Academic Hand Book

CURRICULUM AND SYLLABI

of

B.Tech Programme

(Applicable to 2023 Admission onwards)

http://www.nitgoa.ac.in

राष्ट्रीय प्रौद्योगिकी संस्थान गोवा

NATIONAL INSTITUTE OF TECHNOLOGY GOA

कोट्टामल प्लाटू, कुंकोलिम, सालसेट, दक्षिण गोवा, गोवा - ४०३७०३, इंडिया

Kottamoll Plateau, Cuncolim, Salcete, South Goa, Goa- 403703, India

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1. Institute Vision and Mission

Vision

National Institute of Technology Goa shall emerge as one of the Nation's pre-eminent institutions. Through its excellence, it shall serve the Goan society, India and humanity at large with all the challenges and opportunities.

Mission

- ✓ NIT Goa strives for quality faculty, good students and excellent infrastructure.
- ✓ Strives for excellence, through dissemination, generation and application of knowledge by laying stress on interdisciplinary approach in all the branches of Science, Engineering, Technology, Humanities and Management with emphasis on human values and ethics.

2. Curriculum

The total credits for completing B.Tech. in ***any*** of the engineering discipline is ***168***. The structure of B.Tech. programmes shall have the following course classifications as listed in Table.1.

Table 1: Course classifications of the B.Tech. programmes

Sl. No.	Classifications	Course Type	Credits For CGPA	Courses
1	Basic Sciences	**BS**	21	MA→11, PH→5, CY→5
2	Basic Engineering Sciences and Technical Arts	**ES**	21	EM→3, BMC→3, BES→6, CPPS→4, ED→3, WP→2
3	Humanities and Social Sciences	**HU & HS**	7	PC →4, ECO→ 3
4	Indian Knowledge Systems	**IKS**	5	HH →2 and an Open Elective Course →3
5	Others: Liberal Arts, Innovation & Entrepreneurship	**OT**	2	LA→1, IE→1
6	Mandatory Learning Courses	**MLC**	2	PE→0, ES→ 1, PEHV→ 1
7	Department Core	**DC**	83 - 86	Core Theory and Lab courses, Comprehensive Examination →1, Seminar→1, Summer Internship→1, Project Work→5
8	Department Elective (including MOOCs or any other as approved by the Institute)	**DE**	21-27	7-9 Electives
9	Open Elective (including MOOCs or any other as approved by the Institute)	**OE**	0-6	Upto 2 Open Electives
Total Credits			**168**	
10	Minor Program	**MR**	**18**	

Course abbreviations used in Table 1 are as below:

MA	:	Mathematics	CPPS	:	Computer Programming and Problem Solving	LA	:	Liberal Arts
PH	:	Physics	ED	:	Engineering Drawing	IE	:	Innovation & Entrepreneurship
CY	:	Chemistry	WP	:	Workshop Practices	PE	:	Physical Education
EM	:	Engineering Mechanics	PC	:	Professional Communication	ES	:	Environmental Studies
BMC	:	Basics of Mechanical and Civil Engineering	ECO	:	Economics	PEHV	:	Professional Ethics and Human Values
BES	:	Basic Electrical Engg. / Basic Electronics Engg.	HH	:	Health and Happiness	MOOCs	:	Massive Open Online Courses

3. Contact Hours and Credits

Every Course comprises of specific Lecture-Tutorial-Practical (L-T-P) Schedule. Generally, a courses' credits are fixed based on the following norms. However, there can be a few special courses with a slight variation in credit allotment.

Lectures/Tutorials : 1 hour per week is assigned 1 credit

Lab/Practicals : 3 hours per week assigned with 2 credits will run as a Full-Semester Course

: 2 hours per week assigned with 1 credit will run as a Full-Semester Course

: 3 hours per week assigned with 1 credit will be run as a Half-Semester Course

Example:

a theory course with a L-T-P schedule of 3-1-0 will be assigned 4 credits;

a lab/practical course with a L-T-P schedule of 0-0-3 will be a Full-Semester Course when 2 credits are assigned; with 0-0-2 will be a Full-Semester Course when 1 credit is assigned and 0-0-3 will be a Half-Semester Course when 1 credit is assigned.

4. Programme Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, 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 modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

5. Course numbering scheme

Course numbers are 5 character alpha numeric string following the below rules:

<table>
<tr><th colspan="2">Code of the Department offering the course (departments list is given in next section)</th><th>Year</th><th>Semester</th><th>Course Type</th></tr>
<tr><td rowspan="2">X</td><td rowspan="2">Y</td><td>1 [1st Yr]
2 [2nd Yr]
3 [3rd Yr]
4 [4th Yr]</td><td>0 [Odd]
5 [Even]</td><td>0, 1, 2, … Running Index</td></tr>
<tr><td>5 [Elective]</td><td colspan="2">00, 01, 02,….. Running Index</td></tr>
</table>

- Department Elective (DE) courses start with 500 series
- Open Elective (OE) courses start with 900 series

6. List of Codes for Departments

Department Code	Name of the Department
CS	Computer Science and Engineering
CE	Civil Engineering
CY	Chemistry
EC	Electronics and Communication Engineering
EE	Electrical and Electronics Engineering
HS	Social Sciences
HU	Humanities
MA	Mathematics
ME	Mechanical Engineering
PE	Physical Education
PH	Physics

7. Semester-wise courses of First year B. Tech. Programme

I Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA100	Matrices and Advanced Calculus	BS	3-1-0	4
2.	PH100	Engineering Physics	BS	3-0-0	3
3.	CS100	Computer Programming and Problem Solving	ES	3-0-0	3
4.	EE100	Basics of Electrical Engineering	ES	2-0-0	2
5.	ME100	Engineering Mechanics	ES	3-0-0	3
6.	HU100	Liberal Arts	OT	0-0-2	1
7.	PH101	Engineering Physics Lab	BS	0-0-3	2
8.	CS101	Computer Programming Lab	ES	0-0-2	1
9.	EE101	Basics of Electrical Engineering Lab	ES	0-0-3	1*
10.	ME101	Engineering Drawing	ES	1-0-3	3
	Total Credits				**23**

II Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA150	Differential Equations and Vector Calculus	BS	3-1-0	4
2.	CY150	Engineering Chemistry	BS	3-0-0	3
3.	HU150	Professional Communication	HU	2-0-3	4
4.	EC150	Basics of Electronics Engineering	ES	2-0-0	2
5.	ME150	Basics of Mechanical and Civil Engineering	ES	3-0-0	3
6.	HU151	Health & Happiness	IKS	2-0-0	2
7.	CY151	Engineering Chemistry Lab	BS	0-0-3	2
8.	EC151	Basics of Electronics Engineering Lab	ES	0-0-3	1*
9.	ME151	Workshop Practices	ES	0-0-3	2
10.	PE150	Physical Education	MLC	1-0-2	0#
	Total Credits				**23**

***: Half-Semester Course, #: Non credit Course**

8. Detailed Syllabi of First year courses

Course Code	Course Name	L	T	P	Credits
MA100	Matrices and Advanced Calculus	3	1	0	4

Course Objective

The aim of this course is to provide engineers and scientists with a strong foundation in essential mathematical principles. By focusing on key topics such as differential calculus, integral calculus, sequences & series, Fourier series, and linear algebra, students will develop a deep understanding of applied mathematics.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

- **CO1.** Develop a solid grasp of the basic principles of matrix theory and effectively apply them to solve engineering problems.
- **CO2.** Understanding of the significance of differential calculus and its wide- ranging applications.
- **CO3.** Comprehend the fundamental concepts of integral calculus and its practical applications,
- **CO4.** Apply appropriate techniques to test the convergence of sequences and series, as well as analyze Fourier series,

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	L			L	L	M		H
CO2	H	H	H	M				L	L	M		H
CO3	H	H	H		L			L	L	M		H
CO4	H	H	H	H	L			L	L	M		H

Syllabus

Module 1: Matrices and Applications- *Matrices:* Matrix operations -addition, scalar multiplication, multiplication, transpose, adjoint and their properties; System of linear equations and Gaussian elimination, Determinants and their properties; Cramer's rule;
*Vector Space***:** Subspaces, Linear dependence/independence, Basis, Dimension, Standard Basis of R^n, Linear transformations, Matrix of a linear transformation, change of basis and similarity, rank-nullity theorem; Inner product spaces, Gram-Schmidt process, and Orthonormal bases, Eigenvalues and Eigenvectors, Characteristic polynomials, Diagonalization.
Module 2: Differential Calculus- *Functions of single variable***:** Functions and transcendental Functions; Limits, Continuity and Differentiability; Mean value theorems, Taylor's and Maclaurin's theorems; Parametric equations and Polar coordinates. *Functions of several variables***:** Partial differentiation; Total differentiation, Euler's theorem and generalization;

Change of variables, Jacobians; Maxima and inima, Lagrange's method of Multipliers.

