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)

Second Year B. Tech. (S. Y. B. Tech)

(Revision: A.Y. 2019-2023, Effective from: A.Y. 2020-21)

Department Vision:

To lead the field of Instrumentation and Control towards **inclusive excellence** through integration of **teaching and learning**, advancement of the knowledge base by **research, innovations, scholarships** and **services to the society.**

Department Mission:

- **Set-up** a mechanism for creating high quality undergraduate and post graduate programs in Instrumentation and Control Engineering.
- **Adapt** systems and methods for meaningful collaboration with stakeholders.
- **Take-up** socially relevant and nationally important issues and problems as project assignments.
- **Inculcate** creativity, entrepreneurial attitude and values amongst Learners.

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):

On successful completion of the Program, engineering graduates will able to:

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↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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

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

(Effective from A. Y. 2020-2021)

Semester-I: for Regular Students:

Sr. No	Course Type/Code	Subject Title	Contact Hours			Credits
			L	T	P	
01	BSC/MA-20001	Ordinary Differential Equations and Multivariate Calculus	2	1	0	3
02	MLC/ML-20004	Professional Laws, Ethics, Values and Harmony	1	0	0	0
03	HSMC/HS-20004	Innovation and Creativity	1	0	0	1
04	IFC/MM(IF)-20001	Smart Materials (Offered by Metallurgy Dept)	2	0	0	2
05	SBC/IE-20007	Computational Methods Lab	0	1	2	2
06	PCC/IE-20001	Transducers	3	0	0	3
07	PCC/IE-20002	Analog Electronics	3	0	0	3
08	PCC/IE-20003	Electrical and Electronics Measurement	3	0	0	3
09	LC/IE-20004	Transducers Lab	0	1	2	2
10	LC/IE-20005	Analog Electronics Lab	0	0	2	1
11	LC/IE-20006	Electrical and Electronics Measurement Lab	0	0	2	1
		Total	**15**	**3**	**8**	**21**
		Total Academic Engagement and Credits	**26**			**21**

Semester-I: for Lateral entry students:

Sr. No	Course Type/Code	Subject Title	Contact Hours			Credits
			L	T	P	
01	BSC/MA-20002	Linear Algebra and Univariate Calculus	4	1	0	5
02	MLC/ML-20004	Professional Laws, Ethics, Values and Harmony	1	0	0	0
03	HSMC/HS-20004	Innovation and Creativity	1	0	0	1
04	IFC/MM(IF)-20001	Smart Materials (Offered by Metallurgy Dept)	2	0	0	2
05	BSC/PH-20001	Foundation of Physics	3	0	0	3
06	SBC/IE-20007	Computational Methods Lab	0	1	2	2
07	PCC/IE-20001	Transducers	3	0	0	3
08	PCC/IE-20002	Analog Electronics	3	0	0	3
09	PCC/IE-20003	Electrical and Electronics Measurement	3	0	0	3
10	LC/IE-20004	Transducers Lab	0	1	2	2
11	LC/IE-20005	Analog Electronics Lab	0	0	2	1
12	LC/IE-20006	Electrical and Electronics Measurement Lab	0	0	2	1
		Total	**20**	**3**	**8**	**26**
		Total Academic Engagement and Credits	**31**			**26**

Semester-II: for Regular Students:

Sr. No	Course Type/Code	Subject Title	Contact Hours			Credits
			L	T	P	
01	BSC/ MA-20004	Vector Calculus and Partial Differential Equations	2	1	0	3
02	BSC/AS-20001	Biology for Engineers	3	0	0	3
03	SBC/IE-20013	Micro-Project (From an Idea to Simulation Prototype)	0	0	2	1
04	IFC/EE(IF)-20001	Electrical Machines (Offered by Electrical Dept)	1	0	2	2
05	SBC/IE-20014	Applied Numerical Methods Lab	0	1	2	2
06	PCC/IE-20008	Automatic Control System	3	0	0	3
07	PCC/IE-20009	Signals and Systems	3	0	0	3
08	PCC/IE-20010	Digital Electronics	3	0	0	3
09	LC/IE-20011	Digital Electronics Lab	0	0	2	1
10	LC/IE-20012	Automatic Control System Lab	0	1	2	2
		Total	**16**	**3**	**08**	**23**
		Total Academic Engagement and Credits	**27**			**23**

Semester-II: for Lateral entry Students:

Sr. No	Course Type/Code	Subject Title	Contact Hours			Credits
			L	T	P	
01	BSC/MA-20005	Multivariate Calculus and Differential Equations	4	1	0	5
02	BSC/AS-20001	Biology for Engineers	3	0	0	3
03	SBC/IE-20013	Micro-Project (From an Idea to Simulation Prototype)	0	0	2	1
04	IFC/EE(IF)-20001	Electrical Machines (Offered by Electrical Dept)	1	0	2	2
05	SBC/IE-20014	Applied Numerical Methods Lab	0	1	2	2
06	PCC/IE-20008	Automatic Control System	3	0	0	3
07	PCC/IE-20009	Signals and Systems	3	0	0	3
08	PCC/IE-20010	Digital Electronics	3	0	0	3
09	LC/IE-20011	Digital Electronics Lab	0	0	2	1
10	LC/IE-20012	Automatic Control System Lab	0	1	2	2
		Total	**18**	**3**	**08**	**25**
		Total Academic Engagement and Credits	**29**			**25**

MA-20001 Ordinary Differential Equations and Multivariate Calculus

Teaching Scheme:
Lectures: 2 hours / week
Tutorials: 1hr / week

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

Course Outcomes:

1. **Identify** first order ordinary differential equations, **tell** Laplace transform formulae, **and define** functions of several variables. [PEO1][PO1]
2. **Understand** basic concepts of higher order ordinary differential equations, level curves and level surfaces. [PEO2][PO2]
3. **Solve** linear differential equations using different methods, **find** Laplace transforms of functions using properties and theorems, **and evaluate** directional derivatives and extreme values. [PEO2][PO3]
4. **Prove** theorems, **solve** ordinary differential equations using Laplace transforms, **identify** orthogonal trajectories, optimize functions subject to given constraints. [PEO5][PO3]
5. **Apply** concepts of ordinary differential equations and multivariate calculus to various applications including real life problems.[PEO2][PO4]

Unit 1 Introduction to Order of Differential Equation (11 hours)

Review of first order differential equations, Reduction of order, linear differential equations, homogeneous higher order linear differential equations, non-homogeneous higher order linear differential equations with constant coefficients and reducible to differential equations with constant coefficients (method of undetermined coefficients and method of variation of parameters), systems of differential equations, applications to orthogonal trajectories, mass spring systems and electrical circuits.

Unit 2 Laplace Transform (08 hours)

Laplace Transforms, its properties, Unit step function, Dirac delta functions, Convolution Theorem, periodic functions, solving differential equations using Laplace transform.

Unit 3 Functions of Variables (07 hours)

Functions of several variables, level curves and level surfaces, partial and directional derivatives, differentiability, chain rule, local extreme values and saddle points, constrained optimization.

Test Books

- Thomas' Calculus (14^{th} edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics (10^{th} edition) by Erwin Kreyszig, Wiley eastern Ltd.

Reference Books

- Calculus for Scientists and Engineers by K.D Joshi, CRC Press.
- A Course in Multivariate Calculus and Analysis by Sudhir Ghorpade and Balmohan Limaye, Springer Science and Business Media.
- Differential Equations with Applications and Historical notes by George Simmons, Tata Mc-Graw Hill publishing company Ltd, New Delhi.
- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Advanced Engineering Mathematics (7th edition) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Advanced Engineering Mathematics (2nd edition) by Michael D. Greenberg, Pearson Education.
- Advanced Engineering Mathematics by Chandrika Prasad and Reena Garg, Khanna Publishing Company Private Limited, New Delhi.

