College of Engineering, Pune

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

Department of Instrumentation and Control Engineering

Curriculum Structure & Detailed Syllabus (UG Program)

Third Year B. Tech. - T. Y. B. Tech.

(Revision: 2019-2023, Effective from 2021-22)

Program Education Objectives (PEOs):

PEO1:Core Competency: Graduate will solve real world problems appropriate to the field of Instrumentation & Control Engineering using foundation of mathematics and science.

PEO2:Breadth: Graduate will apply current industry accepted practices, new and emerging technologies to analyze, design, implement, and maintain the state-of-art solutions.

PEO3:Learning Environment: Exhibit self- learning capabilities to assimilate and practice emerging theories and technologies.

PEO4:Professionalism: Inculcate professional and ethical attitude and ability to relate automation issues to society at large as well as exhibit teamwork and effective communication skills.

PEO5:Preparation: Be successfully employed or accepted into a graduate program / higher studies, and demonstrate a pursuit of lifelong learning.

Program Specific Outcomes (PSOs)

PSO1. Design and deploy Instrumentation systems to enhance the performance of the industrial and real life applications.

PSO2. Devise innovative systems and control methodologies to cater the needs of the core industrial problems.

PSO3. Create knowledge base for ease in implementing advanced techniques for seamless integration of the technology for the real life applications.

Program Outcomes (POs):

PO1:Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, to Instrumentation and Control discipline to the solution of complex engineering problems.

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

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4:Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities.

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

PO7:Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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

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

PO11:Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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

Correlation between the PEOs and the POs

PO→ PEO↓	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
PEO1	✓	✓	✓	✓		✓							✓		✓
PEO2	✓	✓	✓	✓	✓		✓							✓	
PEO3	✓	✓	✓	✓	✓				✓			✓			✓
PEO4								✓	✓	✓	✓		✓	✓	✓
PEO5									✓	✓	✓	✓	✓		✓

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	Humanity Science and .....Course
7	MLC	Mandatory Learning Course
8	LLC	Liberal Learning Course
9	IOC	Interdepartmental Open Course
10	DE	Department Elective

CURRICULUM STRUCTURE OF T. Y. B. TECH (I & C)

(Effective from A. Y. 2021-2022)

I- Semester:

Sr. No.	CourseType/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	**Humanities and Social Science Open Course - I**					
	HSMC/ AS (HS)- 21001	English Language Proficiency	2	0	0	2
	HSMC/ AS (HS)- 21003	Japanese Language				
	HSMC/ AS (HS)- 21002	German Language				
	HSMC/ AS (HS)- 21004	Spanish Language				
5	SBC/ IE-21005	Microprocessors and Microcontrollers Lab	0	0	2	1
6	IFC/ CT(IF)-21002	Fundamentals of Machine Learning **[Offered by Computer Science Dept.]**	1	0	2	2
7	PCC/ IE-21001	Microprocessors and Microcontrollers	3	0	0	3
9	PCC/ IE-21002	Process Loop Components	3	0	0	3
10	PCC/ IE-21003	Control System Design	3	0	0	3
11	PCC/ IE-21004	Digital Signal Processing **(Blended MOOC)**	3	0	0	3
12	LC/ IE-21006	Process Loop Components Lab	0	0	2	1
13	LC/ IE-21007	Control System Design Lab	0	0	2	1
14	LC/ IE-21008	Digital Signal Processing Lab	0	0	2	1
		Total	**19**	**1**	**10**	**24**
		Total Academic Engagement and Credits	**30**			**24**

Sr. No.	CourseType/Code	Course Name	Teaching Scheme			Credits
			L	T	P	
Honor: Instrumentation and Control						
1	HT/ IE(HT)-21001	Sensor Modeling and Design	3	0	0	3
Minor: Industrial Automation						
1	MI/ IE(MI)-21001	Sensors and Actuators	3	0	0	3
Minor: Biomedical Instrumentation						
1	MI/ IE(MI)-21002	Anatomy and Physiology of Human Body	3	0	0	3

II-Semester:

Sr. No.	CourseType/Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1	MLC/ ML-21002	Environmental Studies	1	0	0	0
2	**Humanities and Social Science Open Course - II**					
	HSMC/ AS (HS)-21008	Finance for Engineers	2	0	0	2
	HSMC/ AS (HS)- 21007	Engineering Economics				
	HSMC/ AS (HS)- 21005	Industrial Psychology				
	HSMC/ AS (HS)- 21006	Personal Psychology				
3	SBC/ IE-21009	Mini project Design-Simulate- Prototype -Test]	0	1	2	2
4	IOC/ IOC-21001	Programmable Logic Controller and Its Applications	2	0	0	2
5	**Department Elective-I(Industry Floated Elective Course)**					
	DEC/ IE(DE)-21001	Power Electronics and Drives	3	0	0	3
	DEC/ IE(DE)-21002	Automotive Instrumentation				
	DEC/ IE(DE)-21003	Industrial Internet of Things				
6	PCC/ IE-21010	Industrial Automation	3	0	0	3
7	PCC/ IE-21011	Robotics and Automation	3	0	0	3
8	PCC/ IE-21012	Analytical Instrumentation	3	0	0	3
9	PCC/ IE-21013	Instrument and System Design	3	0	0	3
10	LC/ IE-21014	Industrial Automation Lab	0	1	2	2
11	LC/ IE-21015	Robotics and Automation Lab	0	0	2	1
12	LC/ IE-21016	Analytical Instrumentation Lab	0	0	2	1
		Total	**20**	**2**	**08**	**25**
		Total Academic Engagement and Credits	**30**			**25**

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits
			L	T	P	
Honor: Instrumentation and Control						
1	HT/ IE(HT)-21002	Optimization and Optimal Control	3	0	0	3
Minor: Industrial Automation						
1	MI/ IE(MI)-21003	Programmable Logic Controller	3	0	0	3
Minor: Biomedical Instrumentation						
1	MI/ IE(MI)-21004	Medical Sensors	3	0	0	3

[MA-21001] Probability and Statistics for Engineers

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

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

Course Outcomes:

- **Learn** a number of methods of summarizing and visualizing data sets, compute probabilities of events.
- **Use** the concepts of random variables and associated probability distributions, understand the meaning of central limit theorem.
- **Perform** basic statistical inference (t-test, z-test, F-test, χ^2 –test, confidence interval)
- **Perform** basic regression analysis.
- **Demonstrate** use of R software for statistical analysis.

Course Contents

Unit I **(5hrs)**
Descriptive statistics: Measures of location and variation. Visualization of data: Frequency tables, bar diagrams, histograms, heat maps, other visualization tools, Review on introduction to combinatory and probability theory

Unit II **(5hrs)**
Basicsof probability distributions: Binomial, Poisson, Exponential, and Normal. Central limit theorem

Unit III **(5hrs)**
Introduction to 'R': Introductory R language fundamentals and basic syntax, major Rdata structures, Using R to perform data analysis, creating visualizations using R.

Unit IV **(5hrs)**
Basic statistical inference and hypothesis testing: Estimation, basic tests such as t-test, z-test, F-test, χ2 -test.

Unit V **(4hrs)**
Regression methods: Simple linear regression and multiple regressions.

Unit VI **(4hrs)**
Engineering applications of statistics: Discussion on reliability and quality control. Introduction to random processes, stochastic processes, Markov chains.

Text Books

- Ronald E, Walpole, Sharon L. Myers, Keying Ye, Probability and Statistics for Engineers and Scientists (8th Edition), Pearson Prentice Hall, 2007.
- Ross S.M., Introduction to probability and statistics for Engineers and Scientists (8th Edition), Elsevier Academic press, 2014.

Reference Books

- S. P. Gupta, Statistical Methods, S. Chand & Sons, 37th revised edition, 2008.

- Morrison S.J., Statistics for Engineers - An introduction, Latest edition, 2009.
- William W. Hines, Douglas C. Montgomery, David M. Goldsman, Probability and Statistics for Engineering, (4th Edition), Wiley Student edition, 2006.
- 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.
- The practice of Business Statistics by Manish Sharma and Amit Gupta, Khanna Publishing Company Private Limited, New Delhi, 2014.

[ML-21001] Constitution of India

Teaching Scheme
Lectures: 1 hr/week

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

Course Outcomes:

- Interpret the Preamble and know the basics of governance of our nation.
- Identify the different aspects covered under the different important Articles.
- Apprehend the basic law, its interpretation and the important amendments.
- Understand our Union and State Executive better.
- Recognize the basic that along with enjoying the rights one needs to fulfill one's duties.
- Summarize and Gain confidence on our Constitution by knowing it better.

Course Contents

Unit I **(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 II **(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 III **(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 IV **(2 hrs)**
Emergency Provisions, Electoral procedure in India, Amendment procedure and few important Constitutional Amendments

Text Books

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

Reference Books

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

[HS-21001] Entrepreneurship Principles and Process

Teaching Scheme
Lectures: 2 hrs./week

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

Course Outcomes:

- Discover, develop, and assess different types of Entrepreneurial ventures and opportunities.
- Learn about opportunity and risk analysis
- Use the strategies for valuing your own company, and how venture capital is tandangel investors use valuations in negotiating milestones, influence and control
- Pick correct marketing mix and how to position the company in the market by using analytical tools
- Learn how to sale themselves and the product/service and to handle objections
- Know how organizations operates, their process matrices, start new ventures, write winning business plans

Unit I Market Research Types of Companies and Organizations (3 hrs)
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 II Business Finance, Marketing & Digital Marketing (4 hrs)
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 III Sales & Operations Management (3hrs)
Understanding Sales, Pitching Techniques, Sales strategies, Inside Sales v/s Outside Sales, RFP Operational Basics, Process Analysis, Productivity, Quality

Unit IV Start-ups (2 hrs)
Start-up Basics, Terms, Start-up Financing, Start-up Incubation, Start-up Incubation, Getting Listed

Text Books

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

References Books

- Kanungo,R.N.(1998).Entrepreneurship and innovation: Models for development (Ed.,Vol.2). New Delhi: Sage.
- Van Nostrand. Verma, J.C.,& Singh,G.(2002).Small business and industry: A handbook for entrepreneurs. New Delhi: Response-Sage.

- Richard ABrealy& Steward C Myres. Principles of Corporate Finance, Mc Graw Hills, 7thEdn,2004
- Prasanna Chandra, Financial Management: Theory and Practice, Tata McGraw Hills, 6th Edn, 2004 IMPandey, Financial Management, Vikas Publishing

[AS (HS)-21001] English Language Proficiency

Teaching Scheme
Lectures: 2 hrs./week

Examination Scheme
Assignments,T1 and T2: 60 Marks
End-Sem Exam: 40 Marks

Course Outcomes:

- Understand concepts of English language and apply them practically.
- Reproduce meaningful and well-structured sentences for conversation or speech in English.
- Analyze, comprehend and write well and effectively produce enhanced formal communication in English.
- Display their Presentation skills and participate and produce healthy discussions both formally and informally among peers using English.
- Create impact by acquiring professional skills, confidently face interviews and be better employable and industry ready.