Module 3: Integral Calculus- Fundamental theorem of calculus; Improper integrals; Beta and Gamma functions; Applicationsof Integrals.

Module 4: Fourier Series: *Infinite Series:* Convergence of sequences and series, Power series; *Fourier series:* Periodic functions, Euler's formulae, Dirichlet's condition, Even and odd functions, Half Range Series.

Reference Books/Material

1. G. B. Thomas and R. L. Finney, *Calculus and Analytic Geometry* (14thEdition), ISE Reprint, Addison-Wesley, Pearson, 2018.
2. E. Kreyszig, *Advanced Engineering Mathematics* (8th Edition), JohnWiley, 1999.
3. G. Strang, *Introduction to Linear Algebra*, Wellesley, 2021.
4. G. Strang, *Linear Algebra and Its Applications*, Cengage, 2005

R. K Jain and S.R.K. Iyengar, *Advanced Engineering Mathematics*,3rd edition,Narosa publications, 2007.

Course Code	Course Name	L	T	P	Credits
PH100	Engineering Physics	3	0	0	3

Course Objective

To refurbish the understanding of fundamental Physics and provide concepts & application perspectives of modern physics

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

- **CO1.** Understands the basic concepts of Quantum Physics.
- **CO2.** Apply the Quantum Mechanical Principles to solve the physical problems.
- **CO3.** Apply the concepts of interference, diffraction, and polarization in Engineering Measurements.
- **CO4.** Use of lasers and optical fibers in engineering and communication fields.
- **CO5.** Understand the utility of renewable Energy Sources for engineering applications.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	L	M		L	L	L	M		H
CO2	H	H	M	M	M		L	L	L	M		H
CO3	H	H	M	M	M	L	L	L	L	M		H
CO4	H	H	M	M	H	M	M	L	L	M		H
CO5	H	M	M	L	H	M	M	L	L	M		H

Syllabus

Module 1: Dual nature of particles and waves: Representation of a wave, Phase and Group velocities, Black body radiation, Electromagnetic radiation, Dual nature of light and the photoelectric effect, Properties of photons, Matter waves, de-Broglie principles, Davisson and Germer experiment (basic ideas) to show the existence of matter waves.

Module 2: Quantum Mechanics: Limitations of classical mechanics, The wave equation, State functions, Normalization of wave functions, Schrödinger equation, Time-dependent form, operators and expectation values, Time independent Schrödinger equation, Eigen values and Eigen functions, Applications of Schrödinger equation- Particle in an infinite and Finite potential well, tunnelling, Harmonic oscillator, Uncertainty principle, Energy and time form of the uncertainty principle, explanation of zero point energy.

Module 3: Concept of interference, Newton's Rings. Fabry-Perot Interferometer and its application as a wavelength filter, Fraunhofer Class of diffraction at single, double and multiple slits diffraction at the circular aperture, Resolving Power, diffraction grating and its applications. Polarization Devices: Principles, working and applications of wave plates, Half-shade Polari meter, Photo elasticity and plane Polari scope. Lasers and Optical Fibers: Basics principles and Characteristics of laser light. Lasing action, construction and working of Three Level and Four Level Lasing Systems. PN Junction as a light source and Detector-Construction and working of LED and Laser Diode. Principle of Light Guidance in an optical fiber communication. Advantages of optical fibers over conventional systems

Module 4: Modern and Renewable Energy sources: Nuclear fission and fusion; Different Types of Nuclear Reactors-Thermal/Fast Neutron-Description and working of Gas Cooled, Boiling Water (BWR), Pressurised Water (PWR), Pressurised Heavy Water (PHWR) and Fast Neutron (FBR) Nuclear Reactors. Solar Cells: Solar spectrum, photovoltaic effect, structure and working principle of solar cell, I- V characteristics, power conversion efficiency, materials for PV, emerging PV technologies for alternative energy devices. Introduction to other Renewable Energy sources-Wind-Tidal-Geothermal systems

Reference Books/Material

1. David Halliday, Robert Resnick, & Walker Jearl, (2014). *Fundamentals of Physics.* Wiley Publications.
2. Arthur Beiser, Shobhit Mahajan, & S Rai Choudhury, (2017). *Concepts of Modern Physics.* Tata McGraw - Hill Education.
3. S. O. Kasap, (2012). *Optoelectronics and Photonics-Principles and Practices.* Pearson Publications.
4. Raymond A. Serway, & John W. Jewett, (2008). *Physics for Scientists and Engineers with modern physics.* Thomson Brooks/Cole publisher.
5. Ajoy Ghatak, (2021). *Optics.* McGraw Hills Education.
6. P. K Palaniswamy, (2017). *Applied Physics.* SCITECH publications
7. David Halliday, Robert Resnick, & Walker Jearl, (2014). *Principles of Physics.* Willey.

8. Hugh D. Young, Roger A. Freedman, & A Lewis Ford, (2015). *University Physics with Modern Physics.* Pearson Publisher.
9. Vaidyanathan G., (2013). *Nuclear Reactor Engineering (principles and Concepts.* S. Chand Publication
10. Thomas Schulenberg, (2022). *The fourth generation of nuclear reactors: Fundamentals, Types, and Benefits*. Springer Publication

Course Code	Course Name	L	T	P	Credits
CS100	Computer Programming and Problem Solving	3	0	0	3

Course Objective

The objective of the course is to make the students learn problem-solving by writing algorithms and implementing them using C Programming language. The course helps the students to write programs to solve computational problems.

Course Outcomes

At the completion of this course, the student will be able to:

CO1. Develop basic understanding of computers and the concept of algorithms.

CO2. Design algorithms for solving simple computational problems, including searching and sorting.

CO3. Examine the suitability of C programming features to solve specific problems.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	L							
CO2	H	H	H	H	M							
CO3	H	H	H	H	M							

Syllabus

Module 1: Introduction to Computers, Elements of Computing Systems, Overview of Systems Software.

Getting Started: Problem-solving techniques – Basic algorithms**,** C standards. What is C, Getting Started with C, The C Character Set, Constants, Variables, and Keywords, Types of C Constants, Rules for Constructing Integer, Real and Character Constants. Types of C Variables, Rules for Constructing Variable Names, C Keywords. The First C Program: Compilation and Execution, Receiving Input. Algorithms and flowcharts. C Instructions: Type Declaration Instruction, Arithmetic Instruction, Integer and Float Conversions, Type Conversion in Assignments, Hierarchy of Operations, Associativity of Operators, and Control Instructions in C.

The Decision Control Structure: The if Statement, The if-else Statement, Nested if-elses, Forms of if. Use of Logical Operators: The else if Clause, The ! Operator, the Conditional Operators.