MA-20002 Linear Algebra and Univariate Calculus
(For Lateral Entry Students Only)

Teaching Scheme:
Lectures: 4 hours / week
Tutorials: 1hr / week

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

Course Outcomes:

1. **Know** matrices, linear equations, and determinants, **recall** basic vector algebra, differentiability of functions of single variable, and mean value theorems.[PEO1][PO1]
2. **Understand** basic concepts such as vector spaces, linear dependence / independence of vectors, basis. [PEO2][PO2]
3. **Analyze** and **calculate** Eigen values, Eigen vectors, rank nullity of a matrix, **sketch** function graphs, **evaluate** improper integrals, **calculate** integrals using special techniques, apply various tests of convergence. [PEO2][PO4]
4. **Prove** theorems; **evaluate** length / area / volume using single integrals. [PEO5][PO3]
5. **Apply** concepts of linear algebra and Univariate calculus to various applications including real life problems. [PEO2][PO6]

Unit 1 Matrices and linear equations (15 hrs)

Basic properties of matrices, row operations and Gauss elimination, Determinants and their basic properties. Basic concepts in linear algebra: vector spaces, subspaces, linear independence and dependence of vectors, bases, dimensions. Rank of a matrix. Applications to systems of linear equations

Unit 2 Matrices Properties **(12 hrs)**

Rank-nullity theorem, Eigen values, Eigen vectors and their basic properties, Diagonalization.

Unit 3 Limits **(12 hrs)**

Review of limits, continuity and differentiability, Mean value theorems, Taylor's theorem, local extrema, increasing and decreasing functions, concavity, points of inflection.

Unit 4 Surface Area **(13 hrs)**

Surface area, integrals by special techniques: reduction formulae, arc length, solids of revolution, improper integrals, tests for convergence, Gamma and Beta functions.

Text Books

- Thomas' Calculus (14th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano Pearson Education.
- Advanced Engineering Mathematics (10th edition) by Erwin Kreyszig, Wiley eastern Ltd.

Reference Books

- Introduction to Linear Algebra (2nd edition) by Serge Lang, Springer.
- Elementary Linear Algebra (10th edition) by Howard Anton and Chris Rorres, John Wiley and sons.
- Calculus for Scientists and Engineers by K.D Joshi, CRC Press.
- A Course in Calculus and Real Analysis (1st edition) by Sudhir Ghorpade and Balmohar Limaye, Springer-Verlag, New York.
- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Advanced Engineering Mathematics (7th edition) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Differential Calculus by Shanti Narayan, S. Chand and company, New Delhi.
- Applied Mathematics Vol. I (Reprint July 2014) by P.N. Wartikar and J.N. Wartikar Pune Vidyarthi Griha Prakashan Pune.
- Advanced Engineering Mathematics by Chandrika Prasad and Reena Garg, Khanna Publishing Company Private Limited, New Delhi.

ML-2004 Professional Laws, Ethics, Values and Harmony

Teaching Scheme
Lectures: 1 hr/week

Evaluation Scheme
Total - 100 Marks
Continuous evaluation-
Assignments / Presentations/Test

Course Outcomes:

Student will be able to

1. grasp the meaning of the concept – Law [PEO3][PO12]
2. get an overview of the laws relating to Engineers[PEO5][PO11]
3. apprehend the importance of being a law abiding person[PEO5][PO11]
4. self-explore by using different techniques to live in harmony at various levels[PEO3][PO12]
5. analyze themselves and understand their position with respect to the moral and ethical character needed for a successful and satisfactory work life[PEO4][PO8]

Unit 1 Concept of Law (02 hrs)

Understanding Essentials of a Valid Contract and the basics of contract law protecting rights and obligations

Unit 2 Law of Torts (03 hrs)

Introduction to the Law of Torts and the basics to protect oneself and the company, Law affecting the Workplace Employers Responsibilities / Duties Hiring Practices, Introduction to Intellectual Property Law

Unit3 Code of Conduct (01 hr)

Professional Code of Conduct for Engineers
Relationship between Law and Ethics

Unit 4 Self Awareness (02 hrs)

Understanding oneself and others; Johari Window- Concept, explanation, implementation

Unit 5 Needs and Self (02 hrs)

Needs and its importance; Understanding harmony and its relevance in actualization at personal and professional levels

Unit 6 Ethics and Values (02 hrs)

Professional ethics and their importance for students; Understanding the importance of values & their application in everyday life

References

- Business Law- By Saroj Kumar
- Law of Contract- By Avtar Singh
- Business Law- By G K Kapoor
- Business & Commercial Laws – By Sen & Mitra
- Business Law for Engineers- by Calvin Frank Allen
- Hilgard, E. R.; Atkinson, R. C. & Atkinson, R.L. (1975). *Introduction to Psychology*. 6th Edition. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
- Govindarajan, M; Natarajan, G. M. & Senthilkumar, V.S. (2013). *Professional Ethics & Human Values*. Prentice Hall: New Delhi
- Gogate, S. B. (2011). Human Values & Professional Ethics. Vikas Publishing: New Delhi.

- Govindarajan, M; Natarajan, G. M. & Senthilkumar, V.S. (2013). Professional Ethics & Human Values. Prentice Hall: New Delhi
- Jayshree Suresh, Raghavan B.S.(2016). Human Values & Professional Ethics: S Chand & Company.Pvt.Ltd: New Delhi.

HS-2004 Innovation and Creativity

Teaching Scheme
Lectures: 1 hours / week

Examination Scheme:
"Will be declared by Instructor"

Course Outcomes:

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

1. Understand to creativity and innovation terminologies [PEO2][PO6]
2. Explore personal and organizational roadblocks in participating in the creative process [PEO4][PO11]
3. Apply practical tips to discover the innovative potential within the human being.[PEO4][PO8]
4. Study frameworks, strategies, techniques for conceiving ideas.[PEO5][PO4]
5. Develop new ways of thinking and Learn the entire innovation cycle. [PEO5][PO6]
6. Understand different ways to protect innovation, basics on Patents and process [PEO3][PO3]
7. Apply techniques learnt in the course to articulate, refine and pitch a new product or service project [PEO4][PO6]

Syllabus

Introduction to concepts of creativity / invention / innovation and their importance in present knowledge world. Components of the creative process, Analogy/model to represent the creative process.

Understanding persons' Creative potential. Blockages in practicing creative process – Mindset and belief systems. Myths and misconceptions about creativity.

Practical Tips to discover and apply one's creative potential, remove blockages, deal with external factors. Importance of synergistically working in a team. Harnessing creativity from nature.

Idea conception, Idea Brainstorming sessions, Idea Evaluation, Protection/Patent review, Principles of innovation, Review of systematic strategies and methods for innovation, Innovation case study, Review of Idea/Prototype /Product and Market Plan.

Applications Exercise / Assignment: at the end of the course, the student will create teams, presents their innovative ideas, and applies their learning in practice.

Reference Books

- Paul B . Paulus, Bernard A. Nijstad, The Oxford Handbook of Group Creativity and Innovation, Oxford University Press,2019.
- Jeff Dyer, Hal Gregersen, Clayton M. Christensen, " The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators, Harvard Business Review Press, 2011.
- Paddy Miller, Thomas Wedell-Wedellsborg, "Innovation as Usual: How to Help Your People Bring Great Ideas to Life, Harvard Business Review Press, 2013.

PH-20001 Foundation of Physics
(For Lateral Entry Students Only)

Teaching Scheme:
Lectures : 3hrs/week

Examination Scheme:
Test1: 20 marks
Test2: 20 marks
End-Sem Exam- 60 marks

Course Outcomes:
Students will be able to

1. Understand classical and wave mechanics to implement for the problems. [PEO1][PO1]
2. Understand of the laws of thermodynamics to implement in various thermodynamic systems and processes. [PEO2][PO2]
3. Understand the basic principles of Electromagnetism and formulate it to solve the engineering problems.[PEO2][PO3]
4. Aware of limits of classical physics and will be able to use it in the appropriate field in order to solve the problems.[PEO3][PO4]

Unit 1 Oscillations, Waves & Light (7 hrs)
SHM, characteristics of SHM, Waves, Travelling waves and its equation**,** Types of waves, Principle of Superposition, Stationary waves**,** Light as an EM Wave, graphical representation of EM wave, Interference of light due to thin film (uniform thickness), Antireflection coating, Total Internal reflection, Introduction to Optical fiber and its design.

Unit 2 Atomic Nucleus and Nuclear energy (7 hrs)
Atomic Nucleus, Nuclear force, Static properties of nucleus, Mass defect and Binding energy, Law of radioactive decay, Half-life, Applications of radioactivity, Nuclear reactions, Q-value of nuclear reaction, Nuclear fission, chain reaction and Nuclear energy.