Course Contents

Unit I English for communications (8 hrs)
Basic understanding of language and its need for effective business communication for Engineers, Formal and informal expressions, Vocabulary Building, Business Idioms

Unit II Presentation Skill Development (6 hrs)
Oral Presentations, Basic Mannerisms and Grooming required for professionals, Cross cultural communication, Business Etiquette

Unit III Business Writing (8 hrs)
Writing Mechanics, Note making, Summarizing, Letter & Email Writing, Business Reports, and Statement of Purpose

Unit IV Employability Enhancement (6 hrs)
Job Readiness, Interview Skills and Mock Interviews

Reference Books

- Business Communication by Shalini Verma (2nd Edition) (Vikas Publishing House)
- Communication for Business: A Practical Approach by Shirley Tailor (Longman)
- Communication Skills for Engineers by S. Mishra & C. Murali krishna (Pearson)
- Communication Skills for Technical Students by T.M. Farhathullah (Orient Longman)
- Enhancing Employability at Soft Skills by Shalini Varma (Pearson)
- Written Communication in English by Saran Freeman (Orient Longman)
- Corporate Communication by Jai shri Jethwaney (Oxford University Press)

- Business Correspondence and Report Writing, R. C. Sharma & Krishna Mohan (Tata McGraw Hill)
- Essential English Grammar (Intermediate & Advanced) Raymond Murphy (CUP)

[AS (HS)-21003] Japanese Language

Teaching Scheme
Lectures: 2 hrs./week

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

Course Outcomes:

- Acquire knowledge of facts about Japan and Japanese culture,
- Familiarize with pronunciation of Japanese letters and daily greetings, Accent, Intonation and Japanese writing System Hiragana, Katakana and Kanji
- Identify numbers, Colors, Years, Months and Days, Time expressions, Directions to read the city map
- Describe themselves and third person and family members
- Construct simple questions or sentences and interact with the teacher and classmates.
- Apply Engineering Terminology and Japanese work culture such as Monozukuri, 5S, Kaizen, 3M, 5W1H etc.

Course Contents

Unit I **(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 II **(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 III **(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 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
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 IV **(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.

Reference 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)-21002] German Language

Teaching Scheme
Lectures: 2 hrs./week

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

Course Outcomes:

- Acquire knowledge of facts about Germany and German culture (cultural sensitization).
- Adapt pronunciation of German letters and greetings.
- Identify and calculate numerical till 1000.

- Describe themselves and third person.
- Construct simple questions or sentences and interact with the teacher and classmates.
- 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.

Course Contents

Unit I Guten Tag! (Good day) (6 hrs)
Greetings, self introduction and partner introduction, numbers till 100, how to mention telephone number and email address, about countries, nationalities and languages.

Unit II Freunde, Kollegen und ich (Friends, colleagues and myself) (6 hrs)
Hobbys, days of the week, months, seasons and professions, classroom objects and classroom communication

Unit III Dining out (6 hrs)
Understanding German cusine, meal courses, names of the ingredients, conversation with the waiter and in the supermarket.

Unit IV Uhrzeit (Timing) (6 hrs)
Mention time, daily routine, making appointments

Unit V Grammatik (grammar) (6 hrs)
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. 2015. Goyal Publishers & Distributors Pvt. Ltd. Delhi, India
- 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)-21004] Spanish 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 be able to
- Acquire knowledge of facts about Spain and Latin Americaand Spanish culture, pronunciation of Spanish letters and greetings.
- Identify and calculate numerical till 1000.
- Describe themselves and third person.
- Construct simple questions or sentences and interact with the teacher and classmates.
- Comprehend time and time related phrases, illustration of the same in conversations.

Course Contents:

Unit I Hola! (Hello) (6 hrs)
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 II La comida (Food) (6 hrs)
Understanding Spanish cusine, meal courses, names of the ingredients, converstaion with the waiter and in the supermarket.

Unit III La ropa (clothing) (6 hrs)
Clothing, accessory (as per weather), season+ weather, vocabulary, Demonstrative pronouns, how to ask about price, numbers till 1000

Unit IV La hora (Timing) (6 hrs)
Mention time, daily routine, making appointments

Unit V La gramática (grammar) (6 hrs)
Vocab, Verb conjugations, WH-question, verbs, pronounciation, personal pronouns, articles, Singular und Plural, negation.

Reference Books

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

CT(IFC)-21002 Fundamentals of Machine Learning

Teaching Scheme	Examination Scheme
Lectures: 1 hrs./week	Assignment/Quizzes: 40 Marks
Practical: 2 hrs./week	End-Sem Exam: 60 Marks

Prerequisites: Relevant applied math and statistics: probability theory, probability distribution, Conditional probability, Bayesian probabilities.

Course Outcomes:

- To introduce students to the basic concepts, tools and techniques of Machine Learning.
- To develop skills of using recent machine learning software for solving practical problems.
- Analyze and Evaluate the different ML models.
- Implement ML algorithms to solve real life problems.

Course Contents:

Unit I (2 hrs)
Introduction to Machine Learning: Basic concepts, Machine Learning methods: Supervised, Unsupervised, Semi-supervised, Inductive, Reinforcement Learning.

Unit II **(3 hrs)**

Linear Regression: Introduction toLinear regression, Logistic Regression, Naive Bayes Algorithm, Model Selection, Linear basis function model, model assessment, assessing importance of different variables, subset selection. Cross Validations.

Unit III **(3 hrs)**

Hypothesis Design: Types of variables, Types of measurement scales, Constructing the Hypothesis, Null hypothesis, Alternative Hypothesis. Hypothesis testing, type 1 error, Type 2 error, Confidence of Interval.

Unit IV **(3 hrs)**

Instance Based Learning: Feature selection, supervised and unsupervised learning, Classification Algorithms: K-Nearest Neighbour Classification and Decision Tree.

Unit V **(3 hrs)**

Neural Network: Introduction, Feed forward network, Network training, Back propagation NN, Regularization, Error Analysis, Deep Neural Network.

Text Books

- Tom M. Mitchell, "Machine Learning", First Edition, McGraw Hill Education, ISBN 978-12-5909-695-2
- Andreas C. Müller and Sarah Guido , "Introduction to Machine Learning with Python: A Guide for Data Scientists", First Edition, O'Reilly Media, ISBN 978-14-4936-941-5

Reference Books

- Trevor Hastie, Robert Tibshirani, and Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Second Edition, Springer, ISBN 978-03-8784-857-0
- Christopher M. Bishop, "Pattern Recognition and Machine Learning", Second Edition, Springer, 978-03-8731-073-2
- Hadley Wickham and Garrett Grolemund, "R for Data Science: Import, Tidy, Transform, Visualize, and Model Data", First Edition, O'Reilly, ISBN 978-14-9191-039-9

Suggested List of Practical Assignments:

1. Exploratory Data Analysis: Perform following operations on any open dataset available in Python/Kaggle:

- Load data into a data frame from a .cvs or any other file format.
- Identification of variables and data types.
- Display number of rows and columns.
- Find Missing Values.
- Replace/eliminate missing values
- Change column name(s) to short/easy names if required.
- Drop unessential columns.
- Add new columns
- Display first/last few rows.
- Find average/min/max of numeric columns.

- Find mode of non-numeric columns.
- Display unique values in each column.
- Display summary of dataframe

2. Plots: Using various plots explore the relationship between attributes of a dataset.
3. Build a Linear Regression Model using New York Stock Exchange dataset, to predict. This dataset contains historical data from the New York stock market.
4. Build a Linear Regression Model using Real estate price prediction dataset.This real estate dataset was built for regression analysis, linear regression, multiple regression, and prediction models. It includes the date of purchase, house age, location, distance to nearest MRT station, and house price of unit area. Take a dataset contains 1000 or more row, and each input point contains 3 features. Train a linear regression model on the dataset. Report the coefficients of the best fit model.
5. Developed a logistic regression model to predict whether a produced microchip should be accepted or rejected based on a dataset from quality tests.
6. Create a Data frame having below contents:

Day	**Weather**	**Temperature**	**Humidity**	**Wind**	**Play?**
1	Sunny	Hot	High	Weak	No
2	Cloudy	Hot	High	Weak	Yes
3	Sunny	Mild	Normal	Strong	Yes
4	Cloudy	Mild	High	Strong	Yes
5	Rainy	Mild	High	Strong	No
6	Rainy	Cool	Normal	Strong	No
7	Rainy	Mild	High	Weak	Yes
8	Sunny	Hot	High	Strong	No
9	Cloudy	Hot	Normal	Weak	Yes
10	Rainy	Mild	High	Strong	NO

7. Use Decision Tree algorithm to predict to play or not to play.
8. Use a dataset like 'Credit.csv' contains data existing customers with below attributes

Variables	**Variable Description**
Cdur	Credit Duration (in Months)
Cpur	Purpose of credit (Business, electronics, etc)
Camt	Credit amount (in Rs.)
Prop	Properties held by the borrower (Real estate, other cars, etc.)
age	Age of the borrower
Credit Score	Credit rating of the borrower (bad/good)

Build a k-NN model for classifying the credit rating of the customers based on their credit history. What is the highest accuracy (in %) achieved by this k-NN model.

9. Use the 'iris.csv' dataset, which has four features of a flower, as mentioned below. Determining the optimum number of clusters using K-Means clustering algorithm. Build the

algorithm and find the optimum 'k' value, ranging between 1 to 10 by setting the seed value as 111.

Variables	Variable Description
Sepal Length	Sepal Parameters (Length and Width, in cm)
Sepal Width	
Petal Length	Petal Parameters (Length and Width, in cm)
Petal Width	

What is the optimal number of clusters for the k-means model built using the information given above? Determine the value of between-clusters sum of squares of and the value of the total sum of squares for the k-means model built with the optimal k value.

10. Train a neural network classifier using the dataset Run cross-validation and compute the classification error per fold.(https://www.kaggle.com/datasets).
    Also perform a statistical test on the two sets of error observations (one from decision trees and one from neural networks) and report your findings.
11. Add some new emotions to the existing dataset. What changes should be made in decision trees and neural networks classifiers in order to include new classes? Justify

[IE-21001] Microprocessors and Microcontrollers

Teaching Scheme
Lectures: 3 hrs./week

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

Course Outcomes:

- Understanding the basic architecture details of 8-bit CISC and RISC series Microprocessor and Microcontrollers [PEO1][PO-2]
- To impart Microcontroller programming and design skills in students [PEO2][PO-3]
- To encourage the students to have a better understanding on state-of-the-art architecture details, interfacing technologies, their potential applications and their market views [PEO3][PO-5]
- Ability to undertake problem identification, formulation and selection of appropriate Microcontrollers as per applications [PEO5][PO-12]

Unit I Microprocessor and Microcontroller Architecture Basics (8 hrs)

Introduction to computer architecture and organization, CISC Vs RISC design philosophy, Von-Neumann Vs Harvard architecture. Microprocessor 8-bit, 16-bit architecture details, bus configurations, memory structure. Difference between Microprocessor and Microcontrollers

Unit II Programming Basics (8 hrs)

Assembler directives, editor, linker, debugger, simulator, emulator, Introduction to embedded-C. MCS-51 microcontroller: - Instruction set, instruction formats, and various addressing modes of Assembly language programming for 8051. Integrated Development Environment (IDE), cross-compiler. Simple program for delay generation with for loop, subroutines, writing functions.