The Loop Control Structure: Loops: while Loop, for Loop, break statement, continue statement, do-while Loop.

The Case Control Structure: Decisions using the switch, switch versus if-else Ladder, The goto Keyword.

Module 2: Functions & Pointers: Basics of Functions, Value Passing, Scope rules of Functions, calling convention, Advanced Features of Functions. Introduction to Pointers, Pointer Notation, Recursion, Recursion and Stack, Pointers to Functions, Functions returning pointers, Functions with variable number of arguments.

Data Types Re-visited: Integers- long, short, signed, unsigned. Chars-signed, unsigned. Floats & Doubles. Storage Classes in C.

The C Preprocessor: Features of C Preprocessors, Macro Expansion, File Inclusion, Conditional Compilation, #if and #elif Directives, The Build Process.

Module 3: Arrays: Basics of Arrays, Pointers & Arrays, Two-Dimensional Arrays, Array of Pointers, Three-Dimensional Arrays.
Strings: Basics of Strings, Pointers & Strings, Standard Library String Functions, Dynamic Allocation of Memory, Two-Dimensional Array of Characters, Array of Pointers & Strings.

Structures & Unions: Basics, Declaration, and Usage.

Console Input and Output: Formatting output for functions in the printf () family, Formatting input for functions in the scanf () family, Escape sequences.

Module 4: Module File Processing: Opening and closing files, reading and writing sequential files, Using argc and argv.

Operations on Bits: Bitwise Operators, Hexadecimal Numbering System, Relation between Binary and Hex. Mixed Features: Enumerated Data type, Typedef, Typecasting, Bit Fields, The volatile Qualifier.

Books/ Reference Books:

1. Brian W. Kernighan & Dennis M. Ritchie, “The C Programming Language,” Second edition, Prentice Hall Inc.
2. Herbert Schildt, “C: The Complete Reference,” 4th edition, McGraw Hill Education, 2017.
3. R.G. Dromey, How to solve it by Computers? Prentice Hall, 2007.
4. J.R.Hanly and E.B. Koffmann, Problem Solving and Program design in C, 6th Edition, Pearson Education, 2009.
5. E.Balagurusamy, “Programming in ANSI C”, McGraw Hill Education India Private Limited; Seventh edition, July 2017.
6. Byron Gottfried, Programming with C, 4th Edition, Tata McGraw Hill Education, 2018.
7. Yashavant Kanetkar, Let Us C, 15th Edition, BPB Publications, 2016.

Course Code	Course Name	L	T	P	Credits
EE100	Basics of Electrical Engineering	2	0	0	2

Course Objective

The objectives of studying this course are: to understand how electrical power system works, to analyze electrical and magnetic circuits, and also to understand the principle of operation of transformers and electromechanical energy conversion.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. to understand how electrical power is generated, transmitted and distributed.
CO2. to analyze and solve DC circuits and AC circuits.
CO3. to understand the concept of voltage, current, power and energy and their interrelations
CO4. to analyze and solve magnetic circuits
CO5. to understand the principle of operation of transformers and electromechanical energy conversion

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M					M	L					
CO2	M	H			L							
CO3	H	H										
CO4	M											
CO5	H	M										

Syllabus

Module1: Introduction to power engineering: generation, transmission and distribution, sources of energy, renewable energy sources,

Module2: Electric circuit elements and sources, network analysis and theorems, transient analysis,

Module3: AC analysis of single phase systems, series and parallel circuits, resonance, real and reactive power, power factor, improvement in pf, AC analysis of symmetrical 3-phase systems, power and energy measurement in single phase and three phase systems, energy consumption of domestic loads, electricity tariff

Module4: Magnetic circuits and mutual inductance, introduction to transformers, introduction to electromechanical energy conversion.

Text Books:

1. Fitzgerald, D. E. Higginbotham, A. Grabel, Basic Electrical Engineering, 5th Edition, McGraw-Hill, 2009.
2. William H. Hayt Jr. , Jack E. Kemmerly, Steven M. Durbin, Engineering Circuit Analysis, 6th Edition,TMH, 2002
3. Edward Hughes, Electrical and Electronics Technology, 10th Edition, Pearson, 2008

Reference Books:

1. V. Del Toro, "Electrical Engineering Fundamentals," PHI Learning, 2015
2. Giorgio Rizzoni, Fundamentals of Electrical Engineering Paperback – Import, 16 March 2008
3. Parker Smith, Problems on Electrical Engineering, 9th edition, CBS, 2018

Course Code	Course Name	L	T	P	Credits
ME100	Engineering Mechanics	3	0	0	3

Course Objective

The main objective of studying this course is to understand and apply the fundamental concepts of engineering mechanics including statics and dynamics.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

- **CO1.** to describe force and force systems, moments, and equilibrium conditions in static systems
- **CO2.** to understand relationships between forces and motions using free body diagrams and kinematics of particles using rectangular, normal-tangential, and polar coordinates
- **CO3.** to apply the concepts of statics and dynamics to solve engineering problems
- **CO4.** to analyze various problems of statics and dynamics involving force equilibrium, trusses, distributed forces, kinematics, and kinetics of particles

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H											
CO2	H	M										
CO3		H	L	M								
CO4		H	L	M	M							

Syllabus

Module1: Fundamentals of Mechanics: Basic Concepts, Vector and Scalar Quantities, Newton's Laws, Elements of Vector Algebra, Force Systems: Fundamentals, Rectangular Components, Moment and Couple, Resultants.

Equilibrium: Concept of Equilibrium, Free Body Diagrams, Equilibrium Conditions, Plane Trusses, Method of Joints and Sections.

Module2: Distributed Forces: Center of Mass and Centroids of Areas, Moment of Inertia of Mass and Areas, Composite Areas.

Friction: Characteristics of dry friction, Problems involving dry friction, Wedges.

Virtual Work: Definition of Work, Principle of Virtual Work, Principle of Virtual Work for a System of Connected Rigid Bodies, Conservative Forces.

Module3: Kinematics of Particles: Introduction, Rectilinear Motion, Plane Curvilinear Motion, Rectangular, Normal-Tangential, and Polar Coordinates.

Module4: Kinetics of Particles: Introduction, Force, Mass, and Acceleration: Newton's Second Law, Rectilinear and Plane Curvilinear Motion, Work and Energy, Impulse and Momentum.

Module5: Plane Kinematics of Rigid Bodies: Rotation, Absolute Motion, Relative Velocity, Instantaneous Center of Zero Velocity, Relative Acceleration, Motion Relative to Rotating Axes.

Reference Books/Material

1. Hibbler, R. C. *Engineering Mechanics - Statics and Dynamics*, 14th Ed, Pearson Education, 2017.
2. Beer, F. P. & Johnston Jr, E. R. et al. *Vector Mechanics for Engineers - Statics and Dynamics*, 12th Ed, McGraw Hill, 2019.
3. Meriam, J. L, Kraige, L. G., Bolton, J. N. *Engineering Mechanics – Statics*, 8th Ed, Wiley, 2016.
4. Meriam, J. L, Kraige, L. G., Bolton, J. N. *Engineering Mechanics – Dynamics*, 9th Ed, Wiley, 2018.
5. Shames, I. H., Rao, G. K. M. *Engineering Mechanics - Statics and Dynamics*, 4th Ed, Pearson Ed., 2005.

Timoshenko, S. P., Young, D. H., Rao, J. V., Patil, S. *Engineering Mechanics*, 5th Ed, McGraw Hill, 2017.