Unit 3 Electrostatics (7 hrs)
Coulomb's law in vector form ,the electric field, Continuous charge distribution (Line, Surface& Volume)**,** Divergence of E, application of Gauss's law (simple 2 D problems)**,** The curl of E (Faraday's Law), the concept of electric potential V, Potential due to continuous charge distribution.

Unit 4 Magneto statics (7 hrs)
Steady state current (line current, Surface current and volume current), current densities, Magnetic field due to steady current (Biot-Savart's law), divergence and curl of B, Statement of Ampere's Law (with simple examples).

Unit 5 Elements of Thermodynamics (7 hrs)
Concept of Temperature, Terminology in Thermodynamics, Thermodynamic work, Caparison for Heat and Work, First Law and its applications, Heat engine and Thermal efficiency, Second law, Entropy, Disorder of system, Third law and Principle of Unattainability Absolute Zero

(Nernst's Theorem).

Unit 6 Modern physics (7 hrs)

Drawbacks of Classical Mechanics, Plank's quantum hypothesis, Dual nature of matter, De-Broglie's hypothesis, light as a particle(Compton's experiment), De-Broglie's wavelength, Heisenberg's uncertainty principle(position and momentum), Wave function, its properties, conditions and its physical significance, Free particle solution of wave function.

References

- Engineering Physics, Avadhanulu and Kshirsagar.
- Halliday-Resnick (Sixth edition) "Optics", Brij Lal (S. Chand publication)
- Classical Electrodynamics, David Griffith (Pearson India limited)
- H .C. Verma & Halliday-Resnick (Sixth edition), B. B. Laud
- Modern Physics, S. Chand Publication.
- Concepts of Modern Physics, Arthur Beiser, Tata McGraw – Hill Edition.

MM(IF)-20001 Smart Materials

(Offered by Metallurgy and Material Science Department)

Teaching Scheme

Lectures: 2 hours / week

Examination Scheme

Test 1: 20 Marks:
Test 2: 20 Marks:
End-Sem Exam: 60 marks:

Course Outcomes:

1. To introduce students to the concept of "Smart" materials and systems [PEO1][PO1]
2. To inculcate knowledge of various smart materials, their fabrication and their multidisciplinary applications [PEO2][PO4]

Unit 1 (05 hrs)

Concept of Smart Materials: Retrospective review, main notion, energy aspects of external influence, systematization and methods of smart materials description: methods of materials taxonomy, smart material model, classification of smart materials and engineering systems

Unit 2 (05 hrs)

Materials for electrical engineering and electronics: conductors, semiconductors, dielectrics, magnetic materials, optically active materials, materials for thermoelectric devices, smart battery materials, radio wave absorbing materials, sealing materials, heat-insulating and sound absorbing materials

Unit 3 (05 hrs)

Structural materials: self-healing materials, heat and cold resistant materials, radiation resistant materials, corrosion-resistant materials and anti-corrosive coatings, lubricants, frictional materials, materials for operation at abnormal temperatures

Unit 4 **(05 hrs)**

Materials for biological and biomedical systems: materials for implants, targeted drug delivery and tissue growth, antimicrobial materials, filters for water cleaning, biodegradable packages, active and bio-selective packages

Unit 5 **(07 hrs)**

Mechanics of smart materials: Object and subject of smart materials mechanics, structural and functional analysis smart materials in terms of mechanics, the materials with negative characteristics as source of smart effects in structures: Auxetics, statements and solutions of some smart materials based mechanics problems – e.g. self-healing of cracks, self-reinforcing of multimodular materials, porous materials-auxetic materials reversible transformations, self-assembling porous materials etc.

Unit 6 **(03 hrs)**

Smart materials and energy problem: Global energy problem, energy consumption for production of materials, technical and economical efficiency of smart materials and technical systems

Text Books

- Smart Materials Taxonomy by Victor Goldade, Serge Shil'ko, Alexander Neverov, CRC Press, 1st Edition, 2016
- Smart Electronic Materials by Jasprit Singh, Cambridge University Press, 1st Edition, 2005

Reference Books

- Encyclopedia of Smart Materials (Volume 1 and 2) by Mel Schwartz, John Wiley and Sons, 1st Edition, 2002
- Smaert Materials Edited by Mel Schwartz, CRC Press, 1st Edition, 2009
- Design, Fabrication Properties and Applications of Smart and Advanced Materials, Edited by Xu Hou, CRC Press, 1st Edition, 2016
- Smart Materials: Integrated Design, Engineering Approaches and Potential Applications, Edited by Anca Filimon, Apple Academic Press and CRC Press, 1st Edition, 2019

IE-20007 Computational Methods Lab

Teaching Scheme
Tutorials: 1 hours / week
Practical's: 2hrs / week

Examination Scheme
Continuous Assessment -50
Practical Exam. - 50

Course Outcomes:

1. Demonstrate the proficiency of engineering computational platforms. [PEO1] [PO1]
2. Write algorithms to solve different arithmetic with MATLAB platform. [PEO1][PO2]
3. To understand and working with solving ODS's, plotting and data handling with MATLAB [PEO1] [PO4]
4. To understand and learn various MATLAB functions and solvers [PEO2][PO5]

List of Experiments

1. **MATLAB Basics:** MATLAB introduction and use of command window as a calculator. Arithmetic operations. Looping and control structures.
2. **Writing m-file:** Write a m-file with use of *for loop* and *while loop*
3. **Root finding:** Write a program to solve system of nonlinear equations using Newton's method/Secant method and compare the result with in-built command fsolve.
4. **Solution of ODE**: Write a program to solve system of ordinary differential equations and compare the solution with in-built command ODE45 and for symbolic solution using dsolve.
5. **Plotting**: X-Y plotting functions, subplots, interactive plotting, regression, 3-D plots. Write a program to solve system of non-linear equations and plot the solution process.
6. **Matrix and Vectorization:** Entering matrix and vectors, column and row operation with matrix, matrix operations and commands related to matrix operations. Write a program to find inverse of a given matrix or solution of linear system, compare the result with in-built command *inv* and linsolve
7. **Parameterized functions:** Writing a basic function, passing parameters in function, and passing function in a function.
8. **Data and file handling**: Data types and data manipulations, reading from and writing to external text files. Importing data from spreadsheets. Reading images.
9. **Simulink:** Introduction to Simulink, creating simple feedback model in Simulink. Input and output blocks, scope.
10. **Embedded function block:** Writing a function and importing in a Simulink blocks.
11. **GUI:** Creating a simple GUI for radio buttons, bars, panels etc.

Test Books:

- William J. Palm, A Concise Introduction to Matlab, 2008

IE-20001 Transducers

Teaching Scheme
Lectures: 3 hours / week

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

Course Outcomes:

1. Describe working principles of various transducers/sensors [PEO1][PO1]
2. Interpret the characteristics of the transducers/sensors [PEO2][PO2]
3. List various standards used for selection of transducers/sensors [PEO2][PO3]
4. Select transducers/sensors for specific applications [PEO3] [PO6]

Unit 1 Measurement Systems and Temperature Measurement (06 hrs)

Measurement System :- Concepts and terminology of measurement system, transducer, sensor, range and span, classification of transducers, static and dynamic characteristics,

selection criteria, sources of errors and their statistical analysis, standards and calibration.
Temperature Measurement :- Temperature scales, classification of temperature sensors, standards, working principle, types, materials, Non electrical sensors (thermometer, thermostat), electrical sensors (RTD, thermocouple, thermistor), radiation sensors (pyrometers).

Unit 2 Pressure and Level Measurement (08 hrs)

Definition, pressure scale, standards, working principle, types, materials, elastic pressure sensors, secondary pressure sensors, differential pressure sensors, capacitive (delta cell), high-pressure sensors, low-pressure sensors, Standards, working principle, types, materials, design criterion: float, displacers, bubbler, ultrasonic, microwave, radar, resistance, thermal, solid level detectors.

Unit 3 Flow Measurement (08 hrs)

Standards, working principle, types, materials, and design criterion: primary or quantity meters (positive displacement flow meter), secondary or rate meter (obstruction type, variable area type), electrical flow sensors (turbine type, electromagnetic type, and ultrasonic type), Flow switches.