Unit III I/O Programming with MCS-51 (6 hrs)

Ports and Ports structure, I/O programming, interfacing with simple switch, LED. Seven segment

LED interfacing techniques. Programming with alphanumeric LCD and matrix keypad. Watchdog timer and system clocks.

Unit IV On-chip Peripherals (6 hrs)
Programming with on-chip Timers, Counters, Serial Communication, UART, RS485 transceiver. Interrupts, interrupt execution sequence, programming with software and hardware interrupts.

Unit V External Peripherals (8 hrs)
Analog to digital convertor (ADC), interfacing with external serial and parallel ADC's, Digital to analog convertor (DAC), interfacing with DAC. Pulse Width Modulation, PWM, I2C, SPI, Interfacing with RTC, EEPROM.

Unit VI RISC Microcontroller (8 hrs)
RISC Microcontroller architecture, architecture details of 8-bit AVR series Microcontroller and PIC18 series Microcontroller. Programming and working with Arduino Atmega and PIC18FXX Microcontrollers. Case studies and embedded systems development.

Text Books

- The 8051 Microcontroller and Embedded Systems, by Muhammad Ali Mazidi, Janice Mazidi and RolinMckinlay, 2nd edition, Prentice-Hall, Inc, USA, 2005.
- AVR Microcontroller and Embedded Systems: Using Assembly and C, By Muhammad Ali Mazidi, Samad Naimi, SepehrNaimi, Person
- PIC Microcontroller and Embedded Systems using Assembly and C, by Muhammad Ali Mazidi, Pearson

References Books

- Intel Manual: MCS-51 Architecture
- AVR ATmega16 Series Manual
- PIC18 Series Manual

[IE-21002]Process Loop Components

Teaching Scheme
Lectures: 3 hrs./week

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

Course Outcomes:

- Examine the operation of the transmitter, final control elements, pneumatic and hydraulic components generally used in plants[PEO1][PO1]
- Design the required features of transmitter, final control elements, pneumatic and hydraulic components for specific application[PEO1][PO3]
- Review the performance of the transmitter, final control elements, pneumatic and hydraulic components[PEO2][PO3]
- Simulate and solve the problems associated with the functioning of transmitter, pneumatic system, and hydraulic system in instrumentation and control engineering.[PEO4][PO6]

Unit I Introduction to Transmitters (8 hrs)
Function of a transmitter, types, signal conditioning, characterization and calibration, Installation,

Commissioning and trouble shooting of a transmitter, auxiliary components like manifolds etc.SMART transmitter: Comparison with conventional transmitter, Block schematic.Function of a converter, types (I/P and P/I), signal conditioning, characterization and calibration, Installation, commissioning, and trouble shooting of a converter, auxiliary components like lock down relay etc.

Unit II Final Control Elements (8 hrs)

Operation of control valve, Classification of control valves based on: Valve body. Construction, Advantages, Disadvantages & applications, Types of actuators: Spring Diaphragm, Piston cylinder(power cylinder), Pneumatic, Hydraulic, Electro-hydraulic, Electric, and smart actuators, fail-safe operation. Control valve terminology: Range ability, valve capacity, Flashing, Cavitations, dead band, response time, Control valve characteristics: Inherent & installed, Valve sizing. Positioners: Application/Need, Types, Effect on performance of control valves, Volume boosters, Pressure Boosters etc.

Unit III Pneumatic Components and Systems (8 hrs)

Pneumatic Supply and its components: Filter Regulator Lubricator (FRL), Single acting & Double acting cylinder, Special cylinders, Operation of Direction Control valves, Types of pilot signal, operation of speed regulators, pressure control valve, Special valves like quick exhaust, pressure, time delay valve, Standard Symbols for pneumatic components

Pneumatic Circuits: Sequence diagram (step-displacement) for implementing pneumatic circuits, Different Pneumatic Circuits using standard symbols for components: direct acting control, indirect acting control, pressure sequencing, block transfer etc.

Unit IV Hydraulic Components and Systems (6 hrs)

Hydraulic supply: reservoir, Types of filters, Function of accumulators, Hydraulic Actuators, Operation of Direction Control Valve, Standard symbols for hydraulic componentsHydraulic Circuits: Meter in, Meter out, Reciprocating, speed control, Sequencing of cylinders, Direction control, applications

Unit V Auxiliary Components (6 hrs)

Manual switches, Mechanical switches, Relays: Electromechanical, Relay Logic, Solid state relays, relay packages Contactors: Comparison between relay & contactor, contactor size and ratings

Unit VI Hazardous Area Classification and Safety (6 hrs)

Hazardous area classification, Explosion Proof Housing, Encapsulation, Sealing, & Immersion, Purging systems, intrinsic safety, Concept of safety cycle, fault tolerance and safety integrity level(SIL)

Text Books

- Norman A. Anderson , "Instrumentation for Process Measurement and Control", CRC Press, Third Edition, 1980
- Industrial Electronics,Petruzella(Manual),Tata McGraw Hill.
- Pneumatic Instrumentation by Majumdhar, TMH

Reference Books

- William Andrews, "Applied Instrumentation in Process Industries", Gulf, Second Edition, 1979
- B. G. Liptak, "Process Control, Instrument Engineering Hand book", Chilton Book Company, Third Edition, 1995
- Control Valve Handbook, Fisher Controls International, Inc. third Edition, 2001

[IE-21003] Control System Design

Teaching Scheme
Lectures: 3 hrs./week

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

Course Outcomes:

- An ability to design controller in time domain and frequency domain [PEO1, PO-1, 2]
- An ability to design controller in state space [PEO2][PO-1, 3]
- Ability to design observer[PEO1][PO-1, 3, 5]
- Ability to design compensators in time and frequency domain[PEO2][PO-1, 3]

Course Contents:

Unit I Compensator Design (7 hrs)
Compensator design with root locus: transient response via gain adjustment, improving time domain specifications (steady state error, transient response) by cascade compensation, feedback compensation

Unit II Controller Design (Time domain) (8 hrs)
Controller design: Design of Proportional (P), Integral (I), Derivative (D), PI, PD, PID controllers, lead, lag, lead-lag controller by root locus method.

Unit III Controller Design (Frequency domain) (6 hrs)
Design of controller in frequency domain: Design of controller with bode plot, improvement of steady state and transient response with lead, lag, lead lag compensator design

Unit IV State Space Design (7 hrs)
State Space: General state space representation, converting state space to transfer function and vice versa controller design introduction, design with state feedback controller and Ackerman's formula

Unit V Observer Design (7 hrs)
Controller and Observer Design: Pole placement, solving pole placement with MATLAB, Controllability, different approaches for controller design, Introduction to observer, full order and reduced order observer, observability, different approaches for observability design.

Unit VI Uncertainties and Disturbances (7 hrs)
System uncertainties and disturbances: Effect of uncertainties and disturbances on system performance, uncertainty and disturbance estimation, Effect of uncertainties and disturbances on controller and observer design, effect of measurement noise and un- modeled dynamics.

Reference Books

- Franklin G.F., Powell J.D., Emami-Naeini A., Feedback Control of Dynamic Systems, Pearson, Upper Saddle River, New Jersey, 5th edition, 2006.
- Ogata K., Modern Control Engineering, Prentice-Hall of India Pvt Ltd., New Delhi, 3rd edition, 2000.
- Kuo B.C., Automatic Control Systems, Prentice-Hall of India Pvt Ltd., New Delhi, 6th edition, 1991.
- Brogan W. L., Modern Control theory, Prentice Hall International, New Jersey.

[IE-21004] Digital Signal Processing (Blended MOOC)

Teaching Scheme
Lectures: 3 hrs./week

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

Course Outcomes:

- Apply the various programming techniques on DSPs.[PEO1][PO-1, 2]
- Design FIR and IIR filters using different techniques.[PEO2][PO-1, 3, 5]
- Determine frequency, steady state and transient response of LTI systems.[PEO1],[PO-2]
- Apply the DFT and FFT methods for various signals and determine their frequency response.[PEO1],[PO-1, 2]

Course Contents:

Unit I **(6 hrs)**
Frequency Response Characteristics of LTI system: Frequency response of a system to complex exponential and sinusoidal signals, steady state and transient response to sinusoidal inputs signals, computation of frequency response functions.

Unit II **(6 hrs)**
FIR Filters: Finite Impulse Response Filters Introduction to finite impulse response filters, linear phase filters, symmetric & anti –symmetric filters, Design of FIR filter: windowing method, analysis of different types of windows,frequency sampling method, optimal equiripple, FIR differentiators

Unit III **(6 hrs)**
IIR Filters: Infinite Impulse Response Filter Introduction to Infinite Impulse Response filter, Butterworth, Chebyshev approximation. Design of IIR filters: Impulse invariant method, bilinear transformation, approximation derivative method, IIR filters design using least square method: Pade approximation. Frequency transformations: low pass to high pass, band pass, band reject.

Unit IV **(8 hrs)**
Multi-Rate Filters and Sampling: Changing the sampling rate, Down sampling, Up sampling, Fractional rate changes, Noble identities, Poly phase Decomposition Narrowband filter banks, Delay Systems, Integer sampling rate converters, Rational sampling rate converters, Multi rate filter realization structures, sub band processing.

Unit V **(8 hrs)**
Finite word length effect in digital filters: Representation of Numbers in Digital Systems, Binary codes, Radix Number System, Fixed point representation, floating point representation, Types of arithmetic in digital systems one's and two's complement addition, floating point addition, floating point multiplication, comparison of fixed point and floating-point arithmetic.Quantization by truncation and rounding quantization steps, truncation and rounding.Quantization of the input data, filter coefficients, product quantization error.Limit cycles in Recursive systemsZero input limit cycle, overflow limit cycle, scaling to prevent overflow.

Unit VI **(8 hrs)**
Digital Signal Processor: Harvard architecture and modified Harvard architecture. Introduction to fixed point and floating point DSP processors, architectural features, Computational units, bus architecture and memory architecture, data addressing, address generation unit, program control, program sequencer, pipelining, interrupts, features of external interfacing, on-chip peripherals,

hardware timers, host interface port, clock generator, SPORT. Programming of DSP Processor Addressing modes, Instruction set, Programming tools such as DSP Assembler, IDE environments like CCS for DSP chip or visual DSP for Analog DSP chips, programming using DSP processor, I/O Programming.

Text Books

- Proakis, Manolakis, "DSP Principles, algorithms and applications-, Pearson, Fourth ed.,2009.
- Oppenheim and Schafer, "Discrete time signal processing", Pearson Publication, Second ed.,2007.

Reference Books

- TMS320C67XX DSP Reference set, Vol. 2 1999.
- P. Lapsley, J. Bier, A. Shoham, E. A. Lee, "DSP processor fundamentals: Architecture and features", IEEE Press,1997.
- Rulpph Chassaing, "DSP and ApplicationswithTMS320C673&TMS320C716", Wiley IEEE, Seconded. 2008.
- A Antoniou, "DSP filter analysis and Design", McGraw Hill,1979.
- Avtarsingh, S. Srinivasan, "DSP Implementation using DSP microprocessors with examples" from TMS320C54XX",2004.