Course Code	Course Name	L	T	P	Credits
HU100	Liberal Arts	0	0	2	1

Course Objective

The main objective is to introduce students to performing arts and to develop situational communication and inculcate sense of Time Management and Team work

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

- **CO1.** Students will have a fair understanding of Performing Arts
- **CO2.** Students will be able to understand and apply Team Work & Time Management in Practical fields
- **CO3.** Students will develop Communication Skill.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3										H		

Syllabus

Module 1: Introduction to Natya Shashtra by Bharat Muni Natyashastra- Text- Origin of theatre-Scope and purpose-Description of the playhouse-Ten kinds of plays- Dharmi-Acting- Rasa & Bhav

Module 2: Select Playwrights of India and World-Their Seminal Works Kalidasa, William Shakespeare, Arthur Miller, Rabindranath Tagore, Girish Karnad, Habib Tanvir, Tendulkar

Module 3: Fundamentals of Acting Physical aspects of Acting & Exercises, Voice Modulation & Exercises, Speech & Diction & exercise, Process of Action & Character Portrayal or Characterization

Module 4: Introduction to stage craft: Set Design & Light Design Introduction to Set Design, Types of performance spaces, Creative Process of design, Introduction to Light design, Audio-Visual Techniques

Module 5: One Public Performance Any Contemporary Play maybe adopted: (Tughlaq by Girish Karnad)

Reference Books/Material

1. A Treastise on Ancient Indian Dramaturgy and Histrionics : Natyasastram Ascribed to Bharata Muni (2 Vol. set)
2. Felnagle, Richard. H., [1987], Beginning Acting, Prentice Hall, New Jersey
3. Funke, Lewis & Booth, John E., [1961], Actors Talk about Acting, Avon Book Division, New York
4. Hays, David, [1988], Light on The Subject, Seagull Books Calcutta
5. Dasgupta, G.N.,[1986], Guide to Stage Lighting, Annapurna Dasgupta, New Delhi
6. Campbell, Lily. B., [1970], Scenes and Machines on the English Stage during the Renaissance, New York Barnes and Noble Inc
7. Theatre Histories: An Introduction, Edited By Bruce McConachie, Tobin Nellhaus, Carol Fisher Sorgenfrei, Tamara Underiner

Course Code	Course Name	L	T	P	Credits
PH101	Engineering Physics Lab	0	0	3	2

List of Experiments: (8 Experiments will be conducted)

1. Hall Effect
2. Photoelectric Effect
3. Helmholtz Resonator
4. Newton's Rings Experiment
5. Determination of Wavelength of He-Ne Laser using a Metal Scale as a Grating
6. Determine the width of a single slit based on the Diffraction pattern
7. Determination of wavelength of Sodium Light using a transparent diffraction Grating
8. Determination of Optical absorption coefficient of materials using lasers
9. I-V Characteristics of Zener Diode
10. Determination of resonating frequency and bandwidth by LCR circuit.
11. Measurement of the half-life of the radioactive source using GM Counter
12. Determination of acceptance angle and numerical aperture of optical fiber

Course Code	Course Name	L	T	P	Credits
CS101	Computer Programming Lab	0	0	2	1

Course Objective

The objective of the course is to make the students implement the designed algorithms for computational problems using the C Programming language.

Course Outcomes:

At the completion of this course, the student will be able to:

CO1. Demonstrate an ability to work in a UNIX/LINUX environment.

CO2. Demonstrate an ability to develop algorithmic solutions for simple computational problems.

CO3. Implement algorithmic solutions using the C programming language features.

CO4. Develop an application using C Programming language features.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	M							
CO2	H	H	H	H	L							
CO3	H	H	H	H	M							
CO4	H	H	H	H	H							

Syllabus

1. Unix/Linux commands, editor, IDE.
2. Basic programs, program execution, debugging.
3. Programs on conditional control constructs.
4. Programs on loops (while, do-while, for).
5. Programs using user-defined functions and library functions.
6. Programs on arrays and matrices (single and multi-dimensional arrays).
7. Programs using pointers (int pointers, char pointers).
8. Programs on Dynamic memory allocation.
9. Programs on structures, union.
10. Programs on File Handling.
11. Preparing makefile.
12. A project.

Books/ Reference Books:

1. Brian W. Kernighan & Dennis M. Ritchie, “The C Programming Language,” Second edition, Prentice Hall Inc.
2. Herbert Schildt, “C: The Complete Reference,” 4th edition, McGraw Hill Education, 2017.
3. R.G. Dromey, How to solve it by Computers? Prentice Hall, 2007.
4. J.R.Hanly and E.B. Koffmann, Problem Solving and Program design in C, 6th Edition, Pearson Education, 2009.
5. E.Balagurusamy, “Programming in ANSI C”, McGraw Hill Education India Private Limited; Seventh edition, July 2017.
6. Byron Gottfried, Programming with C, 4th Edition, Tata McGraw Hill Education, 2018.
7. Yashavant Kanetkar, Let Us C, 15th Edition, BPB Publications, 2016.

Course Code	Course Name	L	T	P	Credits
EE101	Basics of Electrical Engineering Lab	0	0	2	1* (Half-Semester Course)

Course Objective

To familiarise with equipments, and components used in electrical engineering and analyse simple circuits.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

- **CO1.** to familiarize with different equipments, components, measuring instruments, and power supply systems used in electrical.
- **CO2.** to investigate electrical circuits-and-systems behaviour during excitations
- **CO3.** to analyse the operation and performance of a transformer

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M										
CO2		M	L									
CO3	M	M	L									

Syllabus

1. Familiarisation of Electrical Components & Equipment.
2. Study of Network theorems.
3. Transient analysis of a first order dc circuit.
4. Real and reactive power and energy measurement for an AC load.
5. Determine Voltage regulation and efficiency of a single phase transformer by direct loading.

Course Code	Course Name	L	T	P	Credits
ME101	Engineering Drawing	1	0	3	3

Course Objective

The main objective of studying this course is to understand the theoretical concepts of engineering drawing and draw various projections of points, lines, planes, and solids.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

- **CO1.** to identify and understand the use of various geometrical instruments, concepts of orthographic projections, and conventions used in engineering drawing
- **CO2.** to explain the different types of engineering drawings, types of lettering, dimensioning
- **CO3.** to draw the orthographic and isometric projections of various geometric entities

CO4. to demonstrate the competency of computer aided drawing (CAD) software for drawing various orthographic projections

Relationship of Course Outcomes to Program Outcomes
H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H											
CO2	M	M										
CO3	M	H	H		L					L		
CO4					H					M		

Syllabus

1. Drawing instruments and their uses, Different types of lines, Lettering and dimensioning, Basics of Orthographic Projection
2. Projection of Points and lines, Traces of lines.
3. Projection of plane lamina of geometric shapes, Traces of planes.
4. Projection of solids, Isometric projection.
5. Sections of solid
6. Introduction to Development of Surfaces.
7. Introduction to Drafting Software

Reference Books/Material

1. Bhatt, N. D., Engineering Drawing - Plane and Solid Geometry, 15th Ed, Charotar Publication, 2011.
2. Parthasarathy, N. S., Vela, M., Engineering drawing, Oxford University Press, 2015.
3. Gopalkrishna, K. R., Engineering Drawing (Volume I and II Combined), 27th Ed, Subhas Publication, 2017.
4. Shah, M. B., Rana, B. C., Engineering Drawing, 2nd Ed, Pearson Education, 2009.
5. Giesecke, F. E., Lockhart, H., Goodman, M., Johnson, C. M., Technical Drawing with Engineering Graphics, 16th Ed, Pearson Education, 2016.
6. Jensen, C., Helsel, J. D., and Short, D. R., Engineering Drawing and Design, 7th Ed, McGraw Hills, 2007.
7. Benton, B. C., and Omura, G., *Mastering AutoCAD 2021 & AutoCAD LT 2021*, 2nd Ed, Sybex, 2021.
8. Dhananjay A Jolhe, Engineering Drawing, McGraw Hill Education (India) Private Limited; 1st edition (1 July 2017)

II Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
11.	MA150	Differential Equations and Vector Calculus	BS	3-1-0	4
12.	CY150	Engineering Chemistry	BS	3-0-0	3
13.	HU150	Professional Communication	HU	2-0-3	4
14.	EC150	Basics of Electronics Engineering	ES	2-0-0	2
15.	ME150	Basics of Mechanical and Civil Engineering	ES	3-0-0	3
16.	HU151	Health & Happiness	IKS	2-0-0	2
17.	CY151	Engineering Chemistry Lab	BS	0-0-3	2
18.	EC151	Basics of Electronics Engineering Lab	ES	0-0-3	1*
19.	ME151	Workshop Practices	ES	0-0-3	2
20.	PE150	Physical Education	MLC	1-0-2	0#
	Total Credits				**23**

***: Half-Semester Course, #: Non credit Course**

Course Code	Course Name	L	T	P	Credits
MA150	Differential Equations and Vector Calculus	3	1	0	4

Course Objective

This course offers the essential foundation and relevant background knowledge needed to comprehend other significant engineering mathematics courses provided to engineers and scientists. It covers important topics in applied mathematics, including multiple integrals, vector calculus, ordinary and partial differential equations, as well as Laplace transforms.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

- **CO1.** Develop a solid foundation in multiple integrals and vector calculus, enabling them to understand their significance in engineering such as Fluid Dynamics and Electromagnetic fields.
- **CO2.** Gain proficiency in handling ordinary and partial differential equations through analytical methods and grasp their application in modelling.
- **CO3.** To solve these equations effectively using Laplace transforms.,

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	L			L	L		M	H
CO2	H	H	H	M							M	H
CO3	H	H	H	M	L			L	L		M	H

Syllabus

Module 1: Vector Calculus: Double and Triple integrals; Scalar and Vector fields; Vector Differentiation; directional derivative - Gradient of scalar field; Divergence and Curl of a vector field - Laplacian - Line and surface integrals; Green's theorem in plane; Gauss Divergence theorem; Stokes' theorem.

Module 2: Ordinary Differential Equations and Applications:- First -order linear ODE: Introduction and motivation to differential equations, geometrical Interpretation of solution, equations reducible to separable form, exact equations, integrating factor, linear equations, orthogonal trajectories, Picard's theorem for IVP (without proof) , examples on non-uniqueness. Second and higher order linear ODE: Linear dependence and Wronskians, linear ODE's with constant coefficients, the characteristic equations. Cauchy-Euler equations. Method of undetermined coefficients. Method of variation of parameters, Power series method.

Module 3: Laplace Transforms and Applications:- Laplace transform - Inverse Laplace transform - properties of Laplace transforms - Laplace transforms of unit step function, impulse function and periodic function - convolution theorem - Solution of ordinary

differential equations with constant coefficients and system of linear differential equations with constant coefficients.

Module 4: Partial Differential Equations and Applications:- Introduction to PDE; basic concepts, second order PDE and classification, Solutions using separation of variables

Reference Books/Material

1. G. B. Thomas and R. L. Finney, *Calculus and Analytic Geometry* (14thEdition), ISE Reprint, Addison-Wesley, Pearson, 2018.
2. E. Kreyszig, *Advanced Engineering Mathematics* (8th Edition), JohnWiley, 1999.
3. W. E. Boyce and R. DiPrima, *Elementary Differential Equations* (8thEdition), John Wiley (2005).
4. R. K Jain and S.R.K. Iyengar, *Advanced Engineering Mathematics*,3rdedition, Narosa publications (2007)

Course Code	Course Name	L	T	P	Credits
CY150	Engineering Chemistry	3	0	0	3

Course Objective

To refurbish the understanding of fundamental chemistry and to provide certain concepts and its application towards engineering.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

- **CO1.** Understand the basic concepts of chemistry in compliance with the requirements for the undergraduate engineering program
- **CO2.** Familiarize with analytical instrumental methods
- **CO3.** Awareness of the basics chemistry involved in electrochemical cells and corrosion
- **CO4.** Knowledge on basics of polymer chemistry and advanced polymers
- **CO5.** Understand the phase diagram of multi-component systems and its application.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	L							
CO2	H	H	H	H	L							
CO3	H	M	H	M	H		H			L		L
CO4	H	H	M	H	L		L					L
CO5	H	H	M	M	M							

Syllabus

Module1 : Electrochemistry and Corrosion: Review of concepts of electrode potential, EMF measurement and applications, Types of electrodes, Concentration cell: electrode and electrolyte concentration cell, concentration cell with and without transference, Corrosion: Dry corrosion and wet corrosion, mechanisms, Types of corrosion, Differential metal corrosion, differential aeration corrosion, intergranular, Pitting, Passivity, Polarization, Corrosion control methods: Chemical conversion coatings and organic coatings- Paints, enamels.

Module2 : Instrumental Methods of Analysis: Colorimetry, UV-visible spectroscopy, Infra-red spectroscopy, Magnetic resonance spectroscopy, Qualitative and quantitative analysis, Conductometry and Potentiometry

Module 3: Water Technology: The hardness of water, Boiler troubles, Internal and external treatments, Desalination, Sewage water analysis- Dissolved oxygen (OD), Biological oxygen demand, Chemical oxygen demand and their determination, Sewage water treatment

Module 4: Phase Rules: Definition of terms, phase components, degree of freedom, derivation of Gibbs phase rule, one-component system: H_2O, CO_2, Sulfur, Two-component system: Eutectic systems, reduced phase rule, Pb-Ag system, Compound Formation with congruent melting, Zn- Mg Alloy system, Copper-nickel alloy system, systems with incongruent melting, Na_2SO_4- H_2O system, simple three-component systems.

Module 5: High Polymers: Basic definitions, Addition, Condensation and Coordination polymerization, Co-polymerisation, Molecular weights and their determinations, Methods of polymerization, Tg & Tm and factors affecting them, Teflon, PMMA and UF

Reference books:

1. P. C. Jain, M. Jain, *Engineering Chemistry*, Dhanpat Rai & Sons, 16th edition, 2015
2. P. Atkins, J.D. Paula, Physical Chemistry, 9th Edition, Oxford University Press, 2010.
3. G. Chatwal, S. Anand, *Instrumental Methods of Chemical Analysis*, S. D. Himalaya Publishing House, 2003
4. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co., 47th edition, 2020
5. O. G. Palanna, Engineering Chemistry, Tata McGraw Hill Publishing Co. Ltd., 2012
6. S. Rattan, *Comprehensive Engineering Chemistry*, S.K. Kataria & Sons, Delhi, 2011
7. V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, *Polymer Science*, New Age International (P) Limited, 2005

Course Code	Course Name	L	T	P	Credits
HU150	Professional Communication	2	0	3	4

Course Objective

It aims at developing the four skills of Language learning: LSRW skills and also aims at developing the skill of effective communication.

Course Outcomes

CO1.The students should be able to comprehend, speak and write in English language.