Unit 4 Displacement, Velocity, and Speed Measurement (06 hrs)

Resistive: Potentiometer, Linear and rotary, Loading Effect types of strain gauges. Inductive: LVDT and Eddy current type, Piezoelectric, Ultrasonic transducers and Hall effect transducers, Standards, working principle, types, materials, Electromagnetic tachometer, Photoelectric tachometer, Toothed rotor variable reluctance tachometer. Magnetic pickups, Encoders, Photoelectric pickups, Shaft speed measurement.

Unit 5 Force, Torque, Vibration and Acceleration Measurement (08 hrs)

Standards, working principle, types, materials, Eddy current type, piezoelectric type, Seismic Transducer, Accelerometer, Basic methods of force measurement, elastic force traducers, load cells, shear web, piezoelectric force transducers, vibrating wire force transducers, Inductive torque meter, Magneto-strictive transducers etc.

Unit 6 Advances in Sensor Technology (04 hrs)

Smart sensors, MEMS, Nano sensors, Semiconductor sensors, leak detector, flame detector, smoke detector, humidity, density, viscosity sensors.

Test Books

- D.V.S. Murthi, "Instrumentation and Measurement Principles", PHI, New Delhi, Second ed. 2003.
- D. Patranabis, "Principle of Industrial Instrumentation", Tata McGraw Hill, Second ed., 1999.
- B. C. Nakra and K. K. Choudhari, "Instrumentation Measurements and Analysis" by, Tata McGraw Hill Education, Second ed., 2004.

Reference Books:

- B.G. Liptak, "Process Measurement & Analysis", Chilton Book Company, Fourth ed., 2003.

- E.O. Doebelin, "Measurement Systems", McGraw Hill, Fifth ed., 2003.
- Sabrie Soloman, "Sensors Handbook" ,McGraw Hill Publication, First ed., 1998.
- A. K. Sawhney, "Electrical & Electronic Instruments & Measurement", Dhanpat Rai and Sons, Eleventh ed., 2000.
- R. K. Jain, "Engineering Metrology", Khanna Publisher, Delhi, Eighteenth ed.,2002.

IE-20002 Analog Electronics

Teaching Scheme
Lectures: 3 hours / week

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

Course Outcomes:

1. Analyze transistor circuit using h parameter model. [PEO1][PO3]
2. Design and analyze different op-amp circuits for various applications. [PEO2][PO6]
3. Understand the characteristics of various power devices and power converters [PEO1] [PO1]

Unit 1 Transistor (08 hrs)

Transistor biasing , Hybrid h parameter model and two port model applied to BJT, Analysis of common emitter, common collector and common base configurations- voltage and current gain, input and output impedance, comparison of properties; Current Mirrors Circuit, Class A, B and AB amplifiers, Class C amplifier, Power amplifiers, Servo amplifiers, Applications of Amplifiers.

Unit 2 Operational Amplifiers (08 hrs)

Op-Amp parameters, frequency response, effect of temperature on Op-Amp parameters, differential versus single input amplifiers, instrumentation amplifier, bridge amplifier, adding versatility to the bridge amplifier, differentiator, integrator, Comparators, V to I and I to V Converters, Miller circuits, Voltage controlled oscillators, PLL and its applications, Signal conditioning circuits for temperature transmitter using OP amps. Design of Oscillator's- LC and RC

Unit-3 Signal Generators and filters (07 hrs)

Multivibrators, triangular wave generator, sawtooth wave generator, square wave generator, sine wave generator, Bootstrap Sweep generator, basic low pass filters, low pass and high pass Butterworth filters, band pass, band reject filters, and applications of filters.

Unit-4 Power devices and Applications (07 hrs)

SCR, Triac, DIAC, UJT, MOSFET, IGBT - Characteristics and principal of operation, Switching Characteristics, triggering requirement, protections, and applications.

Unit-5 Regulators (05 hrs)

Line and load regulation, characteristics of regulators, voltage multipliers, three terminal regulators, current boosters, protection circuits for regulators, power supply design, battery

charging circuits.

Unit-6 Power Converters (05 hrs)

SMPS, working principles, performance parameters, DC-DC converters: different types, working principles and analysis, applications.

Test Books

- Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory" Pearson Education, Tenth ed., 2009.
- Ramakant Gayakwad, "Op-Amp and Linear Integrated Circuits", PHI, Forth ed.,2000.

Reference Books

- George Clayton and Steve Winder, "Operational Amplifiers", Newnes Publishers, Fifth ed., 2003.
- 2. M. Rashid, "Power Electronics Circuit, Devices and Applications "Pearson Education, Third ed. 2004.

IE-20003 Electrical And Electronics Measurements

Teaching Scheme
Lectures: 3 hours / week

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

Course Outcomes:

1. Describe working principles of instruments for measurement of electrical quantities [PEO1][PO1]
2. Identify and apply methodology for measurement of electrical quantities[PEO2][PO2]
3. Identify and apply knowledge of digital and analog instruments for measurement [PEO2][PO2]
4. Design methodology for measurement of electrical quantities [PEO2][PO3]

Unit 1 Electrical Circuits (08 hrs)

Mesh analysis, nodal analysis, Maximum power transfer theorem, Reciprocity theorem, One port and two port networks, driving point impedance and admittance, Open and short circuit parameters

Unit 2 Analog meters (08 hrs)

Electromechanical meters, PMMC type, galvanometer, DC ammeter, DC voltmeter, calibration, selection and performance of measuring instruments, multi-range meters, extension of range, loading effect in instruments

Unit 3 Resistance, Inductance and Capacitance Measurement (08 hrs)

Wheatstone bridge, Kelvin bridge, Kelvin double bridge, series ohmmeter, shunt ohmmeter Maxwell's bridge: design and applications, Hay's bridge: design and applications, Schering

bridge: design and applications

Unit-4 Digital Instruments (07 hrs)
ADC, DAC, circuitry and operation, specifications, applications of ADC and DAC, DMM, true RMS meter, Universal Counter, LCR Q-meter

Unit-5 Signal generators and analyzers (05 hrs)
Function generator, sine wave synthesis, arbitrary waveform generators, Spectrum analyzer

Unit-6 Energy and Power Measurement (04 hrs)
Electrodynamometer, moving iron type, measurement of power in ac circuits and dc circuits, smart energy meter, Introduction to smart power measurement system

Test Books

- K. Sawhney, "Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai and Sons, Eleventh ed., 2000.
- David Bell, "Electronic Measurement and Instrumentation", Prentice Hall, Second ed., 2007.

Reference Books

- J. Bouwens, "Digital Instrumentation", McGraw-Hill, Sixteenth reprint, 2008.
- H S Kalsi, "Electronic Instrumentation", Tata McGraw-Hill, Third ed., 2010.
- Albert D. Helfrick, William David Cooper, "Modern electronic Instrumentation and Measurement Techniques" Prentice Hall, Second ed., 1990.
- Clyde F. Coombs, "Electronic Instrument Handbook", McGraw-Hill, Third ed., 2000.
- Wolf, Richard F. M. Smith Stanley, "Electronic Instrumentation Laboratories", Prentice Hall, Second ed., 2004.

IE-20004 Transducers Lab

Teaching Scheme
Tutorial : 1 hour / week
Practical: 2 hours / week

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

Course Outcomes:

1. Identify various elements required for characterization of given transducers/sensors. [PEO1][PO1]
2. Design and conduct experiments for measurement, characterization, and ability to analyze and interpret data. [PEO2] [PO3]
3. Communicate effectively in oral and written form while formulating experiments, reports and other related documents. [PEO4][PO10]

List of Experiments

1. Characterization and calibration of temperature measurement system. (Thermocouple, RTD and Thermistor).
2. Characterization of pressure and vacuum sensor.

