,

Unit IV

Wind power policy: Introduction, permission inquiry, conflicting interests, permission process, wind power politics, wind power on the power market, support schemes for renewable energy, evaluation, independent power producers, competition on equal terms, energy subsidies, policy recommendations.

Wind power planning: Introduction, targets for wind power development, areas of national interest, positive planning, regional and municipal planning, planning tools, secondary generation planning, planning methods.

Unit V

Operation and maintenance issues of wind power plants: Introduction, availability of WPPs, general WPP maintenance, unscheduled maintenance, unscheduled maintenance levels, scheduled maintenance, tower maintenance, SCADA for WPP applications, condition monitoring systems, WPP maintenance costs, warranty and insurance.

Text books

1. Joshua Earnest, Tore Wizelius "*Wind Power Plants and Project Development*", PHI Learning Private Limited, 2011.
2. G. D. Rai, "*Non-Conventional Energy Sources*", Khanna Publications.

Reference Books

1. Bibek Samantaray & Kaushik Patnaik, "*A study of wind energy potential in India*", 2010.
2. "Ministry of New and Renewable Energy (MNRE)", Developmental Impacts and Sustainable Governance Aspects of Renewable Energy Projects, September 2013.
3. Dr. Gray. L. Johhanson, "*Wind Energy Systems*", 2001.
4. B. H. Khan, "*Non-Conventional Energy Sources*", TMH, 3rd edition.

Course Outcomes (COs):

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

1. Understand the basics of wind energy, components and types of wind power plants. (PO-1) (PSO-1)
2. Understand the choice of wind turbine and working of wind power plant. (PO-1) (PSO-1)
3. Understand the grid integration of wind power plant and impact of wind power on environment. (PO-1) (PSO-1)
4. Understand the policy and planning of wind power plants. (PO-1) (PSO-1)
5. Understand the operation and maintenance issues of wind power plant. (PO-1) (PSO-1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2
Internal Test-II	30	CO3, CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO1, CO2, CO3, CO4, CO5
Mini project/ Presentation	10	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

MATERIALS AND SENSORS FOR ELECTRICAL APPLICATIONS	
Course Code: EEOE06	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Pradipkumar Dixit	

Course content

Unit I

Introduction to Electrical and Electronics Materials: Importance of materials, Classification of electrical and electronic materials, Scope of electrical and electronic materials, Requirement of Engineering materials, Operational requirements of electrical and electronic materials, Classification of solids on the basis of energy gap, Products – working principle and materials, Types of engineering materials, Levels of material structure. Spintronic and Spintronic materials, Ferromagnetic semiconductors, Left handed materials.

Conductors: Conductor materials, Factors affecting conductivity, Thermal conductivity, Heating effect of current, Thermoelectric effect.

Unit II

Conductive Materials and Applications: Mechanically processed forms of electrical materials, Types of conducting materials, Low resistivity materials, High resistivity materials, Contact materials, Fusible materials, Filament materials, Carbon as filamentary and brush material, Material for conductors, cables, wires, solder, sheathing and sealing.

Dielectrics: Introduction to dielectric materials, classification of dielectric materials, Dielectric constant, Dielectric strength and Dielectric loss. Polarization, Mechanisms of polarization, Comparison of different polarization process, Factors affecting polarization, Spontaneous polarization, Behaviour of polarization under impulse and frequency switching, Decay and build-up of polarization under ac field, Complex dielectric constant

Unit III

Insulating Materials: Insulating materials and applications – Ceramic, Mica, Porcelain, Glass, Micanite and Glass bonded mica. Polymeric materials – Bakelite, Polyethylene. Natural and synthetic rubber. Paper. Choice of solid insulating material for different applications, Liquid insulating materials – Requirements, Transformer oil, Bubble theory, Aging of mineral insulating oils. Gaseous insulating Materials – Air, Nitrogen, Vacuum.

Magnetic Materials: Origin of permanent magnetic dipole, Magnetic terminology, Relation between relative permeability and magnetic susceptibility. Classification of magnetic materials, Diamagnetic, Paramagnetism, Ferromagnetism, Antiferromagnetic and the corresponding materials. Ferrimagnetism and ferrites – properties and applications, Soft and hard ferrites. Curie temperature, Laws of magnetic materials. Magnetization curve, Initial and maximum permeability. Hysteresis loop and loss, Eddy current loss. Types of magnetic materials, Soft and hard magnetic materials, High energy magnetic materials, Commercial grade soft and hard magnetic materials.

Unit IV

Introduction to Nano materials for electrical applications: Historical background, Classification of Nanomaterials, Dielectrics and Nano dielectrics, Nano fluids development, Nano tech electrical applications.

Equipment for characterisation of materials: Use of each equipment with example Fourier Transform Infrared Spectroscopy, Scanning Electron Microscopy, Dynamic light scattering, Temperature gravimetric Analysis, X-ray diffraction, Impedance analyser, Dilatometer, Surface roughness tester, Thermal conductivity tester. Contact angle meter

Unit V

Introduction to sensors for electrical applications: General properties of sensors, Voltage and Current sensors, Electric field sensors, Temperature sensors- Contact and non-contact type, Position sensor, Speed sensors.

Text Book:

1. Advanced Electrical and Electronics Materials; Processes and Applications by K M Gupta and Nishu Gupta, First edition, Wiley Publisher,2015

Reference Books:

1. Electrical Engineering Materials by A J Dekker, Pearson Publisher,2016
2. Introduction to Sensors for Electrical and Mechanical Engineering by Martin Novak, First edition, CRC Press,2020
3. Handbook of Material Characterization, Springer, 2018
4. An Introduction to Electrical Engineering Materials by C S Indulkur and Thiruvengadam S 6th revised edition, 2011
5. Emerging Nanotechnology Applications in Electrical Engineering by Ahmed Thabet Mohamed · IGI Global, 2021

Course Outcomes (COs):

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

1. Classify Materials for electrical applications (PO-1, PSO-1)
2. Apprehend conductive materials and dielectrics for electrical applications (PO-1,PSO-1)
3. Recognize the need of insulating and magnetic materials in various electrical applications (PO-1, 6, PSO-1)
4. Assimilate the role of Nano-materials and Equipment for characterization (PO-1, PSO-1)
5. Recognize type of sensor for given application (PO-1,6, PSO-1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes attained**
Internal Test-I	30	CO1, CO2
Internal Test-II	30	CO3, CO4, CO5
Average of the two internal test will be taken for 30 marks		
Other components		
Assignment	10	CO1, CO2, CO3
Quiz	10	CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

INNOVATION/SOCIETAL/ENTREPRENEURSHIP BASED INTERNSHIP	
Course Code: INT68	**Credits: 0:0:2**
Pre – requisites: Nil	**Contact Hours: -**
Course Coordinator: Dr. S Poornima	

Course content

Students are required to carry out training in an industry or research organization or with a start-up firm for not less than four weeks after 4th or during 5th semester. The internship addresses innovation/societal contributions or should evolve a student's entrepreneurial skill sets. Students are required to submit a report on the same in the format provided by the evaluation committee at the department. The students will be evaluated by the committee based on the rubrics.

Course Outcomes (COs):

On successful completion of this course, students will be able to

1. Understand the functioning of the industry process, gain knowledge on the recent developments in the area, and integrate the theoretical knowledge with practical processes. (PO-2,4,7,11,12)
2. Enhance the communication skills to work in interdisciplinary teams in industry. (PO-9, 10)
3. Realize the professional and ethical responsibility. (PO-6, 7, 8)

Note: Department has to show PSO mapping in the lesson plan.