College of Engineering, Pune
(An Autonomous Institute of Govt. of Maharashtra, Permanently Affiliated to S.P. Pune University)

Department of Electrical Engineering

Curriculum Structure & Detailed Syllabus (UG Program)
Third Year B. Tech.

(Effective from: A.Y. 2021-22)

Program Educational Objectives (PEOs)

After the completion of the program

I. Student will be employable in the diversified sectors of the industry, government organizations, public sector and research organizations.

II. Student will pursue higher education in electrical engineering or other fields of their interests, at institutes of repute and high ranking.

III. Student will demonstrate effective communication, life long learning ability, integrity, team work, leadership qualities, concern to environment and commitment to safety, health, legal and cultural issues in the fields they choose to pursue.

Program Outcomes (POs):

Engineering Graduate will be able to:

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

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

PO3: Design/Development Solution: Design solution for complex engineering problems and design system component or process that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, social and environmental conditions.

PO4: Conduct Investigation of Complex Problem: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusion.

PO5: Method, Tool Usage: Create, select and apply appropriately technique, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with understanding the limitation.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to access societal health, safety, legal and cultural and consequent responsibility relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solution in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principle and commitment to professional ethics and responsibilities and norms of the engineering practices.

PO9: Individual and Team Work: Function effectively as an individual, and as themember or leader in diverse team and multidisciplinary setting.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, and being able to comprehend and write effective reports and design documentation and effective presentation and give and receive clear instructions.

PO11: Project management and Finance: Demonstrate knowledge & understanding of the engineering and management principles and apply these to ones work, as the member and the leader in a team to manage projects and in multidisciplinary environment.

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

Program Specific Outcome for Undergraduate (PSOs):

PSO1: To design and develop power electronics hardware and its control to cater the needsof industry Such as electric vehicles, renewable interconnections, smart grid and micro-grid.

PSO2: To analyse and solve the problems related to smart grid using modern techniques and tools.

PSO3: To design, simulate, and make prototype of special purpose machines for enhancing the Performance.

Correlation between the PEOs and the POs

PO/PSO → PEO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
I	M	M	M	M	M	H	H	H	H	H	H	H	H	H	H
II	H	H	H	H	H	M	M	H	M	M	M	H	M	M	M
III	M	M	M	M	M	H	H	H	H	H	H	H	H	H	H

List of Abbreviations

Sr. No.	Abbreviation	Stands for:
1	BSC	Basic Science Course
2	SBC	Skill Based Course
3	IFC	Interdepartmental Foundation Course
4	PCC	Program Core Course
5	LC	Laboratory Course
6	HSMC	Humanities Science and Management Courses
7	MLC	Mandatory Learning Course
8	LLC	Liberal Learning Course
9	IOC	Interdisciplinary Open Course

CURRICULUM STRUCTURE OF T. Y. B. TECH. (Electrical Engineering)

(Effective from A. Y. 2021-2022)

Semester I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC	MA-21001	Probability and Statistics for Engineers	2	1	0	3
2	MLC	ML-21001	Constitution of India	1	0	0	0
3	HSMC	HS-21001	Entrepreneurship Principles and Process	1	0	0	1
4	HSMC	AS(HS)-21001 AS(HS)-21002 AS(HS)-21003 AS(HS)-21004	Humanity and Social Sciences Open Course - I • English Proficiency Language • German Language • Japanese Language • Spanish Language	2	0	0	2
5	SBC	EE-21008	Microcontroller Laboratory	0	0	2	1
6	IFC	CT(IF)-21003	Fundamentals of Operating Systems	2	0	0	2
7	PCC	EE-21001	Signal Processing	3	0	0	3
8	PCC	EE-21002	Microcontrollers	3	0	0	3
9	PCC	EE-21003	Synchronous Machines	3	1	0	4
10	PCC	EE-21004	Power System Analysis	3	0	0	3
11	LC	EE-21005	Signal Processing Laboratory	0	0	2	1
12	LC	EE-21006	Synchronous Machines Laboratory	0	0	2	1
13	LC	EE-21007	Power System Analysis Laboratory	0	0	2	1
Total				**20**	**2**	**08**	**25**
Total Academic Engagement and Credits				**30**			**25**

Semester II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	MLC	ML-21002	Environmental Studies	1	0	0	0
2	HSMC	AS(HS)-21005 AS(HS)-21006 AS(HS)-21007 AS(HS)-21008	Humanities and Social Sciences Open Course - II • Industrial Psychology • Personnel Engineering • Engineering Economics • Finance for Engineers	2	0	0	2
3	SBC	EE-21009	Mini Project	0	0	4	2
4	IOC	IOC-21006	Wind Energy Systems	2	0	0	2
5	DEC	EE(DE)-21001 EE(DE)-21002 EE(DE)-21003 EE(DE)-21004 EE(DE)-21005 EE(DE)-21006	Department Elective I: Embedded Systems Wind and Solar Energy Industrial Electrical Systems Mechatronics Utilization of Electrical Energy Restructured Power Systems	3	0	0	3
6	PCC	EE-21010	Control System Engineering	3	1	0	4
7	PCC	EE-21011	Power System Operation and Control	3	0	0	3
8	PCC	EE-21012	Power Electronics	3	1	0	4
9	LC	EE-21013	Control System Engineering Laboratory	0	0	2	1
10	LC	EE-21014	Power Electronics Laboratory	0	0	2	1
11	LC	EE-21015	Machine Learning Laboratory	0	0	2	1
Total				**17**	**2**	**10**	**23**
Total Academic Engagement and Credits				**29**			**23**

Minor Courses:

Sr. No.	Semester	Course Code	Electrical Minor Course	Course Code	Renewable Minor Course	Lectures	Credits
1	V	EE(MI)-21001	Electrical Circuit Analysis and Automatic Control Systems	EE(MI)-21004	Solar Energy Systems	3	3
2	VI	EE(MI)-21003	Machines and Drives	EE(MI)-21005	Wind Energy Systems	3	3

Honors Courses:

Sr. No.	Semester	Course Code	Honors Course	Lectures	Credits
1	V	EE(HO)-21001	Engineering Optimization	3	3
2	VI	EE(HO)-21002	Embedded System Design	3	3

Semester-I

MA-21001 Probability and Statistics for Engineers

Teaching Scheme
Lectures: 2 hrs/week
Tutorial: 1 hr/week

Examination Scheme:
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End Sem. Exam: 60 marks

Course Outcomes:

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

1. demonstrate number of methods of summarizing and visualizing data sets, evaluate probabilities of events.
2. make use of concepts of random variables and associated probability distributions to solve problems, illustrate the central limit theorem.
3. test for basic statistical inference (t-test, z-test, F-test, χ2–test, confidence interval, non parametric tests].
4. explain basic principles of regression analysis and perform the same.
5. demonstrate use of R software for all the above.

Unit 1: **[5 Hrs]**

Descriptive statistics: Measures of location and variation. Visualization of data: Frequency tables, bar diagrams, histograms, heat maps, other visualization tools.
Review on introduction to combinatorics and probability theory.

Unit 2: **[5 Hrs]**

Some of the basic probability distributions: Binomial, Poisson, Exponential, and Normal. Central limit theorem.

Unit 3: **[4 Hrs]**

Introduction to 'R': Introductory R language fundamentals and basic syntax, major R data structures, Using R to perform data analysis, creating visualizations using R.

Unit 4: **[6 Hrs]**

Basic statistical inference and hypothesis testing: Estimation, basic tests such as t-test, z-test, F-test, χ^2 –test, Non parametric tests: Sign test, Wilcoxon signed rank test.

Unit 5: **[4 Hrs]**

Regression methods: Simple linear regression and multiple regression.

Unit 6: **[4 Hrs]**

Engineering applications of statistics (Branch Specific (any 2)): Discussion on reliability and quality control. Introduction to random processes, stochastic processes, Markov chains. Machine learning and data science.

Text Books:

- Ronald E, Walpole, Sharon L. Myers, Keying Ye, "Probability and Statistics for Engineers and Scientists", (8th Edition), Pearson Prentice Hall, 2007.
- Tilman M. Davies, "The book of R: A first course in Programming and Statistics", (1st Edition), No Starch Press, USA, 2016.

Reference Books:

- Ross S.M., "Introduction to probability and statistics for Engineers and Scientists", (8th Edition), Elsevier Academic press, 2014.
- S. P. Gupta, "Statistical Methods", S. Chand & Sons, 37th revised edition, 2008.
- Kishor S. Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Applications", (2nd Edition), Wiley Student edition, 2008.
- Stephens L.J., "Schaum's outline of statistics for Engineers", Latest edition, 2019.
- Manish Sharma and Amit Gupta, "The practice of Business Statistics", Khanna Publishing Company Private Limited, New Delhi, 2014.

References for R Software:

- Norman Matloff, "The Art of R Programming - A Tour of Statistical Software Design", (1st Edition), No Starch Press, USA, 2011.
- Sudha Purohit, Sharad Gore, Shailaja Deshmukh, "Statistics using R", (2nd Edition), Narosa Publications, 2019.
- Randall Pruim, "Foundations and Applications of Statistics - An introduction using R", (2nd Edition), American Mathematical Society, 2018.
- Hadley Wickham and Garrett Grolemund, "For Data Science: Import, Tidy, Transform, Visualize and Model Data", (1st Edition), O'Reilly Publications, 2017.

ML–21001 Constitution of India

Teaching Scheme:
Lectures: 1hr/week

Examination Scheme:
Test 1: 20 marks
Test 2: 20 marks
End Sem. Exam: 60 Marks

Course Outcomes:

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

1. interpret the Preamble and know the basics of governance of our nation.
2. identify the different aspects covered under the different important Articles.
3. apprehend the basic law, its interpretation and the important amendments.
4. understand our Union and State Executive better.
5. recognize the basic that along with enjoying the rights one needs to fulfill one's duties.
6. summarize and Gain confidence on our Constitution by knowing it better.

Unit 1 **[5 Hrs]**

Understanding the concept "Rule of Law".
Meaning and history of Constitution.
Introduction to The Constitution of India, understanding its objects.
Preamble to the constitution of India.

Unit 2 **[4 Hrs]**

Understanding the concept of Human Rights and Fundamental Rights.
Fundamental rights under Part – III, exercise of the Rights, limitations and important cases.
Prerogative Writs.
Fundamental duties & their significance.

Unit 3 **[4 Hrs]**

Relevance of Directive principles of State Policy.
Legislative, Executive & Judiciary (Union and State).
Constitutional Provisions for Scheduled Castes, Scheduled Tribes, & Backward classes.
Constitutional Provisions for Women & Children.

Unit 4 **[2 Hrs]**

Emergency Provisions.
Electoral procedure in India.
Amendment procedure and few important Constitutional Amendments.

Textbooks:

- Durga Das Basu , "Introduction to the Constitution of India", Students Edn., Prentice – Hall EEE,19th/20th Edn., 2001.
- Charles E. Haries, Michael S. Pritchard and Michael J. Robins, "Engineering Ethics", Thompson Asia, 2003-08-05.

Reference Books:

- An Introduction to Constitution of India by M.V. Pylee, Vikas Publishing**.**

HS-21001 Entrepreneurship Principles and Process

Teaching Scheme:
Lectures: 1 hr/week

Examination Scheme:
Field Work/Assignments: 40 marks
End Sem. Exam: 60 Marks

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. discover, develop, and assess different types of Entrepreneurial ventures and opportunities.
2. learn about opportunity and risk analysis.
3. use the strategies for valuing your own company, and how venture capitalist and angel investors use valuations in negotiating milestones, influence and control.
4. pick correct marketing mix and how to position the company in the market by using analytical tools.
5. learn how to sale themselves and the product/service and to handle objections.
6. know how organizations operates, their process matrices, start new ventures, write winning business plans.

Unit 1 **[3 Hrs]**

Market Research, Types of Companies and Organizations
Introduction to Entrepreneurship, Profile of the Entrepreneur, Market Gap /Opportunity Analysis, Market Research Methods, Defining the Focal Market: Market Segmentation, Industry analyzing– Research /Competitive Analysis. Company/Organization Types, Legal Aspects, Taxation, Government Liaison, Building the Team, Mergers and Acquisitions.

Unit 2 **[4 Hrs]**

Business Finance, Marketing & Digital Marketing
Shares and Stakes, Valuation, Finance Creation (Investors/Financers), Revenue Plans and Projections, Financial Ratios, Business Lifecycle, Break Even. Marketing Basics, Marketing Strategy and Brand Positioning, Plans and Execution Techniques, Marketing Analytics, Online Marketing.

Unit 3 **[3 Hrs]**

Sales & Operations Management
Understanding Sales, Pitching Techniques, Sales strategies, Inside Sales v/s Outside Sales, RFP Operational Basics, Process Analysis, Productivity, Quality.

Unit 4 **[2 Hrs]**

Start-ups
Start-up Basics, Terms, Start-up Financing, Start-up Incubation, Start-up Incubation, Getting Listed.

Text Books:

- David Kidder, "The Startup Playbook: Secrets of the Fastest – Growing Startups From Their Founding Entrepreneurs".
- Bill George and Peter Sims, "True North".
- Cardullo, M. W. P. E. "Technological entrepreneurism: Enterprise formation, financing, and growth", England: Research Studies Press Ltd, (1999).

Reference Books:

- Kanungo, R. N., "Entrepreneurship and innovation: Models for development", (Ed.,Vol.2), New Delhi: Sage, 1998.
- Van Nostrand, Verma J. C., & Singh G., "Small business and industry: A hand book for entrepreneurs", New Delhi: Response-Sage, 2002.
- Richard A Brealy & Steward C Myres, "Principles of Corporate Finance", McGraw Hills, 7th Edn, 2004
- Prasanna Chandra, "Financial Management: Theory and Practice", Tata McGraw Hills, 6th Edn, 2004.
- I M Pandey, "Financial Management", Vikas Publishing.

AS (HS)-21001 English Proficiency Language

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
T1 & T2: 60 Marks
End Semester: 40 Marks

Course Outcomes:

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

1. understand concepts of English language and apply them practically.
2. reproduce meaningful and well-structured sentences for conversation or speech in English.
3. analyze, comprehend and write well and effectively produce enhanced formal communication in English.
4. display their Presentation skills and participate and produce healthy discussions both formally and informally among peers using English.
5. create impact by acquiring professional skills, confidently face interviews and be better employable and industry ready.

Unit 1 **[8 Hrs]**

English for communication
Basic understanding of language and its need for effective business communication for Engineers, Formal and informal expressions, Vocabulary Building, Business Idioms.

Unit 2 **[6 Hrs]**

Presentation Skill Development
Oral Presentations, Basic Mannerisms and Grooming required for professionals, Cross cultural communication, Business Etiquette.

Unit 3 **[8 Hrs]**

Business Writing
Writing Mechanics, Note making, Summarizing, Letter &Email Writing, Business Reports, Statement of Purpose.

Unit 4 **[6 Hrs]**

Employability Enhancement
Job Readiness, Interview Skills and Mock Interviews.

Reference Books:

- Shalini Verma, "Business Communication", 2nd Edition, Vikas Publishing House.
- Shirley Tailor, "Communication for Business: A Practical Approach", Longman.
- S. Mishra & C. Muralikrishna, "Communication Skills for Engineers", Pearson.
- T.M. Farhathullah, "Communication Skills for Technical Students", Orient Longman.
- Shalini Varma, "Enhancing Employability at Soft Skills", Pearson.
- Saran Freeman, "Written Communication in English", Orient Longman.
- Jaishri Jethwaney, "Corporate Communication", Oxford University Press.
- R. C. Sharma & Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw Hill.
- Raymond Murphy, "Essential English Grammar (Intermediate & Advanced)", CUP.

AS (HS)-21002 German Language

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
Assignments: 40 Marks
End Sem. Exam: 60 Marks

Course Outcomes:

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

1. acquire knowledge of facts about Germany and German culture (cultural sensitization).
2. adapt pronunciation of German letters and greetings.
3. identify and calculate numerical till 1000.
4. describe themselves and third person.
5. construct simple questions or sentences and interact with the teacher and classmates.

6. comprehend time and time related phrases, illustration of the same in conversations.
7. handle day to day situations like placing an order in the restaurant or interact with shopkeeper in the supermarket.

Unit 1 **[6 Hrs]**

Guten Tag! (Good day)
Greetings, self introduction and partner introduction, numbers till 100, how to mention telephone number and email address, about countries, nationalities and languages.

Unit 2 **[6 Hrs]**

Freunde, Kollegen und ich (Friends, colleagues and myself)
Hobbys, days of the week, months, seasons and professions, classroom objects and classroom communication

Unit 3 **[6 Hrs]**

Dining out
Understanding German cusine, meal courses, names of the ingredients, conversation with the waiter and in the supermarket.

Unit 4 **[6 Hrs]**

Uhrzeit (Timing)
Mention time, daily routine, making appointments

Unit 5 **[6 Hrs]**

Grammatik (grammar)
Vocab, Verb conjugations, WH-question, verbs, pronounciation, personal pronouns, articles, Singular and Plural, negation.

Reference Books:

- Dengler. S., Rusch. P., Schmitz. S., & Sieber. T. Netzwerk, "Deutsch als Fremdsprache",. Goyal Publishers & Distributors Pvt. Ltd. Delhi, India, 2015.
- You tube video series "learn German", "easy German" etc.
- Funk. H., Kuhn. C., & Demme. S., "Studio d A1. Deutsch als Fremdsprache", 2011. Goyal Publishers & Distributors Pvt. Ltd. Delhi, India.

AS (HS)-21003 Japanese Language

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
Assignments: 40 Marks
End Semester: 60 Marks

Course Outcomes:

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

1. acquire knowledge of facts about Japan and Japanese culture,
2. familiarize with pronunciation of Japanese letters and daily greetings, Accent, Intonation and Japanese writing System Hiragana, Katakana and Kanji
3. identify numbers, Colors, Years,Months and Days, Time expressions, Directions to read the city map
4. describe themselves and third person and family members
5. construct simple questions or sentences and interact with the teacher and classmates.
6. apply Engineering Terminology and Japanese work culturesuch as Monozukuri, 5S, Kaizen, 3M, 5W1H etc.

Unit 1 **[6 Hrs]**

Introduction to Japanese Language (Nihongo)
Recognize Japanese Characters Hiragana. Can read /write Hiragana script
Use basic classroom expressions
Exchange greetings Can thank someone or apologize someone
Recognize Japanese Characters Katakana Can read /write Katakana script
Can ask someone to say something again if you don't really understand

About Me & Food
Give simple self introduction Can ask and answer where you live and your age.
Can write your name, nationality, date of birth and occupation in Japanese.
Recognize the parts of a business card
Talk someone briefly about your family using a family photo and answer simple questions such as who is that? Number of family members.
Talk about your favorite foods you like and dislike. Talk about your breakfast.
Can respond when offered a drink. For example saying what you want to drink.
Can look at menu in a fast food restaurant and understand what is available.
Can look at different restaurants' signboards and understand what each place is.

Unit 2 **[6 Hrs]**

Home & Daily life
Say what kind of house you live in. Say what you have in your home.
Write an e mail inviting someone to your home. Visit/ Welcome a friend.
Ask /say where to put things in the room. Can read the buttons on an electric appliance
Can listen to a simple explanation when being shown around a room and understand the layout.
Recognize the name and address on signs. Talk about your daily routine. Say the time you do something.Talk about your schedule at work for the week.

Can listen to short and simple instructions at work and understand what to do.
Can read a simple, handwritten note at work and understand the instructions.
Can ask someone to lend you something at work .
Can look at a list of equipment and confirm if you have all the items.

Unit 3 **[7 Hrs]**

Holidays and Days off 1 and Towns
Can give a simple answer when asked about your hobbies and favorite things to do .
Talk about what you do on your days off.
Can read an event poster and find the important information such as the date, time and place.
Can ask and answer questions about whether you are going to an event etc.
Can say when you are available, when you are inviting someone to something or being invited
Recognize station and Taxi signs.
How to get to particular destination using a map
Can say how you go to work and how long it takes.
Describe places in town and location
Can look at common signs in a station and understand what they mean.

Unit 4 **[6 Hrs]**

Shopping & **Holidays and Days off 2**
Talk about what you want to buy.
Can ask staff in a shopping center etc .Where to go for a certain item and understand the answer .
Can look at discount signs and read the prices.
Make a brief comment on things in a shop.
Can read a short blog / simple e mail
Can talk in simple terms about impressions of the holiday / trip .
Can write a simple post for social media etc . About what you did in holiday.

References Books:

- Marugoto A1 Katsudo Starter Coursebook for Communicative Language Activities.
- Marugoto A1 Rikai Starter Coursebook for Communicative Language Competences.
- The Japan Foundation.
- Minna no Nihongo Main Textbook Elementary Lesson 1-12.
- Minna no Nihongo Translation & grammatical Notes in English Elementary Lesson 1-12, 3A Corporation Goyal Publishers.

AS (HS)-21004 Spanish Language

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
Assignments: 40 Marks
End Semester: 60 Marks

Course Outcomes:

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

1. acquire knowledge of facts about Spain and Latin Americaand Spanish culture, pronunciation of Spanish letters and greetings.
2. identify and calculate numerical till 1000.
3. describe themselves and third person.
4. construct simple questions or sentences and interact with the teacher and classmates.
5. comprehend time and time related phrases, illustration of the same in conversations, handle day to day situations like placing an order in the restaurant or interact with shopkeeper in the supermarket.

Unit 1 **[6 Hrs]**

¡Hola! (Hello)
Greetings, self introduction and partner introduction, numbers till 100, how to mention telephone number and email address, about countries, nationalities and languages. Hobbys, days of the week, months, seasons and professions, classroom objects and classroom communication.

Unit 2 **[6 Hrs]**

La comida (Food)
Understanding Spanish cusine, meal courses, names of the ingredients, converstaion with the waiter and in the supermarket.

Unit 3 **[6 Hrs]**

La ropa (clothing)
Clothing, accessory (as per weather), season + weather, vocabulary, Demonstrative pronouns, how to ask about price, numbers till 1000 .

Unit 4 **[6 Hrs]**

La hora (Timing)
Mention time, daily routine, making appointments

Unit 5 **[6 Hrs]**

La gramática (grammar)
Vocab, Verb conjugations, WH-question, verbs, pronounciation, personal pronouns, articles, Singular und Plural, negation.

Reference Books:

- Aula internacional 1Jaime Corpas, Eva García, Agustín Garmendia, Neus Sans Baulenas (contributor), published by Goyal Publisher's and Distributors Pvt. Ltd.

EE-21008 Microcontroller Laboratory

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Term Work: 50 Marks
Oral/Practical: 50 Marks

Course Outcomes:

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

1. get the hands on experience with the software-tools like assembler, simulator, C Compiler.
2. interpret the datasheets related to the microcontroller and its peripherals Program microcontroller and associated peripheral devices.
3. interface microcontroller with commonly used devices.
4. use microcontroller for specific applications such as speed control of stepper and DC motor.

The laboratory should consist of minimum eight experiments based on the following topics:

List of Experiments:

1. Introduction to Assembly language programming using cross-assembler.
2. Stack and Stack arithmetic operations, Subroutines and parameter passing via register, Stack.
3. Write an Assembly language program to implement LED blinking program using Delay function and Timers.
4. Write an Assembly language program to implement binary LED counter.
5. Write an Assembly language program to generate PWM waveform and display it on the DSO.
6. Interfacing of Push buttons, Key matrix, LCDs, ADC with Microcontroller.
7. Interfacing of DC Motor with microcontroller.
8. Open loop speed control of DC motor.
9. Write a C language program to implement LED blinking program using DSP.
10. Write a C language program to generate PWM waveform using DSP.

CT (IF)-21003 Fundamentals of Operating Systems

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
Assignment/Quizzes: 40 marks
End Sem Exam: 60 marks

Course Outcomes:

Students will be able to:

1. write programs to manipulate processes, files, and hardware resources using appropriate system calls.
2. illustrate the design issues, solutions and complexity of operating system by compiling, modifying an OS kernel, tracing the sequence of activities on processor, data structures of a file system, race conditions, locking mechanisms and storage techniques.
3. correlate the computer architecture features with operating system design issues.
4. make design choices for an operating systems with given constraints.

Unit 1 **[3 Hrs]**

Introduction and Operating Systems Structures
System programs: compiler, linker, loader. Operating system components, O.S. Services, System Calls, Virtual Machines, Boot Sequence.

Unit 2 **[4 Hrs]**

Processes and CPU Scheduling
Process concept, interleaved I/O and CPU burst; Process states; Co-operating processes, Thread, Thread libraries, Multithreaded programming, Scheduling, Scheduling criterion, Scheduling algorithms, Interrupts and Interrupt handling.

Unit 3 **[3 Hrs]**

Inter process Communication
Pipes, Shared memory mechanism, Asynchronous communication, Signals. POSIX API for IPC and programs using it.

Unit 4 **[6 Hrs]**

Process Synchronization
Critical section problem, Hardware support for mutual exclusion, Semaphores, Deadlock-principle, Deadlock detection, prevention and avoidance, Classical problems in concurrent programming: Producer-consumer, Reader-writer with and without bounded buffer. Design of locking primitives like spinlock, semaphore, read-write locks, recursive locks, etc.

Unit 5 **[6 Hrs]**

Memory management
O.S. and hardware interaction, Swapping, Continuous memory management, paging, Segmentation, Virtual Memory Management, Demand Paging, Page replacement algorithms, Allocation of frames, Kernel memory management.

Unit 6 **[6 Hrs]**

File Management and Storage Structures
File Organization, Concept of files and directories, System calls for file systems, Free space management, Data structures like inode and super block, Virtual file system, Disk layout, Formatting, Recovery

Text Books:

- Abranhan Silberschatz, Peter B Galvin, Greg Gagne, "Operating System Concepts", Wiley India Students Edition, 8th Edition, ISBN: 978-81-265-2051-0.
- Andrew S. Tanenbaum, "Modern Operating Systems", Prentice Hall of India Publication, 3rd Edition, ISBN: 978-81-203-3904-0.

Reference Books:

- Milan Milenkovic, "Operating Systems", Tata McGraw Hill, Second Edition, ISBN: 0-07-044700-4
- Maurice J. Bach, "The Design of the Unix Opearating System", Prentice Hall of India, ISBN: 978-81-203-0516-8
- Uresh Vahalia, "Unix Internals, The New Frontiers"; Prentice Hall, ISBN: 0-13-101908-2

List of Assignments:

1. Create two virtual machines using virtual box software. One virtual machine will run a GNU/Linux of your choice on it. The other virtual machine will run any non-Linux operating system.
2. Write a minimal version of a shell with the features to handle pipes and handle redirection.
3. Use debugfs tool to locate a file which was recently deleted on an ext2 file system. Write a program, on the lines of debugfs, to browse an ext2 file system and given the complete name name of a file, print it's inode.
4. Write a program using pthreads to demonstrate the producer consumer synchronization problem. Implement appropriate synchronization. Show the different results with and without synchronization.
5. Write a program to demonstrate the usage of signals – show how processes can wait for each other, kill each other, stop and continue each other.

EE-21001 Signal Processing

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:

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

1. realize the abstraction of signals and systems, from the point of view of analysis and characterization.
2. understand sampling theorem and its implications.
3. perform convolution and correlation operations on signals
4. use mathematical tools like Laplace transform, Z transform, Fourier representation for frequency domain analysis of CT and DT signals.
5. design and realization of FIR and IIR filters.

Unit 1 **[6 Hrs]**

Basics of Signals and Systems
Introduction and classification of continuous time signals, discrete time sequences and systems, elementary operations on signals and sequences, properties of systems, sampling theorem, periodic sampling, frequency-domain representation of sampling, reconstruction of samples, discrete time processing of continuous time signals, continuous time processing of discrete-time signals.

Unit 2 **[6 Hrs]**

Linear Time Invariant Systems
Time domain representations of continuous and discrete time Linear Time Invariant (LTI) systems, properties of LTI systems, impulse response, convolution, differential equation representation for continuous time LTI system, linear constant - coefficient different equation representation for discrete time LTI system.

Unit 3 **[6 Hrs]**

Fourier Representation of the Signals
Signal analysis - discrete and continuous, periodic and non-periodic, and synthesis in Fourier domain, properties of Fourier representations, and application of Fourier representations.

Unit 4 **[6 Hrs]**

Z-Transform
Definition, convergence, properties of Z-transform, inverse Z-transform, system function for discrete time systems characterized by linear constant-coefficient difference equations, recursive and non-recursive structure, block diagram and signal flow graph representation of discrete-time systems.

Unit 5 **[8 Hrs]**

Discrete Fourier Transform

Discrete time Fourier series and its convergence, discrete time Fourier transform, its properties, frequency response, Introduction to DFT in time domain and frequency domain, derivation of DFT from DTFT, inverse DFT, convolution using DFT, computational complexity of the DFT, Decimation In Time (DIT) FFT algorithm, Decimation In Frequency (DIF) FFT algorithm, comparison of DIT and DIF algorithms.

Unit 6 **[8 Hrs]**

Filter Design and other transforms

Introduction, properties - Group delay, linear phase, all-pass, minimum phase, design of FIR digital filters by window design techniques, analog filter design – Buterworth and Chebyshev approximation, design of IIR digital filters by approximation Of derivatives, Impulse invariance and Bilinear Transformation methods, FIR and IIR filter structures, effect of finite register length in FIR filter design.

Text Books:

- Oppenheim, Willsky and Nawab, "Signals and Systems", 2nd edition, Pearson (low price), 1997.
- Proakis and Manolakis , "DSP: Principles, algorithms and applications", 4th edition, Prentice Hall, 1996.
- Tarun Rawat, "Signals and Systems", Oxford University Press, 2010.

Reference Books:

- Hwei Hsu, "Signals and Systems", 3rd edition, Schaum's series, McGraw Hill, 2013.
- Alan V. Oppenheim, Ronald W. Schafer, "Discrete-Time Signal Processing, 3rd edition, Prentice Hall, 2010.
- B. P. Lathi, "Linear Systems and Signals", 2nd edition, Oxford University Press, 2006.
- S. Salivahanan, "Digital Signal Processing", 2nd edition, McGraw Hill, 2011.

e Learning Resources:

- Prof. Alan V. Oppenheim, MIT online lecture series on Signals and Systems https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/index.htm
- Prof. Alan V. Oppenheim, MIT online lecture series on Digital Signal Processing https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/
- Prof. S. C. Datta Roy, IIT Delhi, online lecture series on Digital Signal Processing https://nptel.ac.in/courses/117/102/117102060/

EE-21002 Microcontrollers

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:

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

1. understand the limitations and strengths of different types of microcontrollers and will be able to select the microcontroller as per application.
2. know the internal architecture of 8 bit, 16 bit and 32 bit microcontrollers/DSPs and other salient features.
3. show the technical competency about interfacing microcontroller with different devices.
4. design and program the microcontroller for various applications in electrical engineering domain.

Unit 1 **[8 Hrs]**

Microcontroller Basics
Difference between microprocessor and microcontroller, CISC Vs RISC, Von-Neumann vs. Harvard architecture, architecture of microcontroller, I/O ports, stack and stack pointer, priority, Memory structure, data and program memory, different registers (SFR's), addressing modes, timing diagram.

Unit 2 **[8 Hrs]**

Peripheral Interfaces-1
I/O programming, interfacing with simple switch, LED. 8 bit and 16 bit Timers, various modes of operations of timers, counters, PWM programming.

Unit 3 **[6 Hrs]**

Peripheral Interfaces-2
Interrupt structure, Interrupt priority, and Interrupt programming, Analog to Digital Converter, UART programming, RS 485 transceivers, I/O expansion techniques, Memory expansion.

Unit 4 **[6 Hrs]**

External Interfaces
LCD, Keyboard interfacing, Digital to Analog Converters, Stepper Motor interfacing, DC motor interfacing, CAN Protocol and its interfacing, introduction to Bluetooth and USB protocols.

Unit 5 **[7 Hrs]**

Introduction to Other Advanced Microcontrollers
16-bit Micro-controllers overview, introduction to MSP 430 microcontroller, features, architecture, addressing modes, low power feature of MSP 430.

Unit 6 **[7 Hrs]**

Introduction to DSP
32-bit Digital Signal Processor overview, architecture, peripheral modules, memory mapping, applications of DSP in power electronics.

Text Books:

- Muhammad A. Mazidi, "The AVR Microcontroller and Embedded Systems: A System Approach", 1st Ed., PHI, 2013.
- Muhammad A. Mazidi, "AVR Microcontroller and Embedded Systems: Assembly and C", Pearson; 1st edition, 2015

Reference Books:

- Thomas Grace**, "**Programming & Interfacing Atmel Avr Microcontrollers", Cengage Learning, Inc, 2015.
- Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 2nd edition, 2008.
- Venkataramani, M. Bhaskar "Digital Signal Processors: Architecture, Programming and Applications", Second Edition, Tata McGraw Hill Education Private Limited, 2011.
- Texas Instruments MSP 430 microcontroller Guide and Datasheet.

e Learning Resource:

- Prof. Santanu Chattopadhyay, NPTEL course lectures on Microprocessors and Microcontroller https://nptel.ac.in/courses/108/105/108105102/

EE-21003 Synchronous Machines

Teaching Scheme:
Lectures: 3 hrs/week
Tutorial: 1 hr/week

Examination Scheme:
Test/Quiz (1 and 2): 40 Marks
ESE Exam: 60 Marks

Course Outcomes:

At the end of this course students will able to:
1. analyze the constructional difference among conventional and modern synchronous machines.
2. select armature winding for synchronous machine.
3. evaluate the steady state characteristics of synchronous generator using analytical skills.
4. evaluate the steady state characteristics of synchronous motor using analytical skills.
5. analyze performance of PMSM.
6. analyze performance of BLDC.

Unit 1 **[7 hrs]**

Basic concepts in rotating machines
Revision of electromechanical energy conversion principles, AC machines classification, construction, basic principles of operation, MMF of concentrated windings, Magnetic fields in rotating machines, rotating MMF waves in ac machines, generated voltage, torque in no salient pole machines, MMF in linear machines and magnetic saturation.

Unit 2 **[7 hrs]**

Armature Windings
Operation of ac machines, MMF of concentrated and distributed windings, ac machine windings, winding connections, winding factors, modified emf equation, harmonic causes and their suppression.

Unit 3 **[7 hrs]**

Synchronous Generator
Construction, types, circuit model, effects of saliency, determination of synchronous reactance, phasor diagram, power angle characteristics, parallel operation and load sharing, synchronizing process.

Unit 4 **[6 hrs]**

Synchronous Motor
Synchronous motor, representation, phasor diagram, characteristics curves, torque-speed curves, under and over excitation operation, losses and efficiency, applications.

Unit 5 **[7 hrs]**

Permanent Magnet Synchronous Machines
Permanent magnet synchronous motors, operation, rotor types, equivalent circuit, sine wave motors, air gap flux density, phasor diagram, permanent magnet materials, emf and torque equation, starting, rotor position sensing, speed control, cogging torque, maximum torque, losses and efficiency.

Unit 6 **[6 hrs]**

Brushless DC motors
Operation of three phase brushless DC motor, construction, rotor types, windings, magnetic circuit analysis, emf and torque equitation, emf waveform, torque and emf constants, speed-torque characteristics, losses and efficiency.

Text Books:

- D. P. Kothari and I. J. Nagrath, "Electric Machines", Tata McGraw Hill Publication, (4th edition reprint 2012).
- A. E. Fitzgerald, C. Kingsley, S. D. Umans, "Electrical Machinery", Tata McGraw Hill, 2002, (6th edition).
- Miller, T. J. E., "Brushless Permanent Magnet and Reluctance Motor Drives", Oxford Science Publications, 1989.
- P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 7th edition, 2011.

Reference Books:

- Nasser Syed, "Electrical Machines and Transformers", A New York, Macmillon, 1984.
- P. C. Sen., "Principles of Electric Machines and Power Electronics", 2nd Edition, John Wiley and Sons Inc., 1997.
- Bhag S. Guru and Huseyin R. Hizirouglu, "Electric Machinery and Transformers", 3rd Indian Edition, Oxford University press, Reprint 2014.
- M. G. Say, "Alternating Current Machines", Fifth edition, Low price edition, ELBS, Reprinted 1994
- J. R. Handershot and T.J. E. Miller, "Design of Brushless permanent magnet machines", Book masters Inc. 2010.
- Duane C. Hansalman, "Brushless permanent magnet motor design", second edition, Magna Physics publication, 2006
- K. Venkataratnam, "Special Electrical Machines", Universities press, 2009

e Learning Resources:

- https://nptel.ac.in/courses/108105017; NPTEL: Electrical Engineering, Electrical Machines–I and Electrical Machines -II. Dr. D. Kashta, IIT Kharagpur.
- https://nptel.ac.in/courses/108/105/108105131/ Prof. Tapas Kumar Bhattacharya

e-Book/Notes:

- M. V. Deshpande, "Electrical Machines", PHI Learning Pvt. Ltd. New Delhi, 2011.
- NPTEL web course by Prof. P. Sasidhara Rao, G. Sridhara Rao and Krishna Vasudevan, IIT Madras, https://nptel.ac.in/courses/108/106/108106072/

EE-21004 Power System Analysis

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Assignments /Quiz: 40 Marks
End-Sem Exam: 60 marks

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. get the knowledge of power system, various components, structure, evolution and national level scenario.
2. estimate the parameters, compute the performance of transmission lines and select the model.
3. model and analyze different power system components like generators, transformers etc.
4. analyze the faults on power system, compute fault currents for protection and other studies.
5. perform power flow studies using software and interpret the results.
6. analyze the concept of steady state stability, its evaluation and its importance.

Unit 1 **[8 Hrs]**

Introduction and Basic Concepts of Power Systems
Structure of power systems, Power system scenario in India, concept of regional and National GRID, overview of conventional and non-conventional power generation. Distribution system, impact of EV and DGs, concept of smart and micro grid, Complex power: concept of real, reactive power and their effects on power system operation, per unit system. Transmission line parameters: Resistance, inductance and capacitance of single phase and three phase line, concept of GMR and GMD, Skin effect, Proximity Effect.

Unit 2 **[7 Hrs]**

Models and Performance of Transmission Line
Transmission line models -short, medium and long lines, voltage and current waves, surge impedance loading of Transmission Line, Phenomenon of Corona, complex power flow through transmission lines, power transmission capability, Ferranti effect, Tuned power lines, methods of voltage control.

Unit 3 **[8 Hrs]**

Modeling of Power System Components
Synchronous generators: generator model, steady state characteristics, power transformer: Three phase power transformer and its modelling, network model formulation, synchronous machine transients, determination of transient constants, DC component of stator currents.

Unit 4 **[7 Hrs]**

Power Flow Analysis
Power flow equations and solution techniques. Formation of bus admittance matrix, Gauss-Seidal method, Newton-Raphson method, decoupled and fast decoupled methods, comparison of power flow methods, power flow simulation software.

Unit 5 **[6 Hrs]**

Symmetrical and Unsymmetrical Fault Analysis
Internal voltages of loaded machines under transient conditions, selection of circuit breakers, Symmetrical components of unsymmetrical phasors, effect of the transformation on power, sequence impedances and sequence networks of power system, single Line to Ground (LG) faults, Line-to-Line (LL) faults, Double Line to Ground (LLG) faults and open conductor faults.

Unit 6 **[6 Hrs]**

Power System Stability
Steady-state and transient stability concepts, rotor dynamics and swing equation, equal area criterion, step by step solution of swing curve, multi-machine stability, factors affecting transient stability.

Text Books:

- Grainger John J and W D Stevenson Jr., "Power system analysis", Mc-Graw Hill.

- J. Nagrath, D. P. Kothari, "Modern Power System Analysis", (3rd Edition), Tata McGraw Hill Publishing Co. Ltd., 2003. 14

Reference Books:

- O. I. Elgerd, "Electrical energy systems theory: An introduction" Tata McGraw Hill, edition 1999.
- Hadi Sadat, "Power system analysis", McGraw Hill International, 1999.
- A. R. Bergen and Vijay Vittal, "Power system analysis", (2nd edition), Pearson Education Asia, 2001.
- J. D. Glover and M. Sarma, "Power System Analysis and Design", (3rd edition), Brooks/ Cole Publishing, 2002.
- K. N. Shubhanga, "Power System Analysis-A Dynamic Perspective", (1st edition), Pearson Education India, June 2018.

EE-21005 Signal Processing Laboratory

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Term-work: 50 Marks
Oral/Practical: 50 Marks

Course Outcomes:

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

1. generate the analog signals and discrete sequences in MATLAB/C.
2. verify linear convolution and correlation of given signals/ sequences in MATLAB/C.
3. demonstrate Nyquist sampling theorem and aliasing effects.
4. analyze the signals in frequency domain.
5. design and simulate FIR and IIR filters.

The laboratory should consist of implementation of minimum eight experiments in MATLAB/ C based on the following topics:

List of Experiments:

1. To generate and analyze different types of analog signals and discrete sequences.
2. To perform basic signal manipulations like time-shifting, time-reversal, time-scaling.
3. To perform sampling, up sampling, and down sampling.
4. To perform linear convolution and correlation of two sequences/signals.
5. To find the FFT/IDFT of given signal.
6. To perform circular correlation of two sequences/signals.
7. To perform time and frequency domain analysis of a generated signal, added random noise and the recovered signal from the noisy signal.
8. To study the effect of truncating a time-domain signal by showing the correspondence between spectra of the original and truncated signals.

9. To design and implement FIR Filter for a given specification.
10. To design and implement IIR Filter for a given specification.
11. To process and analyze multidimensional signal.
12. To provide the solution for a given real life problem.

EE-21006 Synchronous Machines Laboratory

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Term-work: 50 Marks
Oral/Practical: 50 Marks

Course Outcomes:

At the end of this course students will be able to:
1. analyze the construction of synchronous machines.
2. determine synchronous machine parameters.
3. evaluate steady state characteristics of synchronous machine.
4. determine the steady state performance of PMSM and BLDC.

The laboratory should consist of minimum eight experiments based on the following topics:

List of Experiments:

1. Perform O.C. and S.C. test on Alternator: Determination of parameters and regulation of synchronous machine by the EMF method.
2. Perform direct loading test on three phase alternator and determine its performance.
3. Estimate "V" and inverse V" curves of synchronous motor at no load and constant load.
4. Determine the power and load angle curve of synchronous machine.
5. Perform a load test on permanent magnet synchronous motor.
6. Perform a load test on line start permanent magnet synchronous motor.
7. Perform a load test on a BLDC motor.
8. Perform a load test on synchronous reluctance motor.
9. Control speed of a brushless DC motor.
10. To study the flux distribution and saturation of Synchronous machine at various load angle using FEM package.

EE-21007 Power System Analysis Laboratory

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Term-work: 50 Marks
Oral/Practical: 50 Marks

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. model electrical power system for steady state and transient studies.
2. use MATLAB and ATP/PSCAD on power system studies.
3. analyze the reactive power requirement of lines, voltage profile along the line and VAR compensation.
4. analyze the symmetrical and unsymmetrical faults.
5. compute the y-bus matrix, perform load flow and interpret the results.
6. analyze power system stability studies.

The laboratory consists of minimum ten experiments from following list and any other experiment based on the prescribed syllabus.

List of Experiments:

Group I:

1. To validate Ferranti effect on an unloaded transmission line.
2. To determine A, B, C, D constants of a given transmission line.
3. To determine effect of surge impedance loading of a transmission line.
4. Effect of VAR compensation on receiving end voltage profile of distribution line.
5. To determine suitability of cable for AC transmission.
6. Visit to HV/EHV substation, power generating station.

Group II (minimum four using MATLAB/ PSCAD)**:**

1. Simulation of typical power system- familiarization with generator, line and load models.
2. Formulation of Y-bus matrix using computer program.
3. Computer aided solution of power flow problem by Gauss Siedal/ Newton-Raphson method.
4. To plot the swing curve.
5. Determination of steady state power limit of transmission line.
6. Simulation and analysis for a symmetrical three phase fault by simulation.
7. Simulation and analysis of unsymmetrical fault - LL, LG and LLG.

Minor Course

EE (MI)-21001 Electrical Circuit Analysis and Automatic Control Systems

Teaching Scheme:
Lecture 3 hrs/week

Examination Scheme:
Assignment/Quiz: 40 marks
End Sem Exam: 60 marks

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. solve simple electric circuit.
2. solve two port network.
3. appreciate role of control system and its applications.
4. analyze control system response in time domain.
5. use bode plot for frequency response analysis.
6. implement PID controller for simple systems.

Unit 1 **[7 Hrs]**

Introduction to Electric circuit
Electric circuit components. Transient response with initial conditions, Initial conditions in circuit elements. Step response and steady state response of RL, RC and RLC circuits.

Unit 2 **[7 Hrs]**

Two Port Network and Network Functions
Network function for one port and two Port Network. Impulse response and system function. Poles and zeros, restrictions on pole and zero locations for driving point and transfer functions, time domain behavior from pole and zero plot. Two port parameters. Relationship of two port variables

Unit 3 **[7 Hrs]**

Introduction to Control System
Introduction to control system block diagram. Importance of Control Systems. Components of control. Explanation with the help liquid level control system. Significance of actuators and sensors. Types of actuators, Types of sensors. Open loop control and closed loop control. Use of relays, switches and contactors in developing simple and sequential control system.

Unit 4 **[8 Hrs]**

Control System Representation and Analysis in Time Domain
Mathematical representation of simple mechanical, electrical, thermal, hydraulic system. Transfer function of these systems. Pole zero concepts. Analysis of step response. Use of root locus for time domain analysis of the system. Concept of stability.

Unit 5 **[8 Hrs]**

Control System Analysis in Frequency Domain
Concept of frequency domain behavior, Bode Plot for analyzing system in frequency domain. Frequency domain performance specifications. Analysis of simple mechanical, electrical, thermal, hydraulic system.

Unit 6 **[6 Hrs]**

PID Controller
Introduction to PID controller, Tuning rules, PID controller for temperature control system, motion control system, level control system.

Text Books:

- M. E. Van Vulkenburg, "Network Theory", 3rd edition Pearson Education, 2006.
- Nagrath & M. Gopal, "Control System Engineering", Anshan, 2008.
- S Mukhopadyay, S. Sen, A. K. Deb, "Industrial Instrumentation, Control and Automation", Jaico Publishing house, 2013.

Reference Books:

- Norman S. Nice, "Control System Engineering", 2008, Wiley.
- Smarajit Ghosh, "Control Systems Theory & Applications", Pearson Education 2007.
- D.Roy Choudhury, "Networks And Systems", New Age International Publications, 2nd edition.

Renewable Minor Course

EE (MI)-21004 Solar Energy Systems

Teaching Scheme:
Lecture 3 hrs/week
Practical: As necessary
Field Visit: As necessary

Examination Scheme:
MCQ-1: 20 Marks
Review Project: 30 Marks
End Sem Exam: 50 Marks

Course Outcomes:

Students will be able to:

1. understand the basics of solar energy, availability, applications, heat transfer as applied to solar thermal systems, various types of solar thermal and photovoltaic systems, introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics.
2. field visits will be designed for firsthand experience and demonstration of the system elements.
3. know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of multiple choice type or of the type define, identify, state, match, list, name etc.)

4. understand basic concepts. (To measure this outcome, questions may be of the type explain, describe, illustrate, evaluate, give examples, compute etc.)

Unit 1 **[6 Hrs]**

Basics of Solar Energy

Sun, Earth, solar radiation, losses, radiation reaching the Earth, rotation of Earth, seasons and variations in solar radiation, solar angles and nomenclature, solar radiation spectrum, basics of heattransfer, conduction, convection, radiation of heat, absorption, reflection and transmission of radiation; movement of Sun in the sky, solar tracking, types of solar tracking systems, methods and algorithms for solar tracking, tracking control.

Unit 2 **[7 Hrs]**

Introduction to Solar Thermal Technologies and Systems

Introduction to solar thermal systems, non-concentrating and concentrating type systems, flat plate collectors, properties of flat plate collectors, systems using flat plate collectors, Evacuated tube collectors, various types of solar concentrating systems, viz. parabolic trough, dish type, linear Fresnel, Heliostat, non-imaging type.

Solar water heating systems and solar air heating systems; Solar cookers: low cost, box, concentrating, standalone dishes and large-scale cooking systems; flat plate collectors, evacuated tube collectors, heat pipes; their designs, components, materials, equipment, characteristics, life.

Unit 3 **[7 Hrs]**

Introduction to Solar Photovoltaic Technologies and Systems

Physics of photovoltaic (PV) electricity, Photodiode and solar cell, Solar radiation spectrum for PV, Types of solar cell and comparison, Introduction to various types of solar module manufacturing, Basic system design, Types of systems, Common applications of solar PV, Introduction to solar PV (SPV) systems, SPV appliances, Solar inverters, Batteries, Operation and maintenance of SPV, Software tools for SPV, Standards and certification for SPV, Basics of SPV systems, Elements of SPV appliances and power plants, Procurement versus production, Bought-outs, assemblies, sub-assemblies, Manufacturing and assembly, Manufacturing standards, Quality assurance and standards, Certification, Site assembly and fabrication, Typical shop layouts, Inventory management, Economics of manufacturing.

Unit 4 **[6 Hrs]**

Solar Power Plants

Various types of solar thermal power plants, parabolic trough, heliostat or central tower, dish, etc., balance of plant for solar thermal systems; Small capacity SPV power plants, Grid tied SPV power plants, Large scale SPV power plants, Balance of system; designs, components, materials, equipment, characteristics, life, site requirements, installation, quality assurance, operations and maintenance, hybrid systems, etc.

Unit 5 **[6 Hrs]**

Life cycle costing, payback, return on investment; calculations for selection, costing and payback for solar water heating system and solar thermal power plants; Financial modeling of SPV, Environmental impact assessment.

Unit 6 **[8 Hrs]**

Field Visit and Practical

One or more of the following visits may be undertaken.

- SPV power plant
- Testing and certification facility for solar energy systems
- Solar thermal system manufacturing facility

One or more of the following practical may be undertaken.

- SPV module characterization
- Effect of temperature on SPV performance
- Estimating efficiency of flat plate solar collector
- Estimating efficiency of solar concentrator

Reference Books:

- "Trainers Textbook Solar Thermal Systems Module", Ministry of New and Renewable Energy, Government of India.
- "Students Workbook for Solar Thermal Systems Module", Ministry of New and Renewable Energy, Government of India.
- S. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill
- Klaus Jäger et. al., " Solar Energy Fundamentals, Technology, and Systems", Delft University of Technology, 2014.

Honors Course Syllabus for Electrical and Renewable

EE (HO)- 21001 Engineering Optimization

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:

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

1. explain and use the basic theoretical principles of optimization and various optimization techniques.
2. develop and select appropriate models corresponding to problem descriptions in engineering and solve them using appropriate techniques.
3. analyze and solve complex optimization problems in power system and machines.

4. design optimization models and use them in solving problems in power system planning and operation.
5. to develop and implement optimization algorithms and use software tools to solve problems in engineering.
6. make sound recommendations based on these solutions, analysis and limitations of these models.

Syllabus Contents:

Introduction to optimization, classical optimization: single variable, multivariable optimization techniques, linear programming: simplex method, duality, transportation problems, non-linear programming: one dimensional minimization methods, unconstrained optimization, dynamic programming: development of dynamic programming, principle of optimality, practical aspects of optimization: reduced basic techniques, sensitivity of optimum solution to problem parameters, modern optimization techniques, solving problems related to power system operation and control.

Text Books:

- S. S. Rao, "Engineering Optimization-Theory and practice", Fourth edition, Wiley Easter Publications, January 2009.

Reference Books:

- R. Fletcher, "Practical Optimization", Second edition, John Wiley and Sons, New York, 1987.
- K. V. Mital and C. Mohan, "Optimization Methods in Operations Research and System Analysis", New age International Publishers, Third edition, 1996.
- Gillette, "Computer Oriented Operation Research", Mc-Graw Hill Publications.
- Bazaraa M. S., Sherali H.D. and Shetty C., "Nonlinear Programming Theory and Algorithms", John Wiley and Sons, New York 1993.
- Bertsekas D. P., "Constrained Optimization and Lagrange Multiplier Methods", Academic Press, New York, 1982.
- D. P. Kothari an d J. S. Dhillon, " Power System optimization", PHI Learning Pvt. Ltd., 2004

Semester-II

ML-21002 Environmental Studies

Teaching Scheme:
Lectures: 1 hr/week

Examination Scheme:
Periodic Assignments & Tests

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

- comprehend sustainable development goals for present generation.
- appreciate environmental resources, functioning of an ecosystem, significance of biodiversity and environmental challenges.
- analyze the current status of environment with respect to precautionary mechanisms and control measures.
- appreciate the role of an engineer for better tomorrow.

Unit 1 **[2 Hrs]**

Multidisciplinary Nature Of Environmental Studies
Definition, scope and importance
Need for public awareness.

Unit 2 **[8 Hrs]**

Natural Resources: Renewable and Non-Renewable Resources
Natural resources and associated problems .
Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies.Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Unit 3 **[6 Hrs]**

Ecosystems
Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystem :-Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 4 **[8 Hrs]**

Biodiversity and its Conservation
Introduction – Definition : genetic, species and ecosystem diversity, Bio geographical classification of India, Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-sports of biodiversity, Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Unit 5 **[8 Hrs]**

Environmental Pollution
Definition, Cause, effects and control measures of :-Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste Management : Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies, Disaster management : floods, earthquake, cyclone and landslides.

Unit 6 **[7 Hrs]**

Social Issues and the Environment
From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Case Studies, Environmental ethics : Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies, Wasteland reclamation, Consumerism and waste products. Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness.

Unit 7 **[6 Hrs]**

Human Population and the Environment
Population growth, variation among nations, Population explosion – Family Welfare Programme, Environment and human health, Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health, Case Studies.

Unit 8 **[5 Hrs]**

Field Work
Visit to a local area to document environmental assets river/forest/grassland/hill/mountain.
Visit to a local polluted site-Urban/Rural/Industrial/Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hill slopes, etc.

Reference Books:

- Agarwal, K.C., "Environmental Biology", Nidi Publ. Ltd. Bikaner, 2001.
- Bharucha Erach, "The Biodiversity of India", Mapin Publishing Pvt. Ltd., Ahmedabad – 380013, India, Email:mapin@icenet.net (R)

- Brunner R.C., "Hazardous Waste Incineration", McGraw Hill Inc. 480p, 1989.
- Clark R.S., "Marine Pollution", Clanderson Press Oxford (TB).
- Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, "Environmental Encyclopedia", Jaico Publ. House, Mumabai, 1196p.
- De A.K., "Environmental Chemistry", Wiley Eastern Ltd.
- "Down to Earth", Centre for Science and Environment (R).
- Gleick, H.P. 1993, "Water in crisis", Pacific Institute for Studies in Dev., Environment & Security, Stockholm Env. Institute Oxford Univ. Press. 473p.
- Hawkins R.E., "Encyclopedia of Indian Natural History", Bombay Natural History Society, Bombay (R).

AS (HS)-21005 Industrial Psychology

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
Assignment/Test: 40 marks
Final Assessment: 60 marks
Field Visit/Expert Lecture Report: 20 marks
Mini-Project Report: 40 marks

Course Outcomes:

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

1. determine the psychological factors that influence individual differences at work and appraise the role of research.
2. explain the concepts of motivation and job satisfaction at work and Utilize the elements of organizational culture for enhancing group/team behavior.
3. evaluate the relevance & functioning of leadership & diversity in workforce and acknowledge the multicultural factors influencing workplace behavior.
4. illustrate the process of recruitment & selection and Experiment with the information required to sustain employability.
5. interpret the nuances of Human Factors in Engineering and Analyze its role in their disciplines.
6. measure the behavioral findings from self-lead projects and Propose corrective actions to improve quality of workplace behavior.

Unit 1 **[6 Hrs]**

Basics of Industrial Psychology (IP)
Difference between IP & Business Programs; Major fields & Employment in IP.
Brief History- Scientific Management, Time and Motion Study, Hawthorne Studies, World War I & II Research in Social Sciences.
Individual Differences at Work: Personality, Intelligence, Emotional Intelligence, Creativity & Innovation, Perception & Attitudes.

Unit 2 **[8 Hrs]**

People at Work

Motivation & Job Satisfaction- Employee Predisposition, Expectations, Goals, Incentives& Equity; Job Characteristic Theory (Diagnostic Model).

Understanding Groups & Teams- Group dynamics, Factors affecting Group performance; Understanding work teams, Types of teams, Team development, Issues with teamwork.

Leadership (Co-Teaching 4 hrs)- Leader characteristics, Leader & situation, Leader & follower; Specific leadership skills, Introduction to Organizational Development (OD).

Diversity- Multiculturalism- Hofstede's theory, Diversity dynamics.

Unit 3 **[8 Hrs]**

Human Factors Engineering (HFE)

Introduction & Brief History of HFE; Essentials of HFE.

Person-Machine Systems- Basic Human Factors: Sensory systems, Perception, Cognition, Information Processing approach, Memory, Decision Making.

Workspace Designs- General Principles, Designing work areas; Machine Displays &Controls; Physical work environment & Anthropometry; Managing workplace strain through Ergonomics (Self-study)

Current trends in HFE- Use of artificial intelligence, cognitive engineering, sociotechnical systems, etc.

Unit 4 **[6 Hrs]**

Managing People at Work

Job Analysis- Brief Background, Types & Importance; Job description.

Recruitment & Selection- Overview, Process, Evaluation.

Gearing for Selection- Interviews & Job Search Skills.

Performance Appraisal (Co-Teaching 2 hrs): Steps in the Evaluation Process; Appraisal Interview.

Text Books:

- Aamodt, M. G., "Industrial Psychology", Cengage Learning: Delhi, 2013.
- Wickens, C. D., Lee, J. D., Liu, Y. & Gordon Becker, S. E., "An Introduction to Human Factors Engineering", 2nd Edition, Pearson Education: New Delhi, 2015.
- Landy, F. J. & Conte, J. M., "Work in the 21st Century: An Introduction to Industrial and Organizational Psychology", 2nd Edition, Wiley India: New Delhi, 2010.

Reference Books:

- Matthewman, L., Rose, A. & Hetherington, A., "Work Psychology", Oxford University Press: India, 2009.
- Schultz, D. & Schultz, S. E., "Psychology and Work Today: An Introduction to Industrial and Organizational Psychology", 7th Edition, Pearson Education: New Delhi, 2013.
- Schultz, D. & Schultz, S. E., "Psychology and Work Today", Pearson Education: New Delhi, 2002.

AS (HS)-21006 Personnel Psychology

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
Assignments: 60 marks
End Sem. Exam: 40 marks

Course Outcomes:

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

1. acquire organizational concepts and will recognize their own personality attributes suitable for corporate world.
2. realize the importance of motivation and apply motivational principles to their lives.
3. experience group dynamics and apply those principles in their lives.
4. grasp and apply different techniques to maintain mental health.

Unit 1 **[6 Hrs]**

Introduction- Understanding own personality and corporate world Basic concepts in Organizational set up and its importance, Know own personality attributes. Preparing for corporate world, work ethics, and self- management.

Unit 2 **[6 Hrs]**

Motivation
Motivational theories for self- motivation and motivating others at work place, Approaches to work.

Unit 3 **[8 Hrs]**

Group Dynamics
Group behavior and leadership, Effective group behavior, Leadership and management principles, virtual teams and Performance appraisal.

Unit 4 **[6 Hrs]**

Mental Health at Work Place
Occupational stress and conflict and strategies for its management, Emotional Intelligence, spiritual Intelligence.

Text Books:

- Khana S. S., "Organizational Behaviour (Text and Cases)", Chand and company Pvt. Ltd. Delhi, 2016.
- Rae Andr'e, "Organizational behavior", Dorling Kindersley, (India) Pvt. Ltd, 2008.
- Wallace H.vand Masters L., "Personality development.", Cengage Learning India Pvt. Ltd, 2008.

Reference Books:

- Robbins S, JudgeA, Vohra N, "Organizational behavior", 15thed, Pearson Education Inc, 2013.

- Singh Kavita, "Organizational behavior-Text and cases", Dorling Kindersley, 2010.

AS (HS)-21007 Engineering Economics

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
Assignment/Test: 40 marks
End Sem. Exam: 60 marks

Course Outcomes:

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

1. demonstrate understanding of economic theories and policies.
2. identify economic problems and solve it by applying acquired knowledge, facts and techniques. in the available framework.
3. categorize, classify and compare economic situations and draw inferences and conclusions.
4. adapt to changing economic atmosphere and propose alternative solutions to the problems.

Unit 1 **[6 Hrs]**

Introduction to Economics:
Definitions, basic concepts of economics: Cost, efficiency and scarcity, Opportunity Cost.
Types of economics: Micro Economics, Macroeconomics and Managerial Economics.
Difference between micro economics and macroeconomics. Application of Managerial economics.

Unit 2 **[8 Hrs]**

Micro Economics Analysis
Demand Analysis, Supply Analysis, Theories of Utility and Consumers Choice, Cost analysis, Competition and Market Structures. Application of micro economics theories

Unit 3 **[8 Hrs]**

Macro Economic Analysis
Aggregate Demand and Supply, Economic Growth and Business Cycles, inflation, Fiscal Policy, National income, theory of Consumption, savings and investments, Commercial and Central banking. Use of macroeconomic theories.

Unit 4 **[8 Hrs]**

International Economics
Balance of Trade and Balance of Payments, Barriers to Trade, Benefits of Trade/Comparative Advantage, Foreign Currency Markets/Exchange Rates, Monetary, Fiscal and Exchange rate policies, Economic Development.
Application of exchange rate policies.

Reference Books:

- N. Gregory Mankiw, "Macroeconomics", 2018.
- Paul Keat, Philip Young, "Managerial Economics: Economic Tools for Today's Decision Makers", 2013.
- Misra and Puri , "Principles Of Macro Economics", Himalaya publishing house, New Delhi, 2009.
- A. Koutsoyiannis, "Modern Microeconomics", Macmillan, London.
- Robert S. Pindyck and daniel L. rubinfeld, "Microeconomics", pearson education Inc. New Delhi.
- K. N. Verma, "Micro economics":

AS (HS)-21008 Finance for Engineers

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
Assignments: 40 marks
End Semester: 60 marks

Course Outcomes:

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

1. comprehend basics of accounting, cost concepts, will be able to read Financial statements of companies.
2. enable them to understand critical financial principles and to enable them to integrate & analyze financial information necessary for Business Decision Making.
3. establish relationship between Risk & Return, time value of money, sources of finance & working capital.
4. appreciate the digital platform of future finance, cryptocurrency, the terms associated with Financial Markets such as Money market, capital market, SEBI & other Regulatory authorities.

Unit 1 **[6 Hrs]**

Introduction to Accounting & Finance
Basic elements of financial accounting, cost concepts, preparation of Profit & Loss Account & Balance Sheet & concept of Budgetary control.

Unit 2 **[6 Hrs]**

Read & interpret Financial Statements
As per Schedule III of Companies Act 2013, Financial statement analysis, concept of cash flow statement.

Unit 3 **[8 Hrs]**

Break-even analysis, Risk & Return relationship, time value of money, sources of finance & working capital.

Unit 4 **[4 Hrs]**

Digital Platform such as Net Banking, Cryptocurrency, Algorithm based stock exchange trading, Basics of Money market, capital market, Commodities market, IPO & Regulatory authorities.

****Pedagogy:** Lectures and PPTs, Use of basic Excel tools for preparation of final accounts, Annual Reports of companies.

Reference Books:

- C Rama Gopal, "Accounting for Managers", Accounting for Management, New Age International Publishers, 2012.
- Prasanna Chandra, "Financial Management – Theory and Practice", Mc Graw Hill publication.

EE-21009 Mini-Project

Teaching Scheme:
Practical: 4 hrs/week

Examination Scheme:
Review seminar: 25 marks
Review Seminar: 25 marks
End-Sem Exam: 50 Marks

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. design power electronics converters, machine prototypes, protection circuits, machine control circuits, IoT applications and power systems application, energy minimization.
2. to understand and use the datasheets and specifications of different components.
3. handling of test and measuring instruments for analysis and debugging.
4. use of modern tools and integrate industry 4.0 wherever necessary.

A group of students 2 to 4 may take up a mini project to design and fabricate power electronics converters, machine prototypes, protection circuits, machine control circuits, IoT applications and application to power systems. The work will involve appropriate literature survey and design calculations. The skill sets like PCB design, hands on fabrication, testing using available instruments and completion level of prototype will be considered for due weight age. The student has to submit reports for T1, T2 and end sem. The evaluation will be based upon the team work, innovation, report writing and relevance.

IOC-21006 Wind Energy Systems

Teaching Scheme:
Lectures: 2 hrs/week
Field Visit: As necessary

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:

Students will be able to:

1. understand the basics of wind energy, availability, applications, various types of wind energy systems, introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics.
2. a field visits will be designed for firsthand experience and demonstration of the system elements.
3. know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of multiple choice type or of the type-define, identify, state, match, list, name etc.).
4. understand basic concepts. (To measure this outcome, questions may be of the type explain, describe, illustrate, evaluate, give examples, compute etc.).

Unit 1 **[6 Hrs]**

Physics of Wind Power
History of wind power, Indian and global statistics, wind physics, Betz limit, tip speed ratio, stall and pitch control, wind speed statistics and probability distribution, wind speed and power.

Unit 2 **[8 Hrs]**

Introduction to Wind Energy Technologies
Introduction to wind turbines, types of wind energy systems, typical construction of various wind energy systems, wind electricity generation, environmental impact of wind electricity generators.

Unit 3 **[8 Hrs]**

Introduction to Small Scale Wind Electricity Generators
Small scale Wind Electricity Generation (WEG) systems, wind turbine basics, generator designs for small scale WEG, site requirements for small scale WEG, controllers for small scale WEG, grid integration, operation and maintenance of WEG, manufacturing, quality assurance, certification.

Unit 4 **[8 Hrs]**

Large Scale Wind Power Plants
Large scale wind turbine basics, turbine design basics, generator design, control systems, safety, grid integration, power evacuation, site selection, state of the art wind turbine manufacturers, applicable standards, certification, power generation forecasting, design of wind farms, operation and maintenance, life.

Unit 5 **[4 Hrs]**

Economics of Wind Energy Systems
Life cycle costing, payback, return on investment; calculations for selection, costing and payback for WEG system, fiscal incentives, tariff calculations.

Unit 6 **[6 Hrs]**

Field Visits
One or more of the following visits may be undertaken.

- Small scale wind electricity generator system manufacturer.
- Large scale wind farm.
- Manufacturer of electronics and control systems for WEG.

Reference Books:

- Tony Burton et al, "Wind Energy Handbook", John Wiley & Sons Ltd., New York, USA.
- Ahmad Hemami, "Wind Turbine Technology", Cengage Learning, Clifton Park, New York, USA.
- Research papers and publications from various manufacturers.
- Government and Electricity Board documents ASTM, DIN and BIS standards.

EE (DE)-21001 Embedded Systems

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. deploy low end applications using low and high level languages on microcontroller platform.
2. test and debug peripherals in embedded system.
3. identify, design and implement applications on embedded platform.

Syllabus contents:

Introduction to embedded system design and embedded system design flow. Signal conditioning and various signal chain elements, their operations, critical specifications, how to smartly choose elements from wide choice available in market. Various elements include operational amplifier, comparators, instrumentation op amp, ADCs, DACs, DC-DC Converters, isolators, level shifters and ESD protection devices. Use case analysis. Systems on chop, memory subsystem, Bus structure, Interfacing protocol, Peripheral Interfacing, testing and debugging, Power management, Software for embedded systems, design of analog signal chain from sensor to processor with noise, power signal bandwidth, accuracy considerations. Software programming optimization, concurrent programming. Real time Scheduling,

I/O management, embedded operating systems. Developing embedded systems, Building dependable embedded systems.

Reference Books:

- Steve Heath, "Embedded Systems Design", Butterworth-Heinemann.
- Wyne Woff, "Principles of embedded computing system design", Morgan Koffman Publications 2000.
- Qing Li, "Real Time Concepts for Embedded Systems", Elsvier, 2011.
- Shibu K. V., "Introduction to Embedded Systems ", Mc Graw Hill.
- Frank Vahid, Tony Givargis, "Embedded System Design", John Wiley.
- Lyla, " Embedded Systems", Pearson, 2013.

EE (DE)-21002 Wind and Solar Energy

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. demonstrate the importance of energy security and sustenance.
2. design standalone solar PV system and solar thermal system for various applications.
3. design standalone wind energy system.
4. design the grid connected solar PV and wind energy system.

Syllabus Contents:

Historical development and current status, characteristics of wind power generation, network integration issues, generators and power electronics for wind turbines, power quality standards for wind turbines, technical regulations for interconnections of wind farm with power systems, isolated wind systems, reactive power and voltage control, economic aspects, impacts on power system dynamics, power system interconnection experience in the world, introduction of solar systems, merits and demerits, concentrators, various applications, solar thermal power generation, PV power generation, cost effectiveness.

Reference Books:

1. Thomas Ackermann, Editor, "Wind power in Power Systems", John Willy and sons ltd.2005.
2. Siegfried Heier, "Grid integration of wind energy conversion systems", John Willy and sons ltd., 2006.
3. K. Sukhatme and S.P. Sukhatme, "Solar Energy", Tata MacGraw Hill, Second Edition, 1996.
4. Mukund Patel, "Wind and Solar Power Systems", CRC Press, 1999.

5. Gilbert M. Master, "Renewable and efficient electric power systems" John Wiley and Sons", 2004.

EE (DE)-21003 Industrial Electrical Systems

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. design the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
2. design and estimate electrical systems.
3. interpret Indian electrical rules.
4. design motor control circuits.

Unit 1 **[2 hrs]**

Electrical Symbols and Standards
Need of electrical symbols, list of symbols, electrical diagrams, methods of representations for wiring diagram.

Unit 2 **[8 hrs]**

Design of Simple Electrical Circuits
Light and Fan Circuits, Alarm Circuits, Introduction to simple light and fan circuits, System of connection of supply and accessories, Introduction to simple alarm circuits with and without relay, Schematic and wiring diagrams for alarm and signal circuits without relays, Alarm circuit with relays, Design of Small Transformer and Chokes, Theory of transformer design, Design and making of a small transformer, Design of Chokes.

Unit 3 **[8 hrs]**

Design Considerations of Electrical Installations
Design and Drawing of Panel Boards, Introduction, Design conditions, standard sizes of boards, Electric supply systems, Three phase four wire distribution systems, Protection of electric installation against overload, short circuit and earth fault, Earthing, General requirements and testing of electrical installations, Indian Electricity rules, Neutral and earth wire, Types of loads, Systems of wiring, Service connections, Service mains, Sub circuits, Location of outlets, Location of control switches, Location of main board and distribution boards, Load assessment, Guidelines for installation of fittings, Permissible voltage drops and sizes of wires, Estimating and costing of electrical installations.

Unit 4 **[8 hrs]**

Electrical Installations
Electrical Installations for different types of buildings and small industries, Electrical installations for residential buildings – estimating and costing of material, Electrical installations for commercial buildings, Electrical installations for small industries.

Unit 5 **[6 hrs]**

Overhead and Underground Transmission and Distribution Lines
Supports for transmission lines, Distribution Lines – materials used Underground cables, Mechanical design of overhead lines, Design of underground cables, Quantity estimation, Substations, Types of substations, Outdoor substations – pole mounted type Indoor substations – flour mounted type.

Unit 6 **[8 hrs]**

Motor Control Circuits
Starting of 3-phase squirrel cage induction motor, Starting of multi-speed squirrel cage motors, Starting of wound rotor motor, Starting of synchronous motors, Stopping of motors, Contactor control circuit components, Basic control circuits, Motor protection Schematic and wiring diagrams for motor control circuits.

Text Books:

- S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 6th edition, 2009.
- K. B. Raina and S. K. Bhattacharya, "Electrical Design, Estimating & Costing", New age International Publisher, Reprint, 2009.

Reference Book:

- Surjeet Singh, "Electrical estimating and costing", Dhanpat Rai and Co., Second edition, 2001, reprint 2008.
- Web site for IS Standards.
- Technical manual of Switchgear Industry.

EE (DE)-21004 Mechatronics

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:
At the end of this course students will able to:
1. use transducer and sensor.
2. use processor/controllers.

3. design PID controllers.
4. build circuit using PLC.
5. design hydraulic and pneumatic circuits.

Unit 1 **[6 hrs]**

Introduction
Definition of mechatronics. Mechatronics in manufacturing, products and design. Review of fundamentals of electronics.

Unit 2 **[8 hrs]**

Elements of Mechatronics
Data conversion devices, sensors, microsensors, transducers, signal processing devices,relays, contactors and timers.

Unit 3 **[4 hrs]**

Processors /Controllers:
Microprocessors, microcontrollers, PID controllers and PLCs.

Unit 4 **[6 hrs]**

Drives and Mechanisms of an Automated System Drives
Stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems.

Unit 5 **[8 hrs]**

Hydraulic System
Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits.

Unit 6 **[8 hrs]**

Pneumatic System
Production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

Text Books:

- K. Ogata , "Modern Control system", Prentice Hall
- S. N. Singh, "Computer aided process control", Prentice Hill

Reference Books:

- Boucher, T. O., "Computer automation in manufacturing - an Introduction", Chapman and Hall, 1996.

E Learning Resource:

- Prof. Dr. Shrikrishna N. Joshi lecture series on mechatronics at http://nptel.iitm.ac.in

EE (DE)-21005 Utilization of Electrical Energy

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. use appropriate method of electrolysis.
2. apply appropriate heating methods.
3. select appropriate welding methods.
4. deign of simple lighting scheme.
5. understand traction system.

Unit 1 **[8 Hrs]**

Electrolytic Process
Definition and Basic principle of Electro Deposition, Important terms regarding electrolysis, Faradays Laws of Electrolysis, Definitions of current efficiency, Energy efficiency, Principle of Electro Deposition, Factors affecting the amount of Electro Deposition. Factors governing the electro deposition, State simple example of extraction of metals, Application of Electrolysis.

Unit 2 **[8 Hrs]**

Electrical Heating
Advantages of electrical heating, mode of heat transfer and Stephen's Law, Discuss principle of Resistance heating, Direct Resistance heating, Indirect Resistance heating, working principle of direct arc furnace and indirect arc furnace, Principle of Induction heating, Working principle of direct core type, vertical core type and indirect core type Induction furnace, Principle of coreless induction furnace and skin effect, Principle of dielectric heating and its application, Principle of Microwave heating and its application.

Unit 3 **[8 Hrs]**

Arc Welding
Principles of arc welding, D. C. & A. C. arc phenomenon, D.C. & A. C. arc welding plants of single and multi-operation type, Types of arc welding, principles of resistance welding, Descriptive study of different resistance welding methods.

Unit 4 **[3 Hrs]**

Illumination - 1

Nature of Radiation and its spectrum, Terms used in Illuminations- i. Luminous intensity, ii. Lumen, iii. Intensity of illumination, iv. MHCP, v. MSCP, vi. MHSCP, vii. Brightness, viii. Solid angle, ix. Luminous efficiency, the inverse square law and the cosine law, polar curves, light distribution and control, maintenance factor and depreciation factors, design of simple lighting schemes and depreciation factor.

Unit 5 **[5 Hrs]**

Illumination - 2

Constructional feature and working of Filament lamps, effect of variation of voltage on working of filament lamps, Discharge lamps, excitation in gas discharge lamps, constructional factures and operation of: - Fluorescent lamp. (PL and PLL Lamps) , Sodium vapor lamps, High pressure mercury vapour lamps. Neon sign lamp, High lumen output & low consumption fluorescent lamps, introduction to Dialux software.

Unit 6 **[8 Hrs]**

Electric Traction

System of traction, System of Track electrification, Running Characteristics of DC and AC traction motor, Explain control of motor, Tapped field control, Rheostatic control, Series parallel control, Metadyne control, Braking of the following types. Regenerative Braking, Braking with 1-phase series motor, Magnetic Braking.

Text Books:

- Partab, "Art & Science of Utilization of electrical Energy", Dhanpat Rai & Sons.
- C. L. Wadhwa, "Generation, Distribution and Utilization of electrical Energy", New Age International (P) Limited, Publishers, 1997
- N. V. Suryanarayana, "Utilization of Electrical Power including Electric drives and Electric traction", New Age International (P) Limited, Publishers, 1996.

Reference Books:

- E. Openshaw Taylor, "Utilisation of Electric Energy", Orient Longman.

EE (DE)-21006 Restructured Power Systems

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

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

1. describe various types of regulations in power systems.
2. identify the need of regulation and deregulation.
3. analyze the Technical and Non-technical issues in Deregulated Power Industry.
4. identify and give examples of existing electricity markets.
5. classify different market mechanisms and to summarize the role of various entities in the market.
6. define and describe various pricing mechanisms in the Generation, Transmission and Distribution sector.

Syllabus Contents:

Fundamentals of restructured system, market architecture, load elasticity, social welfare maximization, OPF: role in vertically integrated systems and in restructured markets, congestion management, optimal bidding, risk assessment and hedging, transmission pricing and tracing of power, ancillary services, standard market design, distributed generation in restructured markets, developments in India, IT applications in restructured markets, working of restructured power systems.

Reference Books:

- Lorrin Philipson, H. Lee Willis, "Understanding electric utilities and de-regulation", Marcel Dekker Pub.,1998.
- Steven Stoft, "Power system economics: designing markets for electricity", John Wiley and Sons, 2002.
- Kankar Bhattacharya, Jaap E. Daadler, Math H. J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
- Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured electrical power systems: operation, trading and volatility", Marcel Dekker.

EE-21010 Control System Engineering

Teaching Scheme:
Lectures: 3 hrs/week
Tutorial: 1 hrs/week

Examination Scheme:
Assignments /Quiz: 40 Marks
End sem exam: 60 Marks

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. appreciate role of the linear feedback control system.
2. analyze mathematical model of the linear feedback control system.
3. solve the linear feedback control system to get time domain response.
4. analyze stability of the linear feedback control system.
5. use bode plot for frequency domain analysis of the linear feedback control system.
6. analyze the linear feedback control system in state space.

Unit 1 **[6 Hrs]**

Introduction to Control System
Introduction to control system block diagram. Importance of Control Systems. Components of control system, explanation with the help liquid level control system. Significance of actuators and sensors. Types of actuators, Types of sensors. Open loop control and closed loop control. Use of relays, switches and contactors for simple and sequential control system.

Unit 2 **[6 Hrs]**

Control System Representation
Mathematical representation of simple mechanical, electrical, thermal, hydraulic system. Block diagram representation and reduction. Signal flow graph. Transfer function of these systems. Pole zero concepts.

Unit 3 **[8 Hrs]**

Time Domain Analysis
Time response of first order, second order systems. Analysis of steady state error, Type of system and steady state error, Time response specifications. Effect of parameter variation on open loop and closed loop system response, sensitivity. Effect of feedback on system response, stability and disturbance.

Unit 4 **[8 Hrs]**

Stability
Concept of stability, Effect of pole zero location on stability, Routh- Hurwitz criterion. Root Locus method for analysis of gain margin, phase margin and stability.

Unit 5 **[8 Hrs]**

Control System Analysis in Frequency Domain
Concept of frequency domain behaviour, Bode Plot for analyzing system in frequency domain. Frequency domain performance specifications. Correlation between time domain and frequency domain specification. Nyquist Analysis.

Unit 6 **[8 Hrs]**

State Space Approach
Representation of system in state space, Converting transfer function model in to state space model. Non uniqueness of state space model, Canonical representation, Eigen values, Solution of state equations, Concept of State feedback control, controllability, Observability.

Text Books:

- Nagrath and M. Gopal, "Control System Engineering", Anshan, 2008.
- Norman S. Nice, "Control System Engineering", 2008, Wiley.

Reference Books:

- Smarajit Ghosh, "Control Systems Theory & Applications", Pearson Education, 2007.
- Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall, 2010.

EE-21011 Power System Operation and Control

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Assignments /Quiz: 40 Marks
End sem exam: 60 Marks

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. understand basics of electrical power system operation and control.
2. identify, formulate and solve power system problems for frequency and voltage control.
3. analyze different control strategies for real and reactive power scheduling using control devices.
4. get knowledge of electricity markets and demand side management.
5. understand various power quality issues and concept of micro-grid.

Unit 1 **[7 Hrs]**

Power System Operation and Constraints
Operational objectives, Operating states of the power systems, Generator capability curve, Dielectric constraints, thermal constraints and stability (angle and voltage) constraints.

Unit 2 **[6 Hrs]**

Frequency Control
Load frequency control and economic load dispatch control (single area and two area), Speed governors, governor characteristics, Automatic generation control (AGC), frequency dependence of loads.

Unit 3 **[8 Hrs]**

Reactive Power Compensation and Voltage Control
Reactive power characteristics of major equipment like generator, transformer, transmission line, cable, HVDC converter, Reactive Power compensation devices: shunt capacitors, reactors, tap changing transformers, static VAR compensators.

Unit 4 **[8 Hrs]**

Power Flow Control and Real Power Scheduling
Power flow control: fixed and variable series reactance compensation, Phase shifter, TCSC, HVDC links, Real power scheduling: operational objectives and constraints, Formulation as optimization problem, Economical power system operation, Optimal power flow.

Unit 5 **[6 Hrs]**

Preventive Emergency And Restorative Control
Introduction to energy management system (load dispatch center), Introduction to state estimation, SCADA, Preventive control: Generation rescheduling, Load tripping, Emergency control: Under-frequency load tripping, generator tripping, system islanding, Restorative control.

Unit 6 **[6 Hrs]**

Power System Economics and Recent Developments
Basic pricing principles, Electricity pricing and markets: market models, Demand side management, Transmission and distribution pricing. Introduction to Power Quality, Integration of renewable energy sources, Concept of micro-grid.

Textbooks:

- I.J. Nagrath & D.P. Kothari, "Modern Power System Analysis", Tata McGraw Hill, 3rd Edition.
- Prabha Kundur, "Power System Stability and Control", McGraw Hill, 1994.

Reference Books:

- K.R. Padiyar, "Power System Dynamics Stability and Control", Edition 2, BS Publications, 2008.
- Grainger John J. and William D. Stevenson, "Power System Analysis"McGraw Hill, 2nd Edition.
- Sadat Hadi, "Power System Analysis", McGraw Hill, 1999.
- R.C. Dugan, "Electrical Power System Quality", 2nd Edition, Tata McGraw-Hill Education, 2012.

EE-21012 Power Electronics

Teaching Scheme:
Lectures: 3hrs/week
Tutorial: 1 hr/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:

After completion of this course students will be able to

1. describe the structure, characteristics, and protection of various P.E. devices.
2. analyse the single phase and three phase AC-DC and AC-AC converters.
3. design and analyse various DC-AC converters.
4. design different control strategies for various DC-AC converters.
5. describe the performance characteristics of various DC-DC converters.
6. identify and design driver circuits and magnetics in various PE converters.

Unit 1 **[7 Hrs]**

Thyristor & Transistor Family Devices
Structure, Characteristics, switching actions, Trigger requirements, Ratings, protection and snubber circuit and application of Power diode, SCR, TRIAC, IGBT, Power MOSFET, GaN, SIC devices and Introduction to IPM.

Unit 2 **[8 Hrs]**

AC-DC and AC-AC Converter
Principle of On-off and phase control Semi and full controlled SCR based converters, Performance parameters and input-output waveforms for R, R-L loads. Single phase AC voltage controllers with triacs. MOSFET based PFC rectifier.

Unit 3 **[8 Hrs]**

DC-AC Converter
Thyristor based inverter: Single phase with R and R-L load. PWM Inverters: single phase and three phase circuits, principle of operation, performance parameters. Multilevel Inverters: Cascaded H bridge, diode clamp, (3 level).

Unit 4 **[8 Hrs]**

PWM Techniques
Selected harmonic elimination PWM, Sinusoidal PWM (1ph and 3ph), third harmonic injection, Space vector PWM. TTL & DSP logic for PWM generation for power converters. PWM for Multilevel inverter .

Unit 5 **[8 Hrs]**

DC-DC Converter
MOSFET/IGBT based choppers: Buck , Boost, Buck-Boost , Fly back converter, their working , output waveforms, performance analysis, continuous conduction mode, Voltage Mode Control, Current mode control, Modeling of VM buck converter in CCM. Concepts of voltage and current balance.

Unit 6 **[8 Hrs]**

Driver Circuit and Magnetic Design for PE Converters
Driver circuit design, Power loss and efficiency calculation for power converters, Heat sink design and selection, Magnetic design for inductor and transformer.

Text Books:

- Ned Mohan, "Power Electronics: A First Course", Wiley Publication.
- P. C. Sen, "Power Electronics", Tata McGraw hill Publication.
- M. H. Rashid, "Power Electronics", PHI publication, 3rd edition, 2004.

Reference Books:

- Keith H. Sueker, "Power Electronic Design: A Practitioner's Guide", Elsevier Publication.
- Kumar L. Ashok, "Power Electronics with MATLAB", Cambridge University Press.
- B W Williams, "Power Electronics: Devices, Drivers, Applications and Passive Components", Mac-millan Publication.
- Issa Bataresh, Ahmad Harb, "Power Electronics circuit design & analysis", second edition.

EE-21013 Control System Engineering Laboratory

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme:
Term Work: 50Marks
Oral/Practical: 50 Marks

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. develop the mathematical model of different components of linear feedback control system using simulation and experiments.
2. analyze the transient characteristics of different first order and second order systems using simulation and experiments.
3. determine the performance of system using root locus.
4. carry out stability analysis of linear feedback control system using Bode plot and Nyquist plot.
5. carry out stability analysis of linear feedback control system using Modern control techniques.
6. demonstrate an industrial application (like Bottle filling/Pick and Place control) using PLC
7. write and present effectively technical reports.

List of Experiments:

1. To study input-output characteristics of various control system components.
2. To obtain step response and find time response specifications of electrical system, hydraulic system, pnematic system and thermal system.
3. To find transfer function and poles zeros of DC motor experimentally.
4. To obtain root locus experimentally.
5. Use Matlab to study the effect of feedback gain on system response.
6. Use Matlab to study the effect of damping factor zeta on time response performance specifications.
7. Use Matlab to obtain root locus for a given system and find performance specifications there from. Study effect of addition of zero and pole on root locus.
8. Use Matlab to get bode plot and obtain gain margin and phase margin for various systems.
9. Use Matlab to obtain state space representation from transfer function, find Eigen values, and analyze controllability, observability and stability.
10. To study an industrial application (like Bottle filling/Pick and Place control) using PLC.

EE-21014 Power Electronics Laboratory

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme:
Term Work: 50Marks
Oral/Practical: 50 Marks

Course Outcomes:

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

1. evaluate the V-I characteristics for different power semiconductor devices.
2. demonstrate the operation and control techniques of power converters.
3. analyze the waveforms exhibited at the input and output ports of the converters.
4. simulate and analyze different converters with their control strategies

List of Experiments:

1. To evaluate SCR Characteristics their Turn-on methods & Commutation methods.
2. To evaluate IGBT/MOSFET Characteristics its loss calculations &measurement of Rds-on and parasitic capacitances including miller capacitor.
3. To study TRAIC application as AC voltage regulator, measurement of harmonics. THD and PF.

Any three from 4 to 8

4. To evaluate the performance of Single phase diode Rectifiers with R, RC and RL load.
5. To evaluate the performance of Single phase PWM Rectifiers
6. To evaluate the open loop performance of DC-DC buck converter
7. To evaluate the open loop performance of DC-DC boost converter
8. To evaluate the performance of MOSFET based PWM Inverter.

Any two from 9 to 12

9. To perform matlab/PSIM simulation of EV charging technology
10. To perform matlab/PSIM Simulation of PFC Converter
11. To perform matlab/PSIM Modeling & analysis of DC-DC converter
12. To perform matlab/PSIM Simulation of Multilevel inverter or various PWM strategies

EE-21015 Machine Learning Laboratory

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Term Work: 50 Marks
Oral/Practical: 50 Marks

Course Outcomes:

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

1. code efficiently in python
2. explain the basic concepts of machine learning.
3. make use of data sets in implementing the machine learning algorithms
4. understand the implementation procedures for the machine learning algorithms
5. appreciate the underlying mathematical relationships within and across machine learning algorithms.
6. design and apply machine learning algorithms to real world problems.

The laboratory should consist of minimum eight experiments based on the following topics:

List of Experiments:

1. Data structure in python.
2. Plotting with python.
3. Linear Regression.
4. Logistic Regression.
5. Classification.
6. Implementation of AND/OR/NOT Gate using Perceptron.
7. Implementation of XOR Gate Using Multi-Layer Perceptron/ Error Back Propagation.
8. Implementation of XOR Gate Using Radial Basis Function Network.
9. Understanding the concepts of Perceptron Learning Rule.
10. Understanding the concepts of Correlation Learning Rule.
11. Write a program to demonstrate the working of the decision tree based algorithm.
12. Implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file.
13. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set.
14. Deep Learning Based experiment – 1.
15. Deep Learning based experiment – 2.

Text Books:

- Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", 2nd edition, Springer, 2017.

Reference Books:

- Ethem Alpaydin, "Introduction to Machine Learning", Second Edition, The MIT Press, 2010.
- Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.
- Stephen Marsland, "Machine Learning: An Algorithmic Perspective", CRC Press, 2009.

e Learning Resources:

- Prof. Andrew Ng, Stanford online lecture series on Machine Learning https://www.coursera.org/learn/machine-learning
- Prof. Andrew Ng, Stanford online lecture series on Deep Learning Specialization https://www.coursera.org/specializations/deep-learning
- Prof. Balaraman Ravindran, IIT MAdra, online lecture series on Machine Learning https://nptel.ac.in/courses/106/106/106106139/

Minor Course

EE (MI)-21003 Machines and Drives

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Assignments /Quiz: 40 Marks
End Sem Exam: 60 Marks

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. evaluate the steady state behavior and basic operating characteristics of A.C Machine
2. demonstrate analytical skills to assess machine performance in steady state
3. understand the basics of electric drives and fundamentals of drive dynamics
4. analyze DC drive, Induction and Synchronous Motors Drives.

Unit 1 **[6 Hrs]**

D.C. Motors
Principles of working, Significance of back emf, Torque Equation, Types, Characteristics and Selection of DC Motors, Starting of DC Motors, Speed Control, Losses and Efficiency, Condition for Maximum Efficiency, Braking of DC Motors, Effect of saturation and armature reaction on losses; Applications, Permanent Magnet DC Motors, Type and Routine tests.

Unit 2 **[8 Hrs]**

Three phase Induction (Asynchronous) Motor
Types of induction motor, flux and mmf waves, development of circuit model, power across air gap, torque and power output, starting methods, speed control, induction generator, induction machine dynamics, high efficiency induction motors, Single phase IM, Modeling of induction machine.

Unit 3 **[9 Hrs]**

Synchronous Machines
Construction, types, armature reaction, circuit model of synchronous machine, determination of synchronous reactance, phasor diagram, power angle characteristics, parallel operation of synchronous generators, synchronizing to infinite bus bars, two axis theory, synchronous motor operation, dynamics, modeling of synchronous machine, PM synchronous machines.

Unit 4 **[6 Hrs]**

Electric Drives, Dynamics and Control
Definition, Advantages of electrical drives, Components of Electric drive system, Selection Factors, speed control and drive classifications, Motor-Load Dynamics, Speed Torque conventions and multi quadrant operation, Equivalent values of drive parameters. Load Torque Components, Nature and classification of Load Torques, Constant Torque and Constant Power operation of a Drive, Steady state stability, Load epilation and selection motors. .

Unit 5 **[6 Hrs]**

DC Motor Drives
DC motors and their performance starting, transient analysis, speed control, ward Leonard drives, Controlled rectifier fed drives, [full controlled3 phase rectifier control of dc separately excited motor], multi-quadrant operation, Chopper controlled drives Closed loop speed control of DC motor.

Unit 6 **[6 Hrs]**

Induction and Synchronous Motor Drives
Induction motor analysis, starting and speed control methods- voltage and frequency control, current control, closed loop control of induction motor drives, rotor resistance control, Slip power recovery – Static Kramer and Scherbius Drive, Single phase induction motor starting, braking and speed control. Synchronous motor operation with fixed frequency, variable speed drives, PMAC and BLDC motor drives, Stepper motor drives, switch reluctance motor drives.

Textbooks:

- D. P. Kothari, I. J. Nagrath, "Electric Machines ", Tata McGraw Hill Publication, Fourth edition, reprint 2012.
- A.E. Fitzgerald, Charles Kingsley Jr., Stephen D. Umans ,"Electric Machinery", Tata McGraw Hill Publication, sixth edition 2002.
- G. K. Dubey, "Fundamentals of Electrical Drives", Second edition (sixth reprint), Narosa Publishing house, 2001.

Reference Books:

- M. G. Say," Alternating current machines", fifth edition, E.L.B.S. Publication.
- A. F. Puchstein, T.C. Lloyd, A.G. Conrad, "Alternating current machines", John Wiley and Sons, New York, 1954.
- P. C. Sen, "Principles of Electric Machines and Power Electronics ", John Wiley and Sons Publication, second edition 1997.
- M. H. Rashid, "Power Electronics -Circuits, devices and Applications", 3rdEdition, PHI Pub. 2004.
- B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.

Renewable Minor Course

EE (MI)-21005 Wind Energy Systems

Teaching Scheme:
Lectures: 3 hrs/week
Field Visit: As necessary

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:

Students will be able to:

1. understand the basics of wind energy, availability, applications, various types of wind energy systems, introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics.
2. a field visits will be designed for firsthand experience and demonstration of the system elements.
3. know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of multiple choice type or of the type-define, identify, state, match, list, name etc.).
4. understand basic concepts. (To measure this outcome, questions may be of the type explain, describe, illustrate, evaluate, give examples, compute etc.).

Unit 1 **[6 Hrs]**

Physics of Wind Power
History of wind power, Indian and global statistics, wind physics, Betz limit, tip speed ratio, stall and pitch control, wind speed statistics and probability distribution, wind speed and power.

Unit 2 **[8 Hrs]**

Introduction to Wind Energy Technologies
Introduction to wind turbines, types of wind energy systems, typical construction of various wind energy systems, wind electricity generation, environmental impact of wind electricity generators.

Unit 3 **[8 Hrs]**

Introduction to Small Scale Wind Electricity Generators

Small scale Wind Electricity Generation (WEG) systems, wind turbine basics, generator designs for small scale WEG, site requirements for small scale WEG, controllers for small scale WEG, grid integration, operation and maintenance of WEG, manufacturing, quality assurance, certification.

Unit 4 **[8 Hrs]**

Large Scale Wind Power Plants

Large scale wind turbine basics, turbine design basics, generator design, control systems, safety, grid integration, power evacuation, site selection, state of the art wind turbine manufacturers, applicable standards, certification, power generation forecasting, design of wind farms, operation and maintenance, life.

Unit 5 **[4 Hrs]**

Economics of Wind Energy Systems

Life cycle costing, payback, return on investment; calculations for selection, costing and payback for WEG system, fiscal incentives, tariff calculations.

Unit 6 **[6 Hrs]**

Field Visits

One or more of the following visits may be undertaken.

- Small scale wind electricity generator system manufacturer.
- Large scale wind farm.
- Manufacturer of electronics and control systems for WEG.

Reference Books:

- Tony Burton et al, "Wind Energy Handbook", John Wiley & Sons Ltd., New York, USA.
- Ahmad Hemami, "Wind Turbine Technology", Cengage Learning, Clifton Park, New York, USA.
- Research papers and publications from various manufacturers.
- Government and Electricity Board documents ASTM, DIN and BIS standards.

Honors Course Syllabus for Electrical and Renewable

EE (HO)-21002 Embedded System Design

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 Marks each
End-Sem Exam – 60 Marks

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

4. deploy low end applications using low and high level languages on microcontroller platform.
5. test and debug peripherals in embedded system.
6. identify, design and implement applications on embedded platform.

Syllabus contents:

Introduction to embedded system design and embedded system design flow. Signal conditioning and various signal chain elements, their operations, critical specifications, how to smartly choose elements from wide choice available in market. Various elements include operational amplifier, comparators, instrumentation op amp, ADCs, DACs, DC-DC Converters, isolators, level shifters and ESD protection devices. Use case analysis. Systems on chop, memory subsystem, Bus structure, Interfacing protocol, Peripheral Interfacing, testing and debugging, Power management, Software for embedded systems, design of analog signal chain from sensor to processor with noise, power signal bandwidth, accuracy considerations. Software programming optimization, concurrent programming. Real time Scheduling, I/O management, embedded operating systems. Developing embedded systems, Building dependable embedded systems.

Reference Books:

- Steve Heath, "Embedded Systems Design", Butterworth-Heinemann.
- Wyne Woff, "Principles of embedded computing system design", Morgan Koffman Publications 2000
- Qing Li, "Real Time Concepts for Embedded Systems", Elsvier, 2011.
- Shibu K. V., "Introduction to Embedded Systems ", Mc Graw Hill.
- Frank Vahid, Tony Givargis, "Embedded System Design", John Wiley.
- Lyla, " Embedded Systems", Pearson, 2013.