3. Characterization and calibration of level measurement system. (Capacitive, resistive, and radar level gauge)
4. Characterization and calibration of flow measurement system. (Orifice, Pitot tube, Venture, Turbine, Electromagnetic and Ultrasonic)
5. Characterization and calibration of potentiometer as displacement sensor.
6. Characterization and calibration of LVDT based displacement measurement system.
7. Characterization of strain gauge using cantilever beam for force measurement
8. Characterization and calibration of speed measurement system.(Photoelectric and magnetic Pick-up).
9. Characterization and calibration of vibration measurement system.(Piezoresistive vibration Pick-up)
10. Study of the detectors.(leak detectors, flame detectors, smoke detectors)

List of Tutorials

1. Analysis of sensor data
2. Identification of temperature sensor from the list, which has minimum response time.
3. Select a pressure sensor for the application which needs highest accuracy.
4. Identify a flow sensor from the list which exhibits best dynamic characteristics.
5. Select an Acceleration sensor for given application
6. Selection of torque sensor for a particular application
7. Selection of force sensor for typical application
8. Identify operation region of humidity sensor for a proposed application

IE-20005 Analog Electronics Lab

Teaching Scheme
Practical: 2 hours / week

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

Course Outcomes:

1. Identify and measure transistor and operational amplifier's parameters [PEO1][PO1]
2. Design and implement various circuits using op-amp for various applications. [PEO2][PO3]
3. Plotting and analyzing characteristics of power devices and its applications.[PEO2][PO2]

List of Experiments

1. Design and Implementation of transistor biasing circuits.
2. Measurement of op-amp parameters.
3. Design and implementation of integrator, differentiator and comparators.
4. Design and implementation of Instrumentation amplifier.

5. Design and implementation of voltage multiplier.
6. Design of Oscillator circuits- LC and RC.
7. Design and implantation of voltage controlled oscillator and its practical applications.
8. Design and implementation of phase locked loop and its applications.
9. Design and implementation of various signal generators.
10. Design of low pass and high pass filter.
11. Study, plot and analyze characteristics of DIAC and SCR.
12. Study, plot and analyze characteristics of BJT, UJT and MOSFET.
13. Study of UJT as relaxation oscillator.
14. Design and implementation of voltage regulator.

IE-20006 Electrical And Electronics Measurement Lab

Teaching Scheme:
Practical : 2 hours / week

Examination Scheme
Continuous evaluation : 50 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

1. Design and implement experimental setup for measurement of electrical quantities. [PEO2] [PO3]
2. Design and implement experimental setup for measurement of analog and digital signals. [PEO2][PO3]
3. Demonstrate the usage of energy, power meters and signal generators. [PEO1] [PO1]

List of Experiment

1. Determination of admittance and impedance of one port network
2. Conversion and extension of PMMC type instruments.
3. Design and implementation of resistance measurement using Wheatstone bridge and validation using V-I method and LCR meter
4. Design and implementation of series and shunt ohmmeters and evaluate its performance.
5. Design of Schering and Maxwell bridges for measurement of inductance and capacitance and validation using LCR – Q meter.
6. Design and implementation of DAC using R-2R ladder network.
7. Design and implementation of ADC using IC 0808/0809
8. Study of DSO control panel, its specifications. Find time constant of a relay using DSO
9. Implementation of Virtual instrumentation for energy, power, power factor measurement
10. Implement and analyze signal generator using virtual instrumentation.

MA- 20004 Vector Calculus and Partial Differential Equations

Teaching Scheme
Lectures:2 hours / week
Tutorials:1 hours / week

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

Course Outcomes:

1. **Know** and **recall** double / triple integrals, vector differentiation, vector integration, partial differential equations. [PEO1] [PO1]
2. **Understand** basic concepts of co-ordinate systems, iterated integrals, gradient, divergence and curl. [PEO2[PO2]
3. **Evaluate** multiple integrals, **find** area / mass / volume using multiple integrals, **and evaluate** line integrals and surface integrals. [PEO2] [PO2]
4. **Prove** theorems, **apply** Green's / Stoke's / Divergence theorem to different type of problems, **model** one dimensional heat / wave equations, **and solve** partial differential equations. [PEO5] [PO3]
5. **Apply** concepts of vector calculus and partial differential equations to various applications including real life problems. [PEO2] [PO4]

Unit 1 Integration (10 hrs)

Double integrals in Cartesian and polar co-ordinates, iterated integrals, change of variables, triple integrals in Cartesian, spherical and cylindrical co-ordinates, substitutions in multiple integrals, Applications to Area, Volume, Moments and Center of Mass.

Unit 2 Differentiation (07 hrs)

Vector differentiation, gradient, divergence and curl, line and surface integrals, path independence, statements and illustrations of theorems of Green, Stokes and Gauss, arc length parameterization, applications.

Unit-3 Partial Differentiation (09 hrs)

Partial differential equations with separation of variables, boundary value problems: vibrations of a string, heat equation, potential equation, vibrations of circular membranes.

Test Books:

- Thomas Calculus (14th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano Pearson Education.
- Advanced Engineering Mathematics (10th edition) by Erwin Kreyszig, Wiley eastern Ltd.

Reference Books:

- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Functions of several variables by Wendell Fleming, Springer-Verlag, New York.
- Partial Differential Equations (4^{th} edition) by Fritz John, Springer.
- Advanced Engineering Mathematics (7th edition) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.

MA-20005 Multivariate Calculus and Differential Equations
(For Lateral Entry Students Only)

Teaching Scheme
Lectures: 4 hours / week
Tutorials: 1hr / week

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

Course Outcomes:

1. **Know** first order ordinary differential equations, **list** Laplace transform formulae, **define** functions of several variables, double / triple integrals, vector differentiation, vector integration, and partial differential equations. [PEO1][PO1]
2. **Understand** basic concepts of higher order ordinary differential equations, level curves and level surfaces, co-ordinate systems, iterated integrals, gradient, divergence and curl. [PEO2][PO2]
3. **Solve** linear differential equations using different methods, **find** Laplace transforms of functions using properties and theorems, **evaluate** directional derivatives and extreme values, **evaluate** multiple integrals, **find** area / mass / volume using multiple integrals, **evaluate** line integrals and surface integrals. [PEO2][PO4]
4. **Prove** theorems, **solve** ordinary differential equations using Laplace transforms, **apply** Green's / Stoke's / Divergence theorem to different type of problems, **model** one dimensional heat / wave equations, **solve** partial differential equations.[PEO5] [PO3]
5. **Apply** concepts of multivariate calculus and differential equations to various applications including real life problems. [PEO2][PO6]

Unit 1 **(09 hrs)**

Review of first order differential equations, linear differential equations, and homogeneous higher order linear differential equations, non-homogeneous higher order linear differential equations with constant coefficients (method of undetermined coefficients and method of variation of parameters).

Unit 2 **(07 hrs)**

Laplace Transforms, its properties, Unit step function, Dirac delta functions, Convolution Theorem, periodic functions, solving differential equations using Laplace transform.

Unit 3 **(07 hrs)**

Functions of several variables, level curves and level surfaces, partial and directional derivatives, differentiability, chain rule, local extreme values and saddle points

Unit 4 **(12 hrs)**

Double integrals in Cartesian and polar co-ordinates, iterated integrals, change of variables, triple integrals in Cartesian, spherical and cylindrical co-ordinates.

Unit 5 **(10 hrs)**

Vector differentiation, gradient, divergence and curl, line and surface integrals, path independence, statements and illustrations of theorems of Green, Stokes and Gauss.

Unit 6 **(07 hrs)**

Partial differential equations with separation of variables, boundary value problems: vibrations

of a string, one dimensional heat equation

Text Books

- Thomas' Calculus (14th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics (10th edition) by Erwin Kreyszig, Wiley eastern Ltd.

Reference Books

- Calculus for Scientists and Engineers by K.D Joshi, CRC Press.
- A Course in Multivariate Calculus and Analysis by Sudhir Ghorpade and Balmohan Limaye, Springer Science and Business Media.
- Differential Equations with Applications and Historical notes by George Simmons, Tata Mc-Graw Hill publishing company Ltd, New Delhi.
- Functions of several variables by Wendell Fleming, Springer-Verlag, New York.
- Partial Differential Equations (4th edition) by Fritz John, Springer.
- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Advanced Engineering Mathematics (7th edition) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Advanced Engineering Mathematics (2nd edition) by Michael D. Greenberg, Pearson Education.
- Advanced Engineering Mathematics by Chandrika Prasad and Reena Garg, Khanna Publishing Company Private Limited, New Delhi.