CO2. The students should be able to use Body Language

CO3. The students will be able to use Professional Etiquette

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										H		
CO2										H		
CO3										H		

Syllabus

Module 1: a. Definition & Process of Communication-Classification-Types of Verbal & Non-Verbal Communication, Proxemics, Chromatics, Haptics, Chronemics, Communication Network, Grapevine, Noise-Types & how to get rid of it. Feedback- Types, Process with examples, Listening-Types, Process and essentials for good listening

Module 2: Video Lecture (without subtitles) followed by the oral presentation of the content

Module 3: 7 Cs of Professional Communication (Principles)

What are the 7Cs Professional Communication? Usage in communication:

1. Credibility, 2. Courtesy, 3. Clarity, 4. Correctness, 5. Consistency, 6. Concreteness, 7. Conciseness (added as per Suggestions)

Module 4: Different types of letters-Sales, Order, Inquiry, Notice, Memo, Agenda, Minutes, Circular

Module 5: Technical Presentation, GD & Debate

Reference Books/Material

1. Kaul, Asha. Effective Business Communication, Prentice Hall, New Delhi, 2007
2. Dhanvel, P.S. English & Soft Skills, Hyderabad: Orient Black Swan, 2010
3. High School Grammar, Wren & Martin, 2012
4. Fundamental Concepts of Language Teaching, H.H. Stern, OUP, 1983
5. Business Communication Essentials, Courtland L Bovee & John V Thill, 2006 (Activity Based Book)

Course Code	Course Name	L	T	P	Credits
EC150	Basics of Electronics Engineering	2	0	0	2

Course Objectives

1. To introduce Electronics Engineering in a nutshell
2. To explain the role of Electronics Engineering in all other engineering disciplines
3. To explain the basic building blocks of digital and analog electronic circuits
4. Understand the behavior and operation of several non-linear electronic devices: the operational amplifier, the PN junction diode, the field-effect transistor, and the bipolar junction transistor.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. Analyze different electronics circuits, transistor characteristics and amplifiers.
CO2. Simplify and realize Boolean expressions, analyze and implement logic circuits.
CO3. Analyze operational amplifier circuits.
CO4. Understanding communication principles and analyzing different modulation techniques.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H		H	M	L							
CO2	H		H	M								
CO3	H		M		L							
CO4	H			H	L							

Syllabus

Module 1: Fundamentals of Electronic Systems, diode circuit models and applications: Introduction to circuit models, rectifiers.

Transistors:- Construction and operation of BJT and MOSFETs & introduction to various biasing schemes. Application of transistor as a basic building block of amplifier and switch.

Module 2: Introduction to Digital Electronics:- Review of number systems, logic gates, Boolean algebra, k-Map, design of digital logic circuits.

Module 3: Operational Amplifier (Op-amp) and application: - Op-amp: Introduction, Op-amp Characteristics. Inverting and Non-inverting amplifiers.

Module 4: Basic Principles of Communication System, Over view on analog modulation schemes (Amplitude, Frequency and Phase Modulation) along with associated modulation and demodulation circuits.

Reference Books/Material

1. S. Sedra, and K. C. Smith, *Microelectronic Circuits*, Oxford University Press, 6th Edition, 2010.
2. Leach, Malvino, and Saha, *Digital Principles and Applications*, McGraw Hill Education, 8th Edition, 2014.
3. David. A. Bell, *Electronic Devices and Circuits*, Oxford University Press, 5th Edition, 2008.
4. L. Boylestad, and Louis Nashelsky, *Electronic Devices and Circuit*, Pearson, 11th Edition, 2017.
5. B Razavi, *Microelectronics*, Wiley India Pvt. Ltd, Student Edition, 2018.
6. John G Proakis, and Masoud Salehi, *Communication Systems Engineering*, Pearson Education,Prentice Hall International, 2nd Edition, 2002.
7. B. P. Lathi, Z. Ding, H. M. Gupta, *Modern Analog and Digital Communication Systems*, Oxford Publication, 4th Edition, 2017.

Course Code	Course Name	L	T	P	Credits
ME150	Basics of Mechanical and Civil Engineering	3	0	0	3

Course Objective

The main objective of studying this course is to provide students with a strong foundation in the principles and concepts of Mechanical and Civil Engineering consisting of Thermodynamics, Mechanical Systems Design, Production Technology, surveying and building plans.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

- **CO1.** to explain/desrcibe principles of Thermodynamics, including concepts such as energy, heat transfer, work, and the laws of Thermodynamics.
- **CO2.** to solve problems based on principles and techniques involved in the analysis of mechanical systems including power transmission mechanisms.
- **CO3.** to illustrate the basics of production technology, including conventional and non-conventional manufacturing techniques.
- **CO4.** to explain/desrcibe various aspects of Civil Engineering, encompassing surveying and building plans.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L										
CO2	H	H										
CO3	H		L									
CO4	H		L									

Syllabus

Part A. Basics of Mechanical Engineering

- **Introduction to Thermodynamics:** Fundamentals of Thermodynamics (I law, SFEE, II law), Fluid Mechanics and Heat Transfer.
- **Energy and Energy Sources:** Energy Scenario – Present and Future Trends, Conventional and Non-Conventional Energy Sources.
- **Energy Conversion:** Energy Conversion Systems, Refrigeration, and Air Conditioning. (12)
- **Basics of Mechanics of Solids:** Concept of Stress, Stresses and Strain under Axial Loading
- **Power Transmission in Mechanical Systems:** Belt Drives, Gear Drives: Types, Gear Trains, Velocity Ratio (12)
- **Manufacturing Processes:** Classification, Casting, Metal Forming, Metal Joining Processes, Machining.
- **Advanced Manufacturing Processes:** Non-Traditional Machining, Additive Manufacturing, Robotics and Automation, Industry 4.0.

Part B. Basics of Civil Engineering

- **General Introduction to Civil Engineering:** Relevance of Civil Engineering in the overall infrastructural development of the country, National building code, Terminologies: Plinth area, Carpet area, Floor area, Build up area, Floor space index, Types of buildings.
- **Surveying:** Classification, Principles, Measurements of Distances, elevation and angles.
- Conventional and modern building materials, Waterproofing Materials, Prefabricated Building components, Green buildings
- Building Plans, Setting out of a Building, Types of foundations, Brick Masonry, Stone Masonry, Beams, Columns, Lintels, Roofing, Flooring, Plastering
- Rain Water Harvesting, Solid Waste Management, Introduction to Highways and Railways, Introduction to Hydropower Engineering, Introduction to Water supply Engineering.

Reference Books/Material

1. Cengel, Y. A. and Boles, M. A., *Thermodynamics: An Engineering Approach*, McGraw Hill, 5th Ed., 2006.
2. Beer, F. P. & Johnston Jr, E. R. et al. *Mechanics of Materials*, 8th Ed, McGraw Hill, 2020.
3. Rattan, S. S., *Theory of Machines*, 5th Ed, McGraw Hill, 2019.
4. Hajra Choudhary, S. K., Hajra Choudhary, A. K. Roy, N., *Elements of Workshop Technology. Vol. I and II*, Media promoters and publishers Pvt Ltd, 2007.
5. Nag, P. K., *Engineering Thermodynamics*, Tata McGraw Hill, 3rd Ed., 2005.
6. Kalpakjian, S., Schmid, S. R., *Manufacturing Engineering & Technology*, 4th Ed, Pearson Education, 2000.

7. Groover, M. P., *Introduction to Manufacturing Processes*, Wiley, 2011.
8. Rao, P. N., *Manufacturing Technology. Vol. I and II*, 2nd Edition. TMH Education, 2006.
9. Groover, M. P., & Weiss, M., *Industrial Robotics, Technology, Programming, and Applications*, McGraw Hill, 1986
10. Famili, A.F., Dana S. Nau, D.S., Kim S.H., *Artificial Intelligence Applications in Manufacturing*, AAAI Press, 1992.
11. Misra, S., Roy, C., and Mukherjee, A., *Introduction to Industrial Internet of Things and Industry 4.0*, CRC Press, 2020.
12. Chen, W. F., & Liew, J. Y. R. (Eds), *The Civil Engineering Handbook*. 2nd Ed, CRC Press, 2002.
13. Chudley, R., & Greeno, R., *Building Construction Handbook*, Addison Wesley, 2020.
14. Kandya, A. A., *Elements of Civil Engineering*, 3rd Ed, Charotar Publishing House, 2017.
15. Mamlouk, M. S., & Zaniewski, J. P., *Materials for Civil and Construction Engineering*, Pearson.
16. Rangwala, S. C., & Dalal, K. B., *Building Construction*, Charotar Publishing House.
17. Shanmugam, G., Palanichamy, M. S., *Basic Civil and Mechanical Engineering*, McGraw Hill.

Course Code	Course Name	L	T	P	Credits
HU151	Health & Happiness	2	0	0	2

Course Objective

The main objective of studying this course is to give overview on importance of food, nutrition and yogic practices to understand holistic view of personality, health and wellness.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. To develop the attitude of fairness and team spirit

CO2. To promote good health, comradeship and spirit of healthy competition

CO3. To improve positive and deep impact on the holistic development of the personality

CO4. To spread a strong message of peace, friendship and understanding among the people.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								H	L	H		H
CO2								H	L	H		H
CO3								M		M		H
CO4								M	L	L		H

Syllabus

Module 1: Introduction to Food & Nutrition, Human Biology, Vital Parameters and Health Check, BMI Calculation, Nutrients, Water, Carbohydrates, Nutrients – Proteins – Structure & Classification, Lipids and Fats, Source of Fats and Oil, Fat Soluble Vitamins, Water Soluble Vitamins, Nutrients – Minerals, Food Groups, concept of Balanced Diet, Phytochemicals and health benefits, Spices and Health Benefits, Cooking Methods. Introduction to quality attributes of food, factors affecting it, methods of quality evaluation. Food Adulteration: Contaminants & Detection, Basic Food Laws and Regulations, Nutrition Labelling and Food Laws. Food Additives- application & safety aspects, Genetically Modified Foods, Issues in GM foods, Food Safety Tools. Food Contamination, Post Harvest Losses of Fruits, Vegetables & its Safety, Food safety Hazards, Expiry Date/Shelf Life.

Module2: Health- definition, signs of health, Healthy lifestyle: Carcadian rhythm, early awakening, dantdhavan, nasya, gandusha, abhyanga, vyayam, urvartan, snan. selection of occupation, Sharira Manas prakriti. Aahar (Diet): ideal diet, Aahar varg: (groups of food): group of cerials, group of pulses, vegetables, fruits, milk and milk products, spices, sugar and jaggery, non- veg diet, cooked/processed food, effect of fast food and junk food on body, preservatives etc. Ahara vidhi:(how to eat), GI motility disorders. Timings of food, digestion, Carcadian rhythm related to digestion. Rutujacharya: 6 seasons, changes in body according to season, change in diet and regimen according to seasonal changes, diet and regimen for each season. Natural urges: diseases due to restrain of natural urges, urges to be with hold. Sleep:effects of good sleep and irregular sleeping habits. Mental health: Sadvrutta:- Rules of good conduct, measures to improve concentration, memory- meditation, tratak, yoga and yogic kriyas.

Module3: Introduction to Hatha yoga-benfits, Basics of Yoga, Ashtang Yoga: yama, niyama, asana, pranayama, pratyahara, dharana, dhyana and Samadhi. Yogic exercises for eyes, Meditation asanas: Vajrasana and Padmasana etc.

Module4: Introduction to Forward bending, Backward bending, Spinal twisting, inverted and Balancing asanas, Surya namaskara. Chandra namaskar, Introduction to Pranayama, Mudra, Bandha, Shatkarma. Yoga and Mental Health, Yoga Related Practical Work,

Reference Books/Material

1. “Food and Nutrition” course at SWAYAM By Dr. Asna Urooj, University of Mysore
2. N. Shakuntala Manay & M. Shadaksharaswamy. (2001). Food: facts and principles. New Age International.
3. Norman, N. Potter. (2013). Food science. Springer.
4. Saraswati, Swami Satyananda, and Janez Kristijan Hiti. (1996). Asana pranayama mudra bandha. Bihar, India: Yoga Publications Trust, 1996.
5. Krishnamacharya, Tirumalai. (1935). "Yoga Makaranda." The Nectar of Yoga.
6. Iyengar, Bellur Krishnamukar Sundara. (1965). "Light on yoga: the definitive guide to yoga practice."
7. Shankar, Sri Sri Ravi. Patanjali Yoga Sutras. Arktos, 2014.
8. Online resource: https://vikaspedia.in/health/ayush/

Course Code	Course Name	L	T	P	Credits
CY151	Engineering Chemistry Lab	0	0	3	2

List of Experiments:

1) Estimation of Iron in Hematite
2) Estimation of copper in brass
3) Determination of pKa and Ka of a weak acid
4) Conductometric titration of strong acids with Strong base
5) Estimation of total chromium by colorimetry
6) Verification of Nernst Equation
7) Determination of molecular weight of the polymer by Viscometry
8) Determination of COD in a given water sample
9) Estimation of total hardness of water
10) Estimation of chloride content in water
11) Determination of percentage of composition by using Abbe's refractometer
12) Study of three component system
13) Estimation of dissolved oxygen in the given water sample
14) Estimation of N_2 in ammonium fertilizer

Note: Any 8 experiments have to be done

References

1) A. I. Vogel, Textbook of quantitative chemical analysis, Prentice Hall, 2000
2) Laboratory Manual, Department of Applied Sciences, National Institute of Technology Goa
3) S. Rattan, Experiments in applied chemistry, 3rd edition, S. K.Kataria & Sons, 2011.

Course Code	Course Name	L	T	P	Credits
EC151	Basics of Electronics Engineering Lab	0	0	3	1* (Half-Semester Course)

Course Objective

To provide hand on experience on electronic systems and to experimentally demonstrate basic electronic circuit design and analysis.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

1. Plot the characteristics of semiconductor diodes and transistors to understand their behavior.
2. Design, construct and test amplifier circuits and interpret the results.
3. Operate electronic test equipment and hardware tools to characterize the behavior of devices and circuits

4. Design and test basic digital logic gates based circuits

Relationship of Course Outcomes to Program Outcomes
H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H		H	M	L							
CO2	H		H	M								
CO3	H		M		L							
CO4	H			H	L							

Syllabus (Any 5 Experiments)

1. Identification of different passive and active components and familiarization with basic electronic Instruments.
2. Study of Electronic equipment's - Power supply, Multimeter, Function generator, UWS and Digital storage Oscilloscope (DSO)
3. Measurement of AC & DC voltage, Current & resistance by digital multimeter, connection, display & measurement of various types of periodic signals (Sine, square & Triangular).
4. Study of static V-I characteristics of semiconductor diode & Zener diode.
5. Study of Halfwave and Full Wave rectifiers using junction diode and filter circuit.
6. Study of transistor characteristics, Op amp as inverting & amp; non-inverting amplifier.
7. Truth table verification of basic logic gates and design of a simple combinational circuit using logic gates.

References

1. S. Sedra and K. C. Smith, *Microelectronic Circuits*, Oxford University Press , 6th edition
2. Leach , Malvino, Saha, *Digital Principles and Applications*, McGraw Hill Education , 8th edition
3. Boylestad, Robert L., Louis Nashelsky, *Electronic Devices and Circuit*, Pearson , 11th edition
4. B Razavi, *Microelectronics*, Wiley India Pvt. Ltd , student edition.

Course Code	Course Name	L	T	P	Credits
ME151	Workshop Practices	0	0	3	2

Course Objective

The main objective of studying this course is to develop a comprehensive understanding of carpentry, fitting, Machining and joining techniques.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. to demonstrate different workshop skills including carpentry, fitting, and welding methods.

CO2. to produce different jobs using carpentry, fitting, and welding techniques.

CO3. to explain advance manufacturing techniques including CNC, Casting, and Power tools

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	M									
CO2	M	L	M						H			
CO3	H											

Syllabus

1. **Carpentry:** Use and setting of hand tools like hacksaws, Jack planes, chisels and gauges for construction of various joints, planning, chiselling, marking and sawing practice
2. **Fitting:** Demonstration of various tools and equipment used in fitting shop, filing, cutting, tapping, male and female joints, stepped joints
3. **Welding:** Demonstration of various welding machines and equipment, Practice on Butt joint and Lap joint using electric arc welding
4. Demonstration of work on lathe, drilling machines, CNC Machine
5. Demonstration of casting practices and mould making.
6. Demonstration and practices on Power tools and Safety Practices.

Reference Books/Material

1. Hajra Choudhary, S. K., Hajra Choudhary, A. K. Roy, N., *Elements of Workshop Technology. Vol. I and II*, Media promoters and publishers Pvt Ltd, 2007.

2. Rao, P. N., *Manufacturing Technology. Vol. I and II*, 2nd Edition. TMH Education, 2006.

Course Code	Course Name	L	T	P	Credits
PE150	**Physical Education**	**1**	**0**	**2**	**0[#] (Non-credit course)**

Course Objective

The main objective of studying this course is to acquire knowledge about the human body as its functioning is influenced by physical activities and to develop positive health-related fitness habits which can be practiced lifelong so as to prevent degenerative diseases.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. to understand the fitness components and their relation to sports performance.

CO2. The Students are aware of a balanced mind and body development. They also develop social relationships with others, leadership qualities and their own personality improvement.

CO3. to execute physical movements correctly and execute them in a perfect way in relation to the functional aspect of various systems.

CO4. Students learn the basic nutritional guidelines and plans related to macro, micronutrients and a healthy diet to control obesity to lead a healthy life.

CO5. to understand the cultural knowledge and the skills necessary for their personal and social survival.

Relationship of Course Outcomes to Program Outcomes
H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						M			H			
CO2						L		H				M
CO3												H
CO4						M						H
CO5						M			H			

Syllabus

Module 1: Fitness: Definition and meaning of Physical fitness, Role and scope of physical fitness, Components of physical fitness, Types of physical fitness, Health related physical fitness, Skill related physical fitness, General and specific warming up. (Practical)

Module 2: Sports for Technical Field: Relaxing techniques, Stress management, Sports for relax, Benefits of Exercise-Psychological and Physiological aspects, Self Confidence and Motivation.

Module 3: Anatomy and Physiology: Basic anatomy, Exercise physiology, Body type, Sports Injury and prevention and their management.

Module 4: Lifestyle Disease and Sports: Diet, Heart attack, Blood pressure, Cholesterol, Obesity, Stress.

Module 5: Indigenous Sports: Kabaddi and Kho Kho - Introduction to the game and historical development with special reference to India, Rules and their interpretations, Fundamental Skills, General Skills of the games

Reference Books/Material

1. Mood, D, Musker, F and Rink, J. (1999). *Sports and recreational activities.* Boston:

McGraw-Hill.
2. Rink, J.E. (1998). *Teaching physical education for learning (3rd Ed.).* Boston: McGraw-Hill.
3. Dey Swapan Kumar (2012). *A Textbook of Sports and Exercise Physiology, New Delhi*: JaypeeBrothers Medical Publications.ISBN: 9789350258736.
4. Nick Draper and Helen Marshall. (2013), *Exercise Physiology: For Health and Sports Performance,* Harlow/GB: Pearson Education Publication Limited. ISBN 13: 9780273778721ISBN 10: 0273778722.
5. William D. McArdle, Frank I. Katch, Victor L. Katch. (2009). *Exercise Physiology: Nutrition, Energy and Human Performance.* United States: Lippincott Williams and Wilkins ISBN:1608318591.
6. Robert Weinberg and Daniel Gould (2010). *Foundations of Sport and Exercise Psychology*. USA:Human Kinetics ISBN: 0736083235.
7. Aidan.P.Moran (2012). *Sport and Exercise Psychology A Critical Introduction,* 2nd Edition, Newyork:Routledge, ISBN: 978041543430.

9. Detailed Syllabi of Department-Wise Courses in Higher Semesters

Course Curriculum

for

Bachelor of Technology Programme

in

Computer Science and Engineering

http://www.nitgoa.ac.in

राष्ट्रीय प्रौद्योगिकी संस्थान गोवा

NATIONAL INSTITUTE OF TECHNOLOGY GOA

कोट्टामल प्लाटू, कुंकोलिम, सालसेट, दक्षिण गोवा, गोवा - ४०३७०३, इंडिया

Kottamoll Plateau, Cuncolim, Salcete, South Goa, Goa- 403703, India

Programme Structure Summary

Sl. No.	Classifications	Course Type	Credits For CGPA	Courses
1	Basic Sciences	**BS**	21	MA→11, PH→5, CY→5
2	Basic Engineering Sciences and Technical Arts	**ES**	21	EM→3, BMC→3, BES→6, CPPS→4, ED→3, WP→2
3	Humanities and Social Sciences	**HU & HS**	7	PC →4, ECO→ 3
4	Indian Knowledge Systems	**IKS**	5	HH →2 and an Open Elective Course →3
5	Others: Liberal Arts, Innovation & Entrepreneurship	**OT**	2	LA→1, IE→1
6	Mandatory Learning Courses	**MLC**	2	PE→0, ES→ 1, PEHV→ 1
7	Department Core	**DC**	83 - 86	Core Theory and Lab courses, Comprehensive Examination →1, Seminar→1, Summer Internship→1, Project Work→5
8	Department Elective (including MOOCs or any other as approved by the Institute)	**DE**	21-27	7-9 Electives
9	Open Elective (including MOOCs or any other as approved by the Institute)	**OE**	0-6	Upto 2 Open Electives
Total Credits			**168**	
10	Minor Program	**MR**	**18**	

Semester-wise Credits Distribution

Sl. No.	Year	Semester-wise Credits		Year-wise Credits
		Semester	**Credits**	
1	First Year	I	23	46
		II	23	
2	Second Year	III	24	48
		IV	24	
3	Third Year	V	22	43
		VI	21	
4	Fourth Year	VII	19	31
		VIII	12	
Total Credits				**168**

Semester-Wise Distribution of the Courses

I Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA100	Matrices and Advanced Calculus	BS	3-1-0	4
2.	PH100	Engineering Physics	BS	3-0-0	3
3.	CS100	Computer Programming and Problem Solving	ES	3-0-0	3
4.	EE100	Basics of Electrical Engineering	ES	2-0-0	2
5.	ME100	Engineering Mechanics	ES	3-0-0	3
6.	HU100	Liberal Arts	OT	0-0-2	1
7.	PH101	Engineering Physics Lab	BS	0-0-3	2
8.	CS101	Computer Programming Lab	ES	0-0-2	1
9.	EE101	Basics of Electrical Engineering Lab	ES	0-0-3	1*
10.	ME101	Engineering Drawing	ES	1-0-3	3
	Total Credits				**23**

II Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA150	Differential Equations and Vector Calculus	BS	3-1-0	4
2.	CY150	Engineering Chemistry	BS	3-0-0	3
3.	HU150	Professional Communication	HU	2-0-3	4
4.	EC150	Basics of Electronics Engineering	ES	2-0-0	2
5.	ME150	Basics of Mechanical and Civil Engineering	ES	3-0-0	3
6.	HU151	Health & Happiness	IKS	2-0-0	2
7.	CY151	Engineering Chemistry Lab	BS	0-0-3	2
8.	EC151	Basics of Electronics Engineering Lab	ES	0-0-3	1*
9.	ME151	Workshop Practices	ES	0-0-3	2
10.	PE150	Physical Education	MLC	1-0-2	0#
	Total Credits				**23**

***: Half-Semester Course, #: Non credit Course**

III Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA201	Probability, Statistics and Queuing Theory	BS	2-1-0	3
2.	CS200	Data Structures	DC	3-