[IE-21005] Microprocessor and Microcontroller Laboratory

Teaching Scheme
Lectures: 2 hrs./week

Examination Scheme
Continuous Assessment: 50 Marks
Practical Exam- 50 Marks

Course Outcomes:

- Understanding and working with the development tools of MCS-51, PIC series and Arduino Microcontrollers[PEO-1][PO-1]
- Ability to develop, design and debug of the high level language programs for MCS-51 based and PIC18FX series microcontroller with basic interfacing techniques on different interfacing devices [PEO-2][PO-2]
- Ability to identify, and select an appropriate microcontroller as well as development tools for given applications [PEO-3][PO-3]
- Ability to function effectively as an individual and in teams, with the capacity to be a leader or manager as well as an effective team member[PEO-4][PO-9]

Students should perform minimum 10 experiments using following embedded platforms:

1. SIX experiments on 8051microcontrollers
2. Two Each experiments using PIC18FXX series microcontroller and ATMEGAXX Microcontroller

Experiments using MCS-51 development platform:

1. Learn and understand assembly instructions for 8051 and assembly programming for arithmetic, compare and memory block transfer.
2. Learn and understand embedded C programming using Keil IDE. Programming for basic arithmetic operations and GPIO programming
   a) Delay generation
   b) LED blinking
   c) Switch and LED interfacing
3. Display interfacing techniques and programming for 7-segment and LCD display

a) 7-segment LED programming
b) Alphanumeric LCD programming

4. On-chip peripherals programming
   a) Timers and counters
   b) PWM generation
   c) Polling method and Interrupt method programming
5. ADC,DAC and Serial port programming
   a) Programming for on-chip UART
   b) ADC Programming
   c) DAC Programming
6. External peripherals programming
   a) Interfacing of external EEPROM and RTC using I2C protocol
   b) Interfacing of external ADC using SPI protocol

Experiments using PIC18FX series and ATMEGAXX series Microcontroller:
Exercises

1. Working with PIC18F4550 and ATMEGA16 as RISC Microcontrollers
2. Learn and understand embedded C programming with Microchip and Arduino development tools.
3. GPIO programming for
   - I/O operations
   - Delay generation
   - LED blinking
   - Switch and LED interfacing
4. On-chip peripherals programming

[IE-21006] Process Loop Components Laboratory

Teaching Scheme
Lectures: 2 hrs./week

Examination Scheme
Term Work: 50 Marks
Practical Exam- 50 Marks

Course Outcomes:

- Design signal conditioning circuit for given transmitter design. [PEO2][PO-1, 3]
- Understand and operate final control element [PEO1][PO-1, 2]
- Understand standard symbols used for components in industry[PEO1][PO-1, 2]
- Select and use pneumatic components to build pneumatic circuit for given application.[PEO2][PO-3, 4]
- Formulate and solve a problem based on learned components[PEO 1, 2][PO-2]

List of Experiments:

1. Design of signal conditioning for a K-type thermocouple/ RTD
2. Configuration of D.P Transmitter and its application for flow measurement
3. Development of mathematical model of control valve
4. Calibration and fault finding of I/P converter
5. Size a control valve for given applications
6. Study of control valve & plot the characteristics of control valve
7. Design High/Low selector for given application

8. Design alarm Annunciator for given application
9. Learn operation of pneumatic components like DCVs, time delay valve, pressure sequence valve,etc
10. Design and develop pneumatic circuit to operate single acting and double acting cylinder
11. Design and Develop pneumatic circuit to press glued components
12. Design and Develop pneumatic circuit for plastic components embossing
13. Design and Develop pneumatic circuit to transfer block from a magazine.
14. Design and develop pneumatic circuit for sequencing of cylinders
15. Design and develop electro-pneumatic circuit
16. Designing intrinsic safety circuits (Zener barrier)
17. Field Visit

[IE-21007] Control System Design Laboratory

Teaching Scheme
Lectures: 2 hrs./week

Examination Scheme
Continuous Assessment: 50 Marks
Practical Exam- 50 Marks

Course Outcomes:

- Able to design controllers and observer for general systems to validate performance on real time system
- Able to design and PI, PD, PID controllers and evaluate the performance
- Able to design and validate the effect of uncertainty and disturbances on controller and observer design

Students have to perform minimum 8 experiments in MATLAB environment and validate in real time domain.

List of Experiments:

1. Find state transition matrix from a given system dynamic
2. Design an observer for a given system by using state space method.
3. Validation of observer design on QUBE (position and speed control).
4. Design state feedback controller for a given system.
5. Validation of controller design on QUBE (position and speed control)
6. Design controller by adjusting gain for a given system by using root locus method.
7. Validation of controller design on QUBE (position and speed control).
8. Design controller for improving transient and steady state response by root locus method.
9. Design of PID controller using Root locus technique
10. Design of PID controller using Bode plot
11. Validation of PID controller design on QUBE (position and speed control).
12. Design of lead controller to satisfy given specifications using bode plot.
13. Design of lag controller to satisfy given specifications using bode plot.
14. Design lag-lead controller to satisfy given specifications using bode plot.
15. Validation of lag-lead controller design on QUBE (position and speed control).
16. Study effect of uncertainty and disturbance on system performance.
17. Design of uncertainty and disturbance method and validate on QUBE.

[IE-21008] Digital Signal Processing Laboratory

Teaching Scheme
Lectures: 2 hrs./week

Examination Scheme
Term Work: 50 Marks
Practical Exam- 50 Marks

List of Experiments

1. Computation of impulse response of LTI system for given transfer function find the impulse response and print the output sequence using DSP LCDK6748 kit
2. Design a FIR filter with windowing technique

   Algorithm
   Input the pass band & stop band edge frequencies
   Input the type of filter (LP, HP)
   Input the order of the filter
   Find the filter coefficients
   Plot the magnitude and phase response

3. Design a FIR filter with windowing technique
   Algorithm
   Input the pass band & stop band edge frequencies
   Input the type of filter (BP, BR)
   Input the order of the filter
   Find the filter coefficients
   Plot the magnitude and phase response

4. Design the IIR Butterworth filter
   Algorithm
   Input the pass band & stop band edge frequencies
   Input the gain/attenuation/ripples
   Calculate order of filter
   Input the type of filter (LP, HP, BP, BR)
   Input the order of the filter
   Find the filter coefficients
   Plot the magnitude and phase response

5. Design the IIR Chebyshev filter
   Algorithm
   Input the pass band & stop band edge frequencies
   Input the gain/attenuation/ripples
   Input the type of filter (LP, HP)
   Input the order of the filter
   Find the filter coefficients
   Plot the magnitude and phase response

6. Program for illustration of upsampling
7. Program for illustration of effect of upsampling in frequency domain
8. Program for illustrationthe effect of anti-imaging filter

9. Program for illustration of downsampling
10. Program for illustration of effect of downsampling in frequency domain
11. Program for illustration the effect of anti-aliasing filter

    The student shall implement the filter design by program on DSP LCDK6748 kit

Honor: Instrumentation and Control

[IE (HT)-21001] Sensor Modeling and Design

Teaching Scheme
Lectures: 3 hrs./week

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

Course Outcomes:

- **Develop** a model a sensory system used in discrete and continuous process for selected applications
- **Identify** the lacunas in the existing model of a sensor, suggest, and implement improvements
- **Analyse** the effects of various parameters on sensor performance
- **Develop** a soft and hard proto-type for effective implementation of automation system at level zero

Course Contents:

Unit I **(6 hrs)**
Overview of modeling techniques, case studies based on first principle and data driven modeling, review of characteristics and performance of sensors.

Unit II **(8 hrs)**
Modeling of sensors for various parameters used for measurement of temperature, pressure, level, and flow

Unit III **(6 hrs)**
Modeling of sensors for various parameters used for measurement of displacement, velocity, and acceleration

Unit IV **(8 hrs)**
Future trends in sensor technologies, SMART sensors, semi-conductor sensors: architecture and fabrication techniques

Unit V **(8 hrs)**
Case studies for development of soft model of a sensor for a particular application, implementation of enhancement techniques for model accuracy,

Unit VI **(6 hrs)**
Case study: Develop a digital twin for a measurement system for the identified application and test it on live plant for its efficacy

Text Books

- Reference Books and material will be provided and access to virtual laboratory will be ensured for self-study.
- All the examinations will be open book and continuous in nature.

Minor: Industrial Automation

[IE (MI)-21001] Sensors and Actuators

Teaching Scheme
Lectures: 3 hrs./week

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

Course Outcomes:

- **Select and specify** a sensor actuator system for an application
- **Implement** a sensor and actuator system for discrete and continuous processes
- **Identify** the lacunas in the existing sensors selection and suggest improvements
- **Troubleshoot** the given sensors and actuators systems and commission it in a stipulated time
- **Develop** a proto-type for effective implementation of automation at level zero

Course Contents

Unit I Overview of discrete and continuous processes (6 hrs)
Characteristics, requirements, specifications, used cases, and cost considerations, block schematic of control loop, various parameters to assess performance

Unit II Overview of sensors and Transducers (6 hrs)
Case studies based on selection, specifications, installation, commissioning, and troubleshooting of various sensors used for measurement of temperature, pressure, level, and flow

Unit III Overview of sensors and Transducers (8 hrs)
Case studies based on selection, specifications, installation, commissioning, and troubleshooting of various sensors used for measurement of displacement, velocity, and acceleration

Unit IV Implementation case studies (8 hrs)
Case studies based on various applications in the area of construction, refrigeration, automotive, and traffic control system

Unit V Actuators (8 hrs)
Working, designing, selecting, and troubleshooting of pneumatic, hydraulic, and electrical actuators. Case studies comprising of application of actuator knowledge in real life situations and in chosen plants.

Unit VI Case studies (6 hrs)
Based on various applications and interfacing of sensors in chosen fields, actuators, safety aspects, maintenance and trouble shooting of sensor actuator systems

Text Books

- Reference Books and material will be provided and access to virtual laboratory will be ensured for self-study.

Minor: Biomedical Instrumentation

[IE (MI) - 21002] Anatomy and Physiology of Human Body

Teaching Scheme	Examination Scheme
Lectures: 3 hrs./week	T1 and T2: 20 Marks each End-Sem Exam: 60 Marks

Course Outcomes:

- Describe the level of structural complexity within the human body
- Define biological terms related to human anatomy and physiology
- Explain the functions of different biological organs and organic systems.
- Describe the structure and functions of heart
- Compare and contrast negative and positive feedback mechanism

Course Contents

Unit I Introduction to human body (8 hrs)

Levels of structural complexity; internal environment and homeostasis; Introduction to cell, tissue and organization of the body; the blood: Characteristics of blood, Cellular content of the blood, blood cell formation

Unit II The Musculoskeletal system (8 hrs)

Skeletal system- anatomy, Bone, Axial skeleton, Appendicle skeleton, Joints, Main synovial joints of the limbs, Muscle tissue- Anatomy, types of muscles, physiology of muscle contraction, generation of action potential, rhythmicity of cardiac muscle contraction, properties of skeletal and Cardiac muscles.

Unit III The Circulatory system (6 hrs)

Heart (Circulatory System)- Anatomy of heart and blood vessels, origin and conduction of heartbeat, cardiac cycle, electrocardiogram, blood pressure, control of cardiac cycle.

Unit IV Respiratory System (6 hrs)

Anatomy of respiratory system, physiology of respiration in the alveolar and tissue capillaries, control of respiration.

Unit V Digestive and Urinary system (8 hrs)

Digestive system- Anatomy of digestive system, nerve and blood supply, physiology of digestion
Kidney and Urinary system - Anatomy of urinary system and kidney, physiology of water and electrolyte balance, acid-base regulation.

Unit VI Nervous and sensory system (6 hrs)

Nervous system- Neuron, anatomy and function of different parts of brain, spinal cord, autonomic nervous system, Sensory system - Visual, auditory, Vestibular, Biological control and feed-back mechanism, clinical and technological implications

Reference Books

- Anne Waugh and Allison Grant, Ross and Wilson Anatomy and Physiology in Health and Illness, Elsevier Health Sciences, 11th edition, 2010.
- Guyton & Hall, "Textbook of Medical Physiology", 12th edition, Elsevier publication.
- Wilson and Wangh, "Anatomy and Physiology", 11th edition, Elsevier publication.
- C. C. Chatterjee, "Human Physiology", Vol- I & II.
- A. V. James & D. L. Sherman, "Human Physiology", 9th edition, McGraw Hill publication.

SEMESTER-VI

[ML-21002] Environmental Studies

Teaching Scheme
Lectures: 1 hrs./week

Examination Scheme
Periodic Assignments & Tests
Assignment:2 hrs/week

Course Outcomes:

- 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

Course Contents

Unit I Multidisciplinary nature of environmental studies (2 hrs)

Definition, scope and importance, Need for public awareness.

Unit II Natural Resources (8 hrs)

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 overutilization 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 III Ecosystems (6 hrs)

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 IV Biodiversity and its conservation (8 hrs)

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 V Environmental Pollution (8 hrs)

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 VI Social Issues and the Environment (7 hrs)

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 VII Human Population and the Environment (6 hrs)

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 VIII Field work (5 hrs)

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. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
- BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
- Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
- 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)-21008] Finance for Engineers

Teaching Scheme
Lectures: 2 hrs./week

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

Course Outcomes:

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

Course Contents

Unit I Introduction to Accounting & Finance (6 hrs)
Basic elements of financial accounting, cost concepts, preparation of Profit & Loss Account & Balance Sheet & concept of Budgetary control

Unit II Read & interpret Financial Statements (6 hrs)
As per Schedule III of Companies Act 2013, Financial statement analysis, concept of cash flow statement

Unit III (6 hrs)
Break-even analysis, Risk & Return relationship, time value of money, sources of finance and working capital

Unit IV (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

- Accounting for Managers – C Rama Gopal (2012), Accounting for Management, New Age International Publishers

- Financial Management – Theory and Practice - Prasanna Chandra [Mc Graw Hill] publication

[AS (HS)-21007] Engineering Economics

Teaching Scheme
Lectures: 2 hrs./week

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

Course Outcomes:

- Demonstrate understanding of economic theories and policies.
- Identify economic problems and solve it by applying acquired knowledge, facts and techniques in the available framework.
- Categorize, classify and compare economic situations and draw inferences and conclusions.
- Adapt to changing economic atmosphere and propose alternative solutions to the problems.

Course Contents

Unit I Introduction to Economics (6 hrs)
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 II Micro Economics Analysis (8 hrs)
Demand Analysis, Supply Analysis, Theories of Utility and Consumers Choice, Cost analysis, Competition and Market Structures. Application of micro economics theories

Unit III Macro Economic Analysis (8 hrs)
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 IV International Economics (8 hrs)
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

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

[AS (HS)-21005] Industrial Psychology

Teaching Scheme
Lectures: 2 hrs./week

Examination Scheme
Assignments/ Tests: 40 Marks
Field Visit/Expert Lecture Report 20 Marks
Mini Project Report: 40 Marks

Course Outcomes:

- Determine the psychological factors that influence individual differences at work and appraise the role of research.
- Explain the concepts of motivation and job satisfaction at work and Utilize the elements of organizational culture for enhancing group/team behavior.
- Evaluate the relevance & functioning of leadership & diversity in workforce and acknowledge the multicultural factors influencing workplace behavior.
- Illustrate the process of recruitment & selection and Experiment with the information required to sustain employability.
- Interpret the nuances of Human Factors in Engineering and Analyze itsrole in their disciplines.
- Measure the behavioral findings from self-lead projects and Propose corrective actions to improve quality of workplace behavior.

Course Contents

Unit I Basics of Industrial Psychology (IP) (6 hrs)
Difference between IP & Business Programs; Major fields & Employment in IP, Brief History- Scientific Management, Time and Motion Study, Hawthorne Studies, World Wars, Research in Social Sciences, Individual Differences at Work: Personality, Intelligence, Emotional Intelligence, Creativity & Innovation, Perception & Attitudes

Unit II People at Work (8 hrs)
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 III Human Factors Engineering (HFE) (8 hrs)
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 IV Managing People at Work (6 hrs)
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. (2013). Industrial Psychology. Cengage Learning: Delhi.
- Wickens, C. D.; Lee, J. D., Liu, Y. & Gordon Becker, S. E. (2015). An Introduction to Human Factors Engineering. 2nd Edition. Pearson Education: New Delhi.
- Landy, F. J. & Conte, J. M. (2010). Work in the 21st Century: An Introduction to Industrial and Organizational Psychology. 2nd Edition. Wiley India: New Delhi.

References Books

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

[AS (HS)-21006] Personal Psychology

Teaching Scheme	**Examination Scheme**
Lectures: 2 hrs./week	Assignments/ Tests: 70 Marks End-Sem Exam: 30 Marks

Course Outcomes:

- Acquire organizational concepts and will recognize their own personality attributes suitable for corporate world.
- Realize the importance of motivation and apply motivational principles to their lives
- Experience group dynamics and apply those principles in their lives
- Grasp and apply different techniques to maintain mental health.

Course Contents

Unit I Introduction- Understanding own personality and corporate world (6 hrs)
Basic concepts in Organizational set up and its importance, Know own personality attributes. Preparing for corporate world, work ethics, and self- management

Unit II Motivation (6 hrs)
Motivational theories for self- motivation and motivating others at work place, Approaches to work

Unit III Group dynamics (8 hrs)
Group behavior and leadership, Effective group behavior, Leadership and management principles, virtual teams and Performance appraisal

Unit IV Mental health at work place (6 hrs)
Occupational stress and conflict and strategies for its management, Emotional Intelligence, spiritual Intelligence.

****The course contents different psychometric tests, case studies and classroom activities and based on this content students have to maintain Personal Profile Journal.**

Text Books

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

Reference books

1. Robbins S, JudgeA, Vohra N:- (2013)Organizational behavior.(15th ed) Pearson Education,Inc.
2. Singh Kavita:- (2010) Organizational behavior-Text and cases. Dorling Kindersley

[IE-21009] Mini Project

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

Examination Scheme
Continuous Assessment: 50 Marks
Practical/ Oral Exam- 50 Marks

Course Outcomes:

- Able to apply the knowledge and skills previously gained into practice.
- Take appropriate decision with respect to various parameters related to production of a system or sub-system.
- Demonstrate the leadership quality along with ability to work in a group.
- Prove the ability to present the findings in a written report or oral presentation.

Course Contents

- Students are required to develop various modules required for their final year project, or a minim project e.g. power supply, processor module, interfacing module, display and signal conditioning module. The PCB and enclosure design is part of the activity of this subject. Testing of various modules as per industrial standards and practices is part of the experimental work. System Design Selection of sensors, signal conditioning, standard signals and noise considerations of typical systems. Student has to develop a mini project which will handle and measure a physical parameter such as temperature, pressure, vibration.
- The mini project shall be carried out in-house i.e. in the department's laboratories/centres by a group 2 – 3 students. In any case the group shall not consist of more than three students.
- The mini project shall consist of design and implementation of any suitable electronic system, sub system or circuit based on knowledge and skills previously gained.
- The mini project outline (a brief or condensed information giving a general view of mini project topic) on the selected topic should be submitted to the course coordinator for approval within one weeks from the commencement of the term.
- Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation.

- Deliverables: A mini project report as per the specified format (available on in the department and institutes website), developed system in the form of hardware and/or software. In addition, student shall maintain a record of attendance and continuous progress (log book in appropriate format available on institute/department's web site) duly signed by course coordinator and present as mini project deliverable along with report.

Evaluation System:
It includes Internal Continuous Assessment (ICA) and End Semester Examination (ESE). Guidelines for ICA and ESE are given bellow.

Internal Continuous Assessment (ICA)
- The ICA shall be evaluated by course coordinator.
- Course coordinator shall judge the students on the principle of continuous evaluation and contribution of individual student in the group.
- It shall be evaluated on the basis of deliverables of mini project and depth of understanding.
- Course coordinator shall maintain the record of continuous evaluation in appropriate format available on institute/department's web site.

End Semester Examination (ESE)
- The End Semester Examination for this course shall be based on demonstration of the system or sub system developed by the group of students, deliverables of mini project and depth of understanding (oral examination). It shall be evaluated by two examiners out of which one examiner shall be out of institute.

[IE (DE)-21001] Power Electronics and Drives (Department Elective-I)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs./week	T1 and T2: 20 Marks each End-Sem Exam: 60 Marks

Course outcomes:
- Understand, select and analyze operations of different power devices for different power electronics applications [PO1]
- Classify ,select and design different converters for various practical application[PO3]
- Understand importance of power quality aspect[PO2]
- Analyze different machine drives [PO3]
- Understand and apply different control strategies for power converters [PO1]

Course Contents

Unit I Power Devices (6 hrs)

Introduction to Power Electronics, Power devices: Diodes, SCRs, GTO, BJT, Power MOSFET, IGBT, IGCT, MCT - Characteristics, working, selection and protection

Unit II Rectifiers and Converters (8 hrs)

Diode rectifiers - Single Phase, three phase and polyphase; Controlled rectifiers – Single phase , three phase, PWM rectifiers and power factor improvement techniques; DC-DC Converters –

Choppers, Buck converter, Boost converter, Buck-Boost converter, Cuk converter, Bidirectional converters, Applications of DC-DC Converters.

Unit III Inverter and Cycloconverter (7 hrs)

Inverters – Introduction, Single phase & Three phase Voltage Source Inverters, Current source inverters, Close loop operation of inverters, multi-stage inverters; AC-AC converters – Single phase AC-AC voltage converter, Three phase AC-AC converter, Cycloconverter, Matrix converter

Unit IV Power Supply and Quality (7 hrs)

Power supplies - Linear series voltage regulators, Linear shunt voltage regulators, Integrated circuit voltage regulators, switching regulators. Power Quality - Reactive power & harmonic compensation, IEEE standards; Active filters – Series & shunt active filters

Unit V Machine Drives (7 hrs)

DC motor drives, Induction motor drives, synchronous motor drives, Permanent magnet synchronous motor drives, Permanent magnet brushless DC motor drives, Servo drives, stepper motor drives, switched reluctance motor drives, synchronous reluctance motor drives, Sensorless vector and Direct-torque controlled drives

Unit VI Control Methods for Power converters (7 hrs)

Introduction – Linear & non-linear control in power electronics, Power converter control using state space averaged models, sliding mode control of power converters, introduction to Fuzzy logic and AI based control of power converters, conclusion

Text Books

- Power Electronics – Converters, Applications and Design, Ned Mohan, Undeland, Riobbins, Wiley Student 3rd Edition2003 Edition, 2015
- Electric Motors and Drives – Fundamentals, types and Applications, Austin Huges& Bill Drury, Newnes Publication 4th Edition, 2013

Reference Books

- Power Electronics – Drives, Circuits and Applications, Muhammad H. Rashid, Pearson Publication 4th Edition, 2014
- Fundamentals of Power Electronics, Robert W. Erickson & Dragan Maksimovie, Sringer, 2nd Edition, 2001

[IE (DE)-21002] Automotive Instrumentation (Department Elective-I)

Teaching Scheme
Lectures: 3 hrs./week

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

Course outcomes:

- Acquire knowledge of key automotive systems, current technology and mega mobility trends.
- Ability to calculate propulsion out force requirement based on vehicle and other parameters.
- Understanding of automotive requirements – functional, non-functional and validation.
- Understanding automotive embedded product development processes.
- Ability to select appropriate sensors and actuators for the automotive embedded system.

- Ability to design electronic control unit.
- Acquire knowledge of future mobility trends – hybrid, electric and fuel cell vehicles.
- Acquire knowledge of motor control for EPS & EV.

Course Contents

Unit I **(5 hrs)**

Electronics in cars, Overview of automotive sensors & actuators, Current trends in automobiles with emphasis on increasing role of electronics andSoftware, Automotive mega trends, Overview of generic automotive control ECU functioning. Overview of typicalautomotive subsystems and communication protocols. Requirements engineering- functional, safety, test & validation, statutory, deriving requirements for electronics, software & mechanical domains etc.Processes – V development process, PEP (Product Engineering Process).

Unit II **(5 hrs)**

Engine fundamentals – 2 stroke, 4 stroke, petrol and diesel engines, Overview of engine systems – fuel delivery, fuel intake, ignition, cooling & exhaust, Sensors & actuators for engine management system – mass air flow, oxygen, throttle position, crank shaft position, cam shaft position, coolant temperature, air temperature, manifold pressure, ignition coil etc. Engine management ECU – transducer selection, design signal conditioning circuits, design output circuits, develop control algorithms.

Unit III **(5 hrs)**

Vehicle dynamics – force equations, deriving required power for engine sizing, gradient and acceleration requirements.

Unit IV **(7 hrs)**

Functional explanation and embedded system design overview for Anti-lock braking, Dynamic rear proportioning, Cornering brake control, Hydraulic brake assist, Traction Control and Electronic Stability, Electric Power steering.

Unit V **(7 hrs)**

Hybrid-Electric-Vehicles-need of electrification, need for hybridization, hybrid vehicle architectures– micro, mild, full hybrid (series & parallel), plug-in. Overview of Electronic technologies and products used in hybrid vehicles – DC-DC, BMS, ISG etc.

Unit VI **(10 hrs)**

Battery-Electric-Vehicle – architecture of vehicles, overview of EV motors, Trapezoidal motor control, FOC motor control, batteries.Fuel-Cell-Vehicles – overview of fuel cell, vehicle architectures, fuel cell reactions & equations.

Text Books

- William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, 2003, Newnes (Imprint of Elsevier Science).

Reference Books

- Young A.P. & Griffiths, " Automotive Electrical Equipment" , ELBS & New Press-1999
- Tom Weather Jr. &Cland c. Ilunter, "Automotive computers and control system", Prentice Hall Inc., New Jersey
- Crouse W.H., "Automobile Electrical Equipment" ,McGraw Hill Co. Inc., New York,1995.
- Bechhold, " Understanding Automotive Electronic", SAE,1998.
- Robert Bosh " Automotive Hand Book" (8th edition),2000.

[IE (DE)-21003] Industrial Internet of Things (Department Elective-I)

Teaching Scheme
Lectures: 3 hrs./week

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

Course Outcomes:

- To get familiar with IIOT concept and make students understand different types of Manufacturing & understanding of IS95/MOMs/ MES
- Understanding of key components of IIoT, Architectures and its pros & cons
- Understand different IIoT Business Models
- To get familiar with various Industrial IoT platforms
- Provide understanding of Privacy, Security & Governance
- Overview of Data analytics, Cloud services, IIoT Use cases & Recent Trends in IOT

Course Contents

Unit I Introduction to IIOT and Manufacturing Basics (10 hrs)

What is IIoT?, Definition of IoT, Overview of Components of IIoT, Differentiation between IoT &IIoT, Differentiation between IIoT& OT, Why need IIoT? Evolution of IoT, Technology & Business Drivers, Business Potential of IIoT& its impact on industry, Hype Cycle, Trends**,** Business Potential of IIoT, Driving Forces of IoT. IoT Taxonomy, Business Avenues in IIoT, Benefits of IIoT, IoT Ecology.**Manufacturing Basics-** Types of Manufacturing. Purdue Enterprise Reference Architecture (PERA)Model. Basics of ISA 88 /95 Standards. Levels of Control Hierarchy. Basic Understanding of Manufacturing Execution Systems (MES) / Manufacturing Operations Managements Systems (MOMS).

Unit II IoT Architecture (6 hrs)

Characteristic of IIoT System, Basics of Plant Software Layout & Hierarchy, Basics of Web Hierarchy. Architectures for IIoT. Elements of an IIoT, types of Architectures, examples, Pros & Cons of each architectures. IOT Architecture Design Patterns, IOT System Levels, Specifications Reference Architectures and Domain Models.

Unit III Basic elements of IIoT (8 hrs)

Sensors- Sensor Basics, Role of sensors in IIoT, Applicability of Sensors in different Industries. Design of sensors, Special requirements for IIoT sensors, Sensor architecture. **Actuators basics-** Types of Actuators, **Field Networks,** Overview of wired and wireless, Topologies of Networks. **Protocols-** Overview of Protocols like ZIGBEE, ZWAVE, MBUS, 6LoWPAN, OPC-UA

Unit IV Components of IIoT (6 hrs)

Different IIoT networks & connectivity, Modes of communications. Overview of various IIoT protocols like - COAP, 6LoWPAN, LWM2M, MQTT, AMPQ etc. Understanding of Edge and FOG Device Architectures. Influence of non-functional requirements on Edge and FOG devices. Edge/FOG Hardware selection criteria. Comparison of Industrial devices vs Prototype devices (Arduino, Mega, Pi, Galileo). Software Architecture of Edge/FOG devices

Unit V IoT Platforms and Data Security (6 hrs)

IOT Platform Architecture, Overview & Understanding of COTS cloud platforms like Predix, Watson, Thing works, Azure etc. Basic understanding of various business models like SaaS, PaaS &IaaS and pros & cons. Security Basics - Risk, Threat & Vulnerability, Risk Assessment. IIoT Security Framework based on IIC. Basic understanding of various IIoT security standards like NIST 82, IEC 62443, NERC, NIC etc.

Unit VI Data Analytics and Cloud Services (6 hrs)

Data Analytics Basics, various techniques – M2M, CSP, Machine Learning, Deep learning, AI. Overview of IOT Cloud Services. IIoT end-to-end use cases – Asset monitoring, utilities metering (power, water, gas). Recent Trends in IOTs

Text Books

- IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things - David Hanes, Gonzalo Salgueiro& others, Cisco Press
- Industry 4.0: The Industrial Internet of Things 1st ed. Edition by Alasdair Gilchrist
- Industrial Automation and Control System Security Principles: Protecting the Critical Infrastructure, Second Edition by Ronald L. Krutz, PhD, PE

Reference Books

- The Industrial Internet of Things Volume G1: Reference Architecture – IIC
- Industrial Internet of Things Volume G4: Security Framework – IIC
- The Industrial Internet of Things, Volume B01: Business Strategy and Innovation Framework – IIC
- Industrial Analytics: The Engine Driving the IIoT Revolution
- Internet of things Book – A hands on Approach byBahga – Madisetti
- The Internet of Things: Key Applications and Protocols 2nd Edition - Olivier Hersent

[IE-21010] Industrial Automation

Teaching Scheme
Lectures: 3 hrs./week

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

Course Outcomes:

- Examine hierarchy of Industrial Automation[PEO1] [PO-1]
- Solve the problem in control network[PEO1] [PO-3]
- Demonstrate functions of PLC and distributed control system[PEO5] [PO-5]
- Develop control logic for engineering system[PEO5] [PO-6]

Course Contents

Unit I Introduction to Automation (6 hrs)

Evolution of instrumentation and Control, types of industries, Benefits of automation, Computer based- Plant Automation, Evolution of Hierarchical system structure, Continuous versus Discrete Process Control

Unit II Instrumentation Standard Protocols (8 hrs)

An introduction to network, Introduction to open system interconnection (OSI)model, overall fieldbus trends, Instrumentation Network Design, Fieldbus advantages and disadvantages, HART Network, Foundation Fieldbus Network, Modbus TCP/IP , Ethernet and TCP/IP based system

Unit III Introduction to Programmable Logic Controller (8 hrs)

Architecture of PLC, Types of Input & Output modules (AI, DI, AO, DO), wiring diagram, ladder diagram using standard symbols, PLC specifications, PLC manufacturers, PLC ladder diagram, basic instructions, Times, counters instruction with timing diagram, advanced instructions

Unit IV Application of Programmable Logic Controller (6 hrs)

Application of Programmable Logic Controller in major Industries: working and automation of pump house, Motor Control Centre (MCC), elevator, drilling station, bottle filling station using the ladder diagram. Introduction to SCADA and Application

Unit V Interfacing to Programmable Logic Controller (6 hrs)

PLC Interfacing to AC and DC Drives/HMI/Hydraulic/Pneumatic/Motion control: Interfacing of VFD TO PLC, Interfacing to Pneumatic circuits, Interfacing to hydraulic system Introduction of Motion control, different elements in motion control

Unit VI Distributed Control System (8 hrs)

Introduction to Distributed Control System, Functional level, data base organization, Operator interface, Introduction to Object Linking and Embedding (OLE) for Process Control, application software, and Knowledge-based software

Text Books

- Gary Dunning , "Introduction to Programmable Logic Controller", Cengage Learning India Pvt. Ltd., Third Edition, 2006
- John W. Webb, "Programmable Logic Controllers", Prentice Hall, Fourth Edition, 1999
- Dobrivoje Popovic, "Distributed Computer Control for Industrial Automation", Marcel Dekker, 1990

Reference Books

- B. G. Liptak , "Process Control, Instrument Engineering Hand book", Chilton Book Company, Third Edition, 1995
- B. G. Liptak, "Process Software and Digital Networks", CRC Press. Third Edition 2000

[IE-21011] Robotics and Automation

Teaching Scheme
Lectures: 3 hrs./week

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

Course Outcomes:

1. **Perform** kinematic and dynamic analyses with simulation.
2. **Design** control laws for a robot.
3. **Integrate** mechanical and electrical hardware for a real prototype of robotic device.
4. **Select** a robotic system for given application.