IE-20013 Micro-Project

(From an Project Idea to Simulation Prototype)

Teaching Scheme:-
Practical: 2 hr/week

Evaluation Scheme-
Total - 100 Marks
Continuous evaluation-
Assignments / Presentations

Course Outcomes

1. Designing and simulation of mini project which includes measurement of parameter; signal conditioning and processing, controlling, debugging as defined in the project problem statement. [PEO3][PO3]
2. To understand the user requirements and project scope. [PEO3][PO2]
3. To learn various simulation tools, like Matlab, circuit simulation tools, designing tools, programming simulation tools, etc. [PEO2][PO5]

Contents

Students are required to learn to understand the user requirements, design and development of various mini project Ideas. The paper design and simulation is part of the work. Simulation of various modules such as power supply, processor module, interfacing module, display and signal conditioning module as per industrial standards and practices, system design. Various aspects of

sensors selections, simulation of signal conditioning, standard signals and noise considerations of typical systems. Student has to develop a mini project of real time concept/social problem in simulation which includes various sensors used for real-time measurements such as temperature, pressure, vibration, et. with some sort of control.

AS-20001 Biology for Engineers

Teaching Scheme
Lectures: 3 hours / week

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

Course Outcomes:

1. Understand basic biological principles and organizational structure of living systems at molecular level [PEO1][PO1]
2. Comprehend basic biological principles and organizational structure of living systems at cellular level [PEO1][PO2]
3. know Energy transformations and information processing in biological systems [PEO2][PO4]
4. Appreciate biological process with engineering perspective [PEO2][PO6]
5. Impart knowledge about the common corridors of biology and engineering and biologically inspired technologies [PEO5][PO7]

Unit 1 Biomolecules and biopolymers: (6 hrs)

Structure and Function

Organic and inorganic molecules; Unique Properties of water, Vitamins and Minerals, Carbohydrates, Lipids, Amino Acids and proteins, Nucleic Acids (DNA and RNA)

Unit 2 Levels of organization of life (6 hrs)

Cell as a basic unit of life, prokaryotic and eukaryotic cells, microbes, plant and animal cells; Cell organelles – structure and function; Cell membrane

Levels of organization: cells, tissues, organs, systems & organism

Unit 3 Energy transformations in Chloroplast (6 hrs)

Photosynthesis (photochemical & biochemical phase) and ATP generation, Aerobic and anaerobic systems. Energy transformations in Mitochondria: Cellular respiration (glycolysis and Kreb cycle) and ATP generation. Bioenergetics: Thermodynamic principles applied to biology, negative entropy changes in biological systems, Free Energy, Chemical Equilibrium

Unit 4 Expression and Transmission of Genetic Information: (06 hrs)

DNA replication, Enzyme driven process of DNA cloning, Protein synthesis- Transcription & translation Techniques for optimization:

a. At molecular level: Recombinant DNA Technology, DNA hybridization, PCR, DNA microarray

Unit 5 Transport Phenomena in Biological Systems (06 hrs)

Membrane channels and ion channels; Fluid flow and mass transfer (nutrients & ions); In plants: Xylem and Phloem; In animals: Blood and Lymph Transport of gases: Oxygen and Carbon dioxide

Heat Transport - Body temperature regulation. Communication: Cell junctions, Cell-cell communications– cell signaling, Hormones, Pheromones and cell behavior, Defense mechanisms:

In plants: Herbivore, secondary metabolites,. In animals: Innate and Adaptive immune systems

Unit 6: Engineering perspectives of biological sciences (06 hrs)

Biology and engineering, crosstalk – At cell level: Hybridoma, technology, At tissue level: Plant Tissue Culture, Animal Tissue. Culture; Tissue Engineering: Principles, methods and applications Introduction to Biomimetics and Biomimicry, nanobiotechnology

Reference Books

- Lodish H, Berk A, Zipursky SL, et al. (2000) Molecular Cell Biology. W. H. Freeman.
- Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2000). Lehninger principles of biochemistry. New York: Worth Publishers.
- Rao CNR, et.al. Chemistry of Nanomaterials: Synthesis, Properties and Applications.
- Eggins BR. (1006) Biosensors: An Introduction. John Wiley & Sons Publishers.
- Palsson B.O. and Bhatia S.N. (2009) Tissue Engineering. Pearson.
- Yoseph Bar-Cohen (2005). Biomimetics- Biologically Inspired Technologies
- Joseph D. Bronzino, John Enderle, Susan M. Blanchard (1999) Introduction to Biomedical Engineering.
- Routledge Taylor and Francis group (2012). Introduction to Bio-medical Engineering technologies

EE(IF)-20001 Electrical Machines

(Offered by Department of Electrical Engineering)

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

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

Course Outcomes:

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

1. Identify various DC, AC and special purpose modern machines and understand the operation. [PEO1][PO1]
2. Select suitable motors for various applications. [PEO2][PO6]
3. Evaluate and analyze the parameters, operating characteristics and performance of various machines.[PEO1][PO2]
4. Analyze starting, speed control methods of DC, induction and synchronous motors. [PEO3]PO2]
5. Select a suitable energy efficient motors and special purpose machines for appropriate application. [PEO2][PO6]

Unit 1 Induction Motors (07 hrs)

Types of three phase induction motors, operation, circuit model, on load operation, torque developed, torque- speed characteristic, speed control, starting, braking, losses and efficiency, applications; types of single phase induction motors and working, double revolving field theory, circuit model, torque-speed characteristics, speed control, efficiency, applications, energy efficient

induction motors.

Unit 2 Synchronous Machines (07 Hrs)

Three-phase synchronous machines: construction, types, generation and motoring operation, emf equation, torque equation, power losses, efficiency. Permanent magnet synchronous motors, types, closed loop drive scheme, rotor topologies, torque-speed curve, losses and efficiency. Introduction to brushless dc motors, switched reluctance motors. Stepper motors, types, ac servo motors, torque-speed characteristics, control, applications.

List of Experiments:

1. Perform load test on three phase squirrel cage induction motor to estimate losses and efficiency
2. Perform no load and blocked rotor test on three phase squirrel cage induction motor to estimate it's equivalent circuit parameters, losses and efficiency. Plot circle diagram to estimate the maximum and starting torque components
3. Perform no load and blocked rotor test on single phase induction motor to estimate its circuit parameters and various torque components
4. Speed control of three phase squirrel cage and slip ring induction motor
5. Determination of equivalent circuit parameters and torque components of a single phase induction motor by no load and blocked rotor test.
6. Perform the load test on the synchronous motor/generator to evaluate the losses and efficiency
7. Parallel operation of two synchronous generators and study of turbine/ governor control and excitation control on the generator load sharing
8. Perform the load test on the permanent magnet synchronous motor and estimate its efficiency. Estimate the experimental torque speed curve.
9. Speed control of permanent magnet brushless dc motor.
10. Perform a load test on a permanent magnet brushless dc motor

Text Books

- D. P. Kothari and I. J. Nagrath, "Electric Machines", Tata Mc Graw Hill Publication, 4th edition 2010, Reprint 2012.
- E. Fitzgerald, C. Kingsley, S. D. Umans, "Electrical Machinery", Tata Mc Graw Hill, 6th edition, 2002.
- P. S. Bimbhra: Electrical Machinery – Khanna Publishers, 7th Edition, 2011.
- L Thareja, A. K. Thareja,, " A text book of Electrical Technology, Vol. II, AC and DC Machines" S chand Publication, Multicolour edition, Reprint 2004.
- T. J. E Miller, "Brushless Permanent Magnet and Reluctance motor Drives", Oxford Science Publications, 1989.
- Duane Hanselman, " Brushless permanent magnet motor design", Second edition, Magna Physics Publishing, 2016.

Reference Books

- Nasser Syed, "Electrical Machines and Transformers", A New York, Macmillon 1984.
- Langsdorf A. S., "Principles of DC Machines", 6th Edition, Mac Graw Hill Book Company 1959.
- P. C. Sen., "Principles of Electric Machines and Power Electronics ", 2nd Edition, John Wiley and Sons Inc., 1997.
- M. G. Say, "Alternating Current Machines", Fifth edition, Low price edition, ELBS, Reprinted

1994
- Bhag S. Guru and Huseyin R. Hiziroglu, "Electric Machinery and Transformers", Third Indian edition, Oxford University Press, Reprint 2014.

E-Resources

- **E- resource** https://nptel.ac.in/courses/108102146/#; NPTEL:Electrical Engineering, Electrical Machines, Course Instructor: Prof. G. Bhuvaneswari, IIT Delhi.
- **E- resource:** https://nptel.ac.in/courses/108/105/108105155//; NPTEL: Electrical Engineering, Electrical Machines –I, Course instructor: Prof. Tapas Kumar Bhattacharya, IIT Kharagpur
- **E- resource:** https://nptel.ac.in/courses/108105131/; NPTEL: Electrical Engineering, Electrical Machines –II, Course instructor: Prof. Tapas Kumar Bhattacharya, IIT Kharagpur

IE-20014 Applied Numerical Methods Laboratory

Teaching Scheme
Practical:2 hours / week
Tutorials:1 hours / week

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

Course Outcomes:

1. Be familiar with the use of numerical methods in modern scientific computing [PEO1][PO1]
2. Be familiar with finite precision computation. [PEO1][PO1]
3. Be familiar with numerical solutions of nonlinear equations in a single variable [PEO1][PO1]
4. Be familiar with numerical integration and differentiation[PEO1][PO4]
5. Ability to determine different methods of numerical interpolation and approximation of functions. [PEO3][PO3]

List of Experiments:

1. **Roots of Non-Linear Equations**-To find the roots of non-linear equations using Bisection method.
2. **Roots of Non-Linear Equations** -To find the roots of non-linear equations using Newton-Raphson method.
3. **Interpolation**- Using Linear or Quadratic interpolation, finds intermediate data points from given set of data.
4. **Interpolation**- Using Lagrange interpolation, find intermediate data point form given set of data and compare the result with linear or quadratic interpolation.
5. **Curve Fitting**- For a give data set; find best fit curve using linear regression
6. **Curve Fitting**- For a give data set; find best fit curve using polynomial regression.
7. **Linear Solver**-To solve system of linear equations using Gauss Elimination method.
8. **Linear Solver**-To solve system of linear equations using Gauss Jordan method.

9. **Integration**-To integrate numerically using Trapezoidal Rule.
10. **Integration**-To integrate numerically using Simpson's Rule.
11. **Matrix Eigen values**-To find Eigen values of matrix by power method
12. **Differential Equation**-To find numerical solution of ordinary differential equations by Euler's methods.
13. **Differential Equation**-To find numerical solution of ordinary differential equations by Runge- Kutta methods.

Test Books:

1. 1. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, 7th Edition, McGraw-Hill
2. Steven C. Chapra, Applied Numerical Methods with Matlab for Engineers and Scientist McGraw-Hill

IE-20008 Automatic Control System

Teaching Scheme
Lectures: 3 hours/week

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

Course Outcomes:

1. Describe elements of control system. [PEO1] [PO1]
2. Design mathematical model for electrical, mechanical and electromechanical system. [PEO2] [PO3]
3. Application of basic methods for analysis of control systems. [PEO2] [PO6]

Unit 1 Introduction and Classification of Control systems (07 hrs)

Introduction to control systems, Introduction to design process, classification of control system, Review of Laplace and inverse Laplace transform, transfer functions, modeling of mechanical, electrical, and electromechanical systems.

Unit-2 Signal Flow Graph (07 hrs)

Block diagram reduction techniques, signal flow graph, Mason's gain formula, signal flow graph from block diagram.

Unit 3 Time Response Analysis (08 hrs)

Time response analysis, 1st, 2nd and higher order systems, effect of addition of poles and zeros, steady state errors (SSE) for feedback systems, static error constants and system types, steady state errors for external disturbances. Design of system parameters from SSE.

Unit 4 Stability Analysis (05 hrs)

Stability of open loop and closed loop systems, Routh-Hurwitz criterion, Stability and performance analysis.

Unit 5 Root Locus **(05 hrs)**

Root locus techniques, Root locus construction rules, Sketching of Root Locus.

Unit 6 Frequency response analysis **(08 hrs)**

Frequency response analysis, Bode plot, Asymptotic approximations and refining of plot, Gain Margin, Phase Margin via Bode plot, Polar plot, Nyquist plot, Stability, Gain Margin, Phase Margin via Nyquist plot.

Test Books

- Norman Nise, Control System Engineering, Wiley International, sixth edition, 2011
- Nagrath and Gopal, Control System Engineering-, New Age International Publication, fifthedition,2003

Reference Books

- G. Goodwin, S.Graebe, Mario Salgado, Control System Design –, Pearson Education, first edition, 2000.
- G. Franklin,J.Powell,A. Naeini, Feedback Control of Dynamic Systems- Pearson, seventh edition, 2014.
- K. Ogata, Modern Control Engineering- Prentice Hall Publications, fifth edition, 2012.
- Automatic Control Systems, Farid Golnaraghi and Benjamin C Kuo, 9th Edition, John Wiley and Sons, 2010.

IE-20009 Signals and Systems

Teaching Scheme

Lectures: 3 hours / week

Examination Scheme

Test 1: 20 Marks
Test 2: 20 Marks
End-Sem Exam: 60 Marks

Course Outcomes:

1. Ability to classify systems based on their properties: in particular, to understand and exploit the implications of linearity, time-invariance, causality, memory, and bounded-input, bounded-out (BIBO) stability. [PEO2][PO2]
2. Ability to analyze and realize discrete system using z transform [PEO2][PO2]
3. Determine Fourier transforms for continuous-time and discrete-time signals (or impulse-response functions), and understand how to interpret and plot Fourier transform magnitude and phase functions. [PEO1][PO4]
4. Understand the sampling theorem and how it links continuous-time signals to discrete-time signals. [PEO1][PO1]

Unit 1 Introduction to Signals and Systems **(08 hrs)**

Introduction to Signals, Classification of Signals, Continuous Time and Discrete Time Signals, Step and Impulse Functions, Transformation of Independent Variable. Introduction to Systems, Classification of Systems, Properties of Systems, Normal Form of System Equation, Initial Conditions, Impulse Response of a Physical System, system Impulse Response

Unit 2 Analysis of Systems **(06 hrs)**

System characteristics, Introduction to Convolution, Convolution Sum, Linear and Circular

Convolution, Sampling theorem, reconstruction, aliasing, sampling in the frequency domain, sampling of discrete time signals, decimation and interpolation

Unit 3 Fourier Transform Analysis (06 hrs)

Fourier analysis for Continuous time signals and systems, Continuous time Fourier series and its convergence, Continuous time Fourier Transform, its properties, frequency response

Unit 4 Discrete Fourier Transform (08 hrs)

Discrete time Fourier series and its convergence, discrete time Fourier Transform, its properties, frequency response. Introduction to DFT in time domain and frequency domain, Filtering: Ideal frequency selective filters, Non Ideal frequency selective filters, examples, Butterworth filters

Unit 5 Z-Transform (08 hrs)

Definition, properties of z-transform, z-transform of standard sequences, inverse Z-transform, relationship of z-transform with Fourier transform applications of Z-transform to solutions of difference equations, Properties and applications of Z transform

Unit 6 FIR and IIR system (06 hrs)

Introduction to FIR and IIR system, block diagram representation, cascade, parallel, and feedback interconnections. FIR and IIR system realization, Direct Form I, Direct Form II, cascade, parallel and transposed realization

Test Books

- Michael J. Robert, "Introduction to Signals and Systems", TMH, Second ed., 2003, Tarun Kumar Rawat "Signals and Systems", Oxford University Press, first edition 2010

Reference Books

- Alan V Oppenhein, Alan S Wiilsky, "Signals and systems" PHI, Second ed. 2009

IE-20010 Digital Electronics

Teaching Scheme

Lectures:3 hours / week

Examination Scheme

Test 1: 20 Marks
Test 2: 20 Marks
End-Sem Exam: 60 Marks

Course Outcomes:

1. Describe various logic families and select a logic family logic gate(s) for a typical application [PEO1][PO1]
2. Apply Boolean algebra and other minimization techniques to digital circuits. [PEO1][PO4]
3. Design combinational and sequential circuits for a given problem / case studies related to digital circuits. [PEO2] [PO3]
4. Evaluate appropriate hardware and software tools for combinational and sequential circuit design, implementation and verification. [PEO2] [PO2]

Unit 1 Logic Families (06 hrs)

Digital IC specification terminology, different types of logic families, complementary metal oxide semiconductor logic, logic families interfacing – TTLdriving CMOS, CMOS driving TTL, measurement

of specification parameters of IC's, 5400 /7400 series ICs, Tristate Logic, Comparison of Different logic families.

Unit 2 Combinational Circuits (06 hrs)

Introduction to Combinational circuits, analysis procedure, design procedure, Boolean algebra, K-map, Tabular method, binary adder, binary subtractor, decimal adder and their implementation, binary multiplier, magnitude comparator, decoders, encoders, multiplexer, hardware design logic for combinational circuits, Combinational Logic design using MSI Circuits, Hazards in Combinational circuits.

Unit 3 Sequential Circuits (07 hrs)

Flip Flops, Conversion of flip flops, ripple counters, synchronous counters, Hardware for counters , Ring, Johnson, Binary, BCD, Up-Down counters and its applications, registers, shift registers and their applications, Hardware design logic for counters, Hazards in sequential Circuits

Unit-4 Analysis of sequential circuits (07 hrs)

Synchronous and Asynchronous Sequential Logic: Sequential circuits, latches, analysis of clocked sequential circuit, hardware design logic for sequential circuits, state reduction, State diagram, and state equation, Asynchronous logic, circuits with latches, design procedure,
reduction of state and flow tables, race free state assignments, design examples

Unit 5 Programmable Logic Devices I (06 hrs)

Introduction to memories, Types of memories, Memory specification, Introduction to PAL, PLA, Configurable Programmable Logic Devices, Various types of CPLD's.

Unit-6 Programmable Logic Devices II (07 hrs)

Introduction to FPGA and its various architectures, PLD Programming concepts, Introduction to PLD Programming languages, Realization of combinational and sequential circuits on PLDs.

Test Books

- Ronald J. Toccii, "Digital Systems: Principles and Applications", Pearson LPE, Fourthed. 2009.
- R. P. Jain, "Modern Digital Electronics", McGraw Hill Higher Education, Fourth ed.,2010

Reference Books:

- Mano M.M, "Digital Logic and Computer Design", Pearson LPE, Fourth, ed., 2009.
- Boyce J. C., "Digital Logic: Operation and Analysis", Prentice Hall, Second ed., 1982

IE-20011 Digital Electronics Laboratory

Teaching Scheme

Practicals:2 hours / week

Examination Scheme

Continuous Assessment: 50 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

1. Design experimental setup for measurement of digital IC parameters & its verification. [PEO1] [PO3]
2. Design, realize and analyze various combinational and sequential circuits [PEO1] [PO3]
3. Select and use latest hardware and software tools for digital system realization. [PEO2] [PO6]

List of Experiments:

1. Measurement of IC's parameters like rise time, fall time, propagation delays, and current and voltage parameters.
2. Design and implementation of arithmetic circuits.
3. Design and implementation of various code converters and its applications.
4. Design and implementation of multiplexer and demultiplexer and its applications.
5. Design and implementation of encoders and decoders and its applications.
6. Design and implementation of synchronous and asynchronous counters and its applications.
7. Design and implementation of non-sequential counters.
8. Design and implementation of shift registers and its applications.
9. Implementation and verifications of Combinational circuits on programmable logic devices.
10. Implementation and verifications of sequential circuits on programmable logic devices.

IE-20012 Automatic Control System Laboratory

Teaching Scheme
Practical: 2hours/week

Examination Scheme
Continuous Assessment: 50 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

1. Stability analysis of Control System. [PEO1] [PO1]
2. Develop mathematical model for electrical systems. [PEO2] [PO3]
3. Analyse second order systems and validate using MATLAB. [PEO1] [PO2]

List of Experiments:

1. Study of SISO and MIMO control system.
2. To find the transfer function of unknown system (electrical / mechanical / Electromechanical system)
3. Study of type 0 and type 1 systems analysis for transient and steady state error.
4. Analysis of second order (R-L-C) system in time domain.
5. Write a program to find Routh table and comment on its stability
6. Write a program to design controller using root locus technique
7. Write a program to draw bode plot of a given transfer function

8. Write a program to find step and ramp response of a second order system and verify with
9. physical system
10. Write a program to draw Nyquist plot of a given transfer function
11. Develop a Simulink model to find steady state error for a type 0, type 1 and type 2 system.

IE(IF)-20001 Feedback Control System
(Offered by Department of Instrumentation and Control to other Departments)

Teaching Scheme
Lectures: 1 hour / week
Tutorial: 1 hour/ week

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

Pre-requisite: Basics of Signals and System, Basic Physics laws, Laplace Transform.

Course Outcomes:

1. Understand the effects of feedback in linear systems. [PEO1][PO1]
2. Develop a mathematical model of electrical, mechanical and electromechanical system. [PEO2][PO3]
3. Ability to apply various feedback control analysis and design methods. [PEO1][PO2]
4. Design a closed-loop system to meet a desired behavior [PEO2][PO3]

Unit 1 **(06hrs)**

Importance of control systems, Control situations in Industry and around, classification of control system, transfers function, System modeling in the time domain.

Unit 2 **(08hrs)**

Dynamics of electrical and mechanical systems. Signal flow graph, System response in the time domain, Time-domain specifications. Time response analysis, 1st, 2nd and higher order systems. Basic properties of feedback, Advantage of feedback, Steady state errors (SSE) for feedback systems, static error constants and system types.

Unit 3 **(06hrs)**

Stability of open loop and closed loop systems, Routh-Hurwitz stability criterion. Root locus techniques, Root locus construction rules, Effects of Pole and Zeros. Using root-locus ideas to design controller, reducing steady-state error.

Tutorials:

1. To study SISO and MIMO Systems
2. To find the transfer function of unknown system (electrical / mechanical / Electromechanical system)
3. Develop a MATLAB/Simulink program to generator standard test signals.
4. Analysis of second order (R-L-C) system in time domain.

5. Write a program to find step and ramp response of a second order system and verify with physical system.
6. Develop a Simulink model to find steady state error for a type 0, type 1 and type 2 systems.
7. Write a program to find Routh table and comment on its stability
8. Write a program to design controller using root locus technique

IE(IF)-20002 Sensors and Automation

(Offered by Department of Instrumentation and Control to other Departments)

Teaching Scheme:
Lectures: 1hour / week
Practical: 2hrs/week

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

Course Outcomes:

1. Interpret the characteristics of the transducers/sensors [PEO2][PO2]
2. Select transducers/sensors for specific applications [PEO1] [PO6]
3. Understanding of working principle of Programmable Logic Controller (PLC) and Distributed Control Systems (DCS) [PEO1] [PO1]
4. Understanding the concept of Industrial Automation[PEO1][PO1]

Unit 1 Basics of Sensors (07 hrs)

Concepts and terminology of transducer, sensor, sensor classifications and characteristics (Static and dynamic), Working principle, characterization and applications of: strain gauges, LVDT, capacitive, RTD, thermocouple, thermistor, Solid-State, pressure, optical, chemical sensors, integration of sensors for IOT and Industry 4.0 applications.

Unit 2 Industrial Automation (07 hrs)

Industrial Automation: concept, automation components, necessity and working principle, block schematic of Programmable Logic Controller (PLC). Input & Output modules (AI, DI, AO, DO), Introduction to Ladder Programming, introduction to Distributed Control Systems (DCS). Industrial automation leads to Industrial IOT and Industry 4.0.

List of Experiments

1. Case study /Characterization of RTD/semiconductor Temp IC
2. Characterization of level sensors
3. Characterization of strain gauge/ Displacement measurement using LVDT/ Encoders
4. Characterization of PH, Conductivity, color sensor
5. Introduction to PLC programming languages (ladder programming)

6. Ladder Programming for relay, coil, On/OFF, Sequencing of motors,;
7. Ladder Programming with Timers/Counters
8. Ladder Programming for Pick and Place type of robotics application

Text Books

- B. C. Nakra and K. K. Choudhari, "Instrumentation Measurements and Analysis" by, Tata McGraw Hill Education, Second ed., 2004.
- C.D. Johnson, " Process Control Instrumentation Technology" by, Pearson Education Limited , eighth ed., 2014

Reference Books

- G. Goodwin, S. Graebe, Mario Salgado, Control System Design –, Pearson Education, first edition, 2000.
- G. Franklin, J. Powell, A. Naeini, Feedback Control of Dynamic Systems- Pearson, seventh edition, 2014.
- K. Ogata, Modern Control Engineering- Prentice Hall Publications, fifth edition, 2012.

Web References

- NPTEL video lectures "Control Engineering" by M. Gopal, IIT Delhi.