Course Contents

Unit I **(7 hrs)**

Introduction to Robotics: Types and components of a robot, Classification of robots, closed-loop and open loop control systems. Kinematics systems; Basic definitions of Robotics, Descriptions: Positions, Orientations, Frames, Robot Anatomy – Links, Joints and Joint Notation scheme, Degrees of Freedom (DOF), mechanisms and manipulators, Required DOF in a Manipulator.

Unit II **(7 hrs)**

Robot Kinematics and Dynamics: Kinematic Modeling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics, Dynamic Modeling: Equations of motion: Euler-Lagrange formulation

Unit III **(8 hrs)**

Robotic sensor: Contact and Proximity, Position, Velocity, Force, Tactile, Force-Torque sensors. Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.Vision System: Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations, Vision applications in robotics.

Unit IV **(7 hrs)**

Robotics control: Second order linear system, Feedback control laws: P, PD, PID, Non-linear trajectory tracking control, joint controller, Control Hardware and Interfacing with sensors, actuators, components, Robotic Programming (ROS and VAL II), Applications of Industrial robot (PUMA, KUKA, FANUC, MTAB).

Unit V **(6 hrs)**

Artificial Intelligence in Robotics: Applications in unmanned systems, defense, medical, process industries, Motion planning – potential fields, projective path planning, Robotics and Automation for Industry 4.0

Text Books

- Ashitava Ghoshal, Robotics Fundamental Concepts & Analysis, Oxford University Press. (2006).
- Mittal and Nagrath , Robotics and Control , Tata McGraw-Hill Publishing Company Ltd., New Delhi (2004)
- Nikku, S.B., Introduction to Robotics, Prentice Hall of India Private Limited (2002).
- Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.

Reference Books

- Richard D. Klafter, Thomas A Chmielewski and Michael Negin, Robotics Engineering: An integrated approach, Prentice Hall. (1998)
- John Craig , Introduction to Robotics, mechanics and control, Pearson Education, New Delhi. (2005)
- M.P. Groover, Mitchell Weiss, Roger N. Nagel & Nicholas Godfrey, Industrial Robotics. Tata McGraw Hill Education Pvt. Ltd. (2001)
- Gonzalex, R. C. and Fu, K. S., Robotics Control Sensing, Vision and Intelligence, McGraw Hill (1985).
- Koren,Y., Robotics for Engineers, McGraw Hill (2004).

[IE-21012] Analytical Instrumentation

Teaching Scheme
Lectures: 3 hrs./week

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

Course Outcomes:

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

- Select the required instruments for spectroscopic analysis. [PEO1][PO-3]
- Understand the effects of different constituent in a process outcome and analysis the performance of various on-line or off-line instruments. [PEO3][PO-10]
- Apply the knowledge of chromatography to separate the constituents from a complex mixture. [PEO1][PO-11]
- Distinguish gas analyzer based on different principles [PEO2][PO-5]
- Interpret/ summarize chemical sensors and associated research in analytical instrumentation [PEO3][PO-12].

Course Contents

Unit I **(6 hrs)**

Introduction to Chemical instrumental analysis, advantages over classical methods, classification: Spectral, electro analytical and separative methods, Interaction of radiation with matter, Source (continuous and LASER), detector and optics design, Visible spectrophotometer,online colorimeter for process applications, turbidity meter,turbidityanalyzers and its applications

Unit II **(7 hrs)**

UV-Visible spectrophotometers and its types with its optical system design and its applications,UV and Visible analyzers with its applications in process industries, FTIR spectrophotometers and its applications

Unit III **(6 hrs)**

Emission Spectra, Quantitative measurements, Flame Photometer and its applications,concept of design of atomic absorption spectrophotometer, spectrum interpretation, interferences, applications of atomic absorption spectrophotometer

Unit IV **(8 hrs)**

Classification of Chromatographic methods, Gas chromatography, Process Gas Chromatograph, High Performance Liquid Chromatography (HPLC), applications in industries such as process, food and pharmaceuticals, mass spectrometer

Unit V **(6 hrs)**

Different types of gas analyzers based on measurement of quantitiessuch as infrared absorption, paramagnetism, thermal conductivity, its working and applications

Unit VI **(8hrs)**

Introduction to chemical sensors, semiconductor gas sensors for trace gas analysis and monitoring, electrochemical sensors such as Voltametry and conductometry based liquid sensors, smart chemical sensor system design and its applications

Text Books

- Willard, Merritt, John AurieDean, "Instrumental Methods of Analysis", CBS Publishers & Distributors, New Delhi, Seventh ed., 1988.
- R. S. Khandpur, "Handbook of Analytical Instruments", Tata McGraw–Hill Publications, Second ed., 2006.

Reference Books

- Bela G Liptak, "Analytical Instrumentation Handbook", Chilton, Second ed., 1994.
- Leslie S Ettre, Albert Zlatkis, "The Practice of Gas Chromatography", John Wiley and son's publication, First ed., 1967.
- Skoog, Holler, Nieman, "Principles of Instrumental Analysis", Thomson bookscole publications, Sixth ed., 2006.

[IE-21013] Instrument and System Design

Teaching Scheme
Lectures: 3 Hrs/week

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

Course Outcomes:

- Analyze the need analysis of system requirement
- Identify circuit noise and system components which are responsible for noise generation
- Understand and design various noise reduction techniques.
- Select and design appropriate shielding and enclosures
- Understand different PCB design guidelines.
- Estimate and analyze the reliability of instruments and system

Course Contents

Unit I **(8 hrs)**

Basic concept of instrumentation design, needs analysis with respect to systems deployed, medical systems, challenges in medical system design, Industrial systems, test and measurement, home appliances, military functional requirements & specifications, impact on the design due to adverse electrical, thermal and mechanical operational environments, attributes related to subsystem selections for particular industrial and medical application

Unit II **(8 hrs)**

Noise sources, electrical, magnetic, RF, static, ground loops, shielding, near and far field, shielding effectiveness, absorption and reflection loss, shielding with magnetic material, contact protection, glow and arc discharges, loads with high inrush current, Inductive and resistive load contact protection networks for inductive loads, intrinsic noise sources.

Unit III **(7 hrs)**

ESD, inductive charging human body model, ESD protection in equipment, software in ESD protection, sensitive devices, input filters, clamping suppressors

Unit IV **(8 hrs)**

Electronic design guideline noise in electronic circuits, capacitive and inductive coupling and effect of shield, shielding to prevent magnetic radiation, co-axial and twisted pair cable, grounding, safety ground, signal ground, single and multi point ground, hybrid ground, grounding of cables shields, ground loops and low frequency and high frequency analysis of common mode signals, guard shields.

Unit V **(8 hrs)**

Enclosure Design Guidelines, System specifications and standards , NEMA, DIN, BSI, ANSI standards Index protection (IP), cable design guidelines; Printed circuit board design guideline, layout scheme, grid systems, PCB size, design rules for analog circuits, digital system design guidelines, single and multilayer PCB, CE Compliance.

Unit VI **(7 hrs)**

Reliability, bath tub curve, Reliability for series parallel system, MTTF, MTTR, MTBF, availability, Redundancy and stand by systems, reliability modeling and analysis, hazard rate, quality of a instrument and system.

Text Books

- Henry OTT, "Noise reduction Techniques in Electronics Circuit", Wiley International, Second ed., 2009.

Reference Books

- Balguruswamy, "Reliability Engineering", TATA McGraw-hill Publication, Third ed. , 2005
- Walter C. Bosshart, "Printed Circuit Board", Tata McGraw-Hill publication, Third ed.,2009

[IE-21014] Industrial Automation Laboratory

Teaching Scheme
Lectures: 2 hrs./week
Tutorial: 1 Hr/week

Examination Scheme
Continuous Assessment: 50
MarksPractical Exam- 50 Marks

Course Outcomes:

- Understanding of architectures of PLC and DCS [PEO1] [PO-1]
- Understanding of communication protocol used in industry [PEO1] [PO-5]
- Develop programming skills for PLC and DCS [PEO5] [PO-5]
- Solve engineering problem using programming language [PEO5] [PO-5]

List of Experiments

1) Implementation of logical function using PLC programming
2) Implementation of Timer and counter for a given applications using PLC programming
3) Implementation of PLC programming for applications like elevator, bottle filling, motor control center
4) Interfacing PLC to Pneumatic circuits
5) Interfacing PLC to Variable Frequency Drive
6) Study of HART protocol
7) Communicate field devices using fieldbus protocol to delta V controller
8) Study of Delta-V distributed control System architecture
9) Configuration and commissioning of Digital I/O's
10) Configuration and commissioning of Analog I/O's for a typical system.
11) Configuration and commissioning of control block for a typical system.
12) Configure PID block for given control loop
13) Development of GUI for a typical plant.
14) Development of an alarm, and historian system for a typical process.
15) Study Modbus protocol for controller to controller communication

[IE-21015] Robotics and Automation Laboratory

Teaching Scheme
Lectures: 2 hrs./week

Examination Scheme
Continuous Assessment: 50 MarksPractical Exam- 50 Marks

Course Outcomes:

- Acquire the knowledge on advanced algebraic tools for the description of motion
- Analyze and design the motion for articulated systems
- Use software tools for analysis and design of robotic systems
- Detect the object and path tracing using vision sensor

Students should perform minimum 08 experiments using robotics platform:

1. Study components of a real robot and its DH parameters.
2. Forward kinematics and validate using software (Robo Analyser or any other free software tool).
3. Inverse kinematics of the real robot and validation using any software.
4. Use of open source computer vision programming tool openCV.
5. Image Processing using openCV.
6. Image Processing for color/shape detection.
7. Positioning and orientation of robot arm.
8. Control experiment on flexible link using available hardware or software.
9. Integration of assorted sensors (IR, Potentiometer, strain gages etc.), Micro controllers and ROS (Robot Operating System) in a robotic system.
10. Trajectory planning and analysis

[IE-21016] Analytical Instrumentation Laboratory

Teaching Scheme
Lectures: 2 hrs./week

Examination Scheme
Continuous Assessment: 50 MarksPractical Exam- 50 Marks

Course Outcomes:

- Understand the design criterion for optical spectrospy instruments [PEO1] [PO-1]
- Critique spectroscopy and analyse a given sample using spectrophotometer [PEO3] [PO-2]
- Evaluate chromatography analysis methods [PEO3] [PO-3]
- Describe a real world problem based on liquid and gas sensors on [PEO1] [PO-5]

List of Experiments

1. Design a handheld visible spectrophotometer for qualitative analysis of sample
2. Visible spectrophotometer for qualitative and qualitative measurement of sample
3. UV-Visible spectrophotometer for qualitative and qualitative measurement of sample and compare the results with Visible spectrophotometer.
4. To analyse a given water sample using combinations of light source and detectors and evaluate its performance
5. Perform liquid sample analysis based on pH and conductivity
6. Design a gas sensor system and evaluate its performance.
7. Design Thermal conductivity detector/ GC analysis system using open source software
8. Design an electronic tongue system for taste identification
9. Design smart system for detection of parameters such as moisture, temperature and gas

Honor: Instrumentation and Control

[IE (HT)-21002] Optimization and Optimal Control

Teaching Scheme
Lectures: 3 Hrs/week

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

Course Outcomes:

- Understanding of different types of optimization problems
- Familiarization with different techniques used to solve unconstrained optimization problems
- Get familiar with analytical techniques used to solve single objective, and constrained optimization problems
- Tools and methods used to solve constrained and unconstrained optimization problems
- Dynamic optimization and techniques used to solve dynamic optimization problems and optimal control problems for real-time control applications.

Course Contents

Unit I Optimization Fundamentals (6 hrs)

Optimization problems, objective function, constraint and unconstraint, classification of optimization problems. Convexity and concavity of functions having one and two variables.

Unit II Unconstrained Optimization (8 hrs)

Optimization of a function with one and multiple variables, gradient vectors, subject to equality constraints and Lagrangian multipliers, Hessian matrix formulation, necessary and sufficient conditions of optimality (KKT) conditions. First derivative method, Newton's and quasi-Newton's method, conjugate gradient method of unconstrained optimization problems.

Unit III Constrained optimization (LP) (8 hrs)

Linear Programming problems, Simplex method, simplex algorithm, construction of simplex tableau, minimization versus maximization problem. Interior point Method.

Unit IV Constrained optimization (QP) (8 hrs)

Quadratic Programming Problems, equality constrained and inequality constrained optimization problems, KKT conditions, Lagrangian methods, NLP and solution of NLP by sequential quadratic programming (SQP) methods. Interior point methods and Active Set Methods

Unit V Optimal Control Problems (OCP) (6 hrs)

Optimal Control problems, different forms of OCPs, Classical numerical methods to solve OCPs, LQR and methods used to solve LQR problems, discrete-time OCPs.

Unit VI Dynamic Optimization (6 hrs)

Dynamic programming, discretization methods used to discretize dynamic programming problems,single shooting and multiple shooting methods, solution methods of dynamic programming problems.

Text Books

- Edger, Himmelblau, Lasdon, Optimization of Chemical Processes, McGraw-Hill International, Edition.
- S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International Pvt. Ltd., New Delhi.

Reference books

- K. Deb, "Optimization for Engineering Design-Algorithms and Examples", Prentice-Hall of India Pvt. Ltd., New Delhi, 1995.

Minor: Industrial Automation

[IE (MI)-21003] Programmable Logic Controller (SEM-VI)

Teaching Scheme
Lectures: 3 Hrs/week

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

Course Outcomes:

- Develop relay logic for various applications[PEO1] [PO-1]
- Identify and select various components for given application[PEO1] [PO-3]
- Examine the correctness of ladder logic for given application[PEO2] [PO-3]

- Develop control logic for engineering system using Programmable Logic Controller[PEO4] [PO-6]

Course Contents

Unit I **(6 hrs)**

Introduction to relay logic, Architecture of PLC, Types of Input & Output modules (AI, DI, AO, DO), wiring diagram, ladder diagram using standard symbols, PLC specifications, PLC manufacturers, PLC ladder diagram, basic instructions: Examine if closed and examine if open, Times, counters instruction with timing diagram.

Unit II **(6 hrs)**

Times, counters instruction with timing diagram, PLC advanced instruction, Application of Programmable Logic Controller in major Industries: working and automation of pump house, Motor Control Centre (MCC), elevator, drilling station, bottle filling station using the ladder diagram

Unit III **(8hrs)**

Serial Communication, OSI network model, Networking hardware, Networking standard: Devicenet, Controlnet, CANnet, Networking Issue

Unit IV **(8hrs)**

PLC Interfacing to AC and DC Drives/HMI/Hydraulic/Pneumatic/Motion control: Interfacing of VFD TO PLC, Interfacing to Pneumatic circuits, Interfacing to hydraulic system Introduction of Motion control, different elements in motion control

Unit V **(6hrs)**

Development of SCADA, tag definition, alarms and trends, GUI Industrial Standards, Interfacing with MES

Unit VI **(6hrs)**

Maintenance and troubleshooting of PLC based industrial system, tools, sequence of operation and recommissioning

Text Books

- Gary Dunning , "Introduction to Programmable Logic Controller", Cengage Learning India Pvt. Ltd., Third Edition, 2006
- John W. Webb, "Programmable Logic Controllers", Prentice Hall, Fourth Edition, 1999
- B. G. Liptak, "Process Software and Digital Networks", CRC Press. Third Edition 2000

Reference books

- Distributed Computer Control for Industrial Automation by D. Popovic and Vijay Bhatkar, 1st edition, Marcel Dekker Inc., 1998.
- Programmable Logic Controllers: Principles and Application by John W. Webb, Ronald A. Reis, 5 th Edition, McGraw Hill Inc., 2006.
- Securing SCADA System by Ronald L. Krutz, 1st edition, Wiley Publishing, 2007.
- Programmable Controllers by Batten G. L., 2nd Edition, McGraw Hill Inc., 2004.

Minor: Biomedical Instrumentation

[IE(MI)-21004] Medical Sensors

Teaching Scheme
Lectures: 3 Hrs/week

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

Course outcomes:

- Choose techniques detecting and convert physiological information's to electrical signals
- Understand various sensors / transducer's used in Biomedical Instruments / Equipment / systems / devices
- Design signal conditioning for medical sensors
- Create rubric for selecting sensors / transducers / electrodes / biosensors for biomedical applications

Course Contents:

Unit I **(6 hrs)**
Physiological Mesurands and Biopotential Measurement: Biopotentials, bioimpedance, mechanical, acoustic and thermal signals, Electrodes; ECG, EMG and EEG measurement

Unit II **(7 hrs)**
Resistive sensors: RTD, Thermistor and its biomedical applications; strain gage for the measurement of blood pressure; force and accelerations of the body

Unit III **(7 hrs)**
Inductive sensors and Capacitive Sensors: Simple and mutual inductance and its medical applications, Respiratory flow measurement by the gradient of pressure, Proximity sensors

Unit IV **(7 hrs)**
Piezoelectric sensors: Force platform, accelerometer, angular rate sensor for the measurement of tremors and body movements, ultrasound transducer - measurement of pressure and flow rate, Ultrasound machine probes

Unit V **(7 hrs)**
Optical sensors: Photoplethysmography, pulsedoxymetry, Optical fiber sensors

Unit VI **(6 hrs)**
Biosensors: Electrochemical Biosensors, Immunosensors, Magnetic Biosensors, Thermometric Biosensors, Acoustic Biosensors, Optical Biosensors

Text Books

- Jacob Fraden, "Handbook of Modern Sensors -Physics, Designs, and Applications" 4th edition, Springer, 2010
- John G. Webster, "Medical Instrumentation Application and Design", John Wiley& Sons Pvt. Ltd,3rd ed., 2009.
- R. S. Khandpur, "Handbook of Biomedical Instrumentation", TMH, 2nd ed., 2008.

Reference Books

- John G Webster, "Encyclopaedia of Medical Devices and Instruments", Wiley Publications, 1988.
- Carr and Brown "Introduction to Biomedical Equipment Technology", Pearson LPE, 4th ed., 2001.

Institute Level Open Elective (IOC)

[IOC-21001] Programmable Logic Controllers and Its Applications

Teaching Scheme
Lectures: 3 Hrs/week

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

Course Description:
This course develops the functional design, hardware configuration, programming and application of Programmable Logic Controllers (PLC). The design and programming of control circuits using examples from industrial applications will be emphasized.

Course Outcomes:

- **Explain** the generic architecture and constituent components of a Programmable Logic Controller.
- **Develop** a ladder logic program using modern engineering software tools and technique for analog and discrete control.
- **Apply** knowledge gained about PLCs to identified real-time industrial applications.
- **Select** proper PLC configuration, analog and discrete input-output devices, communication protocols for industrial control.

Course Contents

Unit I **(7 hrs)**
Introduction to PLC: Definition and Evolution of PLC, PLC Architecture, PLC Input and Output modules, central processing unit, CPUs and Programmer/monitors, Solid state memory, the processor, Input modules (Interfaces), Power supplies, PLC classifications and their general specifications, selection criteria for PLC.

Unit II **(8 hrs)**
Programming of PLC: Fundamentals of PLC ladder diagram, Basic components and their symbols in ladder diagram, Boolean logic and relay logic, Analog and discrete Input-output (I/O) devices, Programming instructions set, Timer and counter types along with wave form, shift registers, sequencer function, latch instruction; Arithmetic and logical instruction with various examples.

Unit III **(8 hrs)**
Advanced PLC Function, Analog PLC operation, PID control of continuous processes, PLC interface, and developing ladder logic for sequencing of motors, tank level control, ON-OFF temperature control, elevator, bottle filling plant and car parking. Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller, Variable speed (Variable Frequency) AC motor Drive.

Unit IV **(7 hrs)**

Overview of Open systems interconnection (OSI) Model, Functions of OSI Model Layers, OSI Protocols, Functions of Transmission control protocol / Internet protocol (TCP/IP) Layers, TCP/IP protocol, DNP3 protocol, IEC61850 layered architecture, Control and Information Protocol (CIP), DeviceNet, ControlNet, EtherNet/IP, Flexible Function Block process (FFB), Process Field bus (Profibus).

Text Books

- Computer-based Industrial Controls by Krishan Kant, 2nd edition, PHI India, New Delhi, 2004.
- Computer Control of Process by M. Chidambaram, 1st edition, Narosha Publishing. 2005.
- Introduction to Programmable controller by Garry Dunning, 2nd Edition, Thomson Asia, Pte, Ltd, Singapore, 2002.
- Programmable Logic Controllers Programming Methods and Applications by John R. Hackworth, Frederick D., Hackworth Jr., 3rd edition, Pearson Education, 2005.
- Programmable Logic Controllers with Applications by P. K. Srivstava, BPB Publications, 1 st edition, 2001.
- Programmable Controllers Theory and Implementation by L. A. Bryan, E. A. Bryan, Industrial Text Company Publication, 2nd edition, 1998.

Reference Books

- Distributed Computer Control for Industrial Automation by D. Popovic and Vijay Bhatkar, 1st edition, Marcel Dekker Inc., 1998.
- Programmable Logic Controllers: Principles and Application by John W. Webb, Ronald A. Reis, 5 th Edition, McGraw Hill Inc., 2006.
- Securing SCADA System by Ronald L. Krutz, 1st edition, Wiley Publishing, 2007.
- Programmable Controllers by Batten G. L., 2nd Edition, McGraw Hill Inc., 2004.
- Instruments Engineers Handbook Process Control ,VoL-II by Bela G. Liptak, CRC Press, 4 th edition, 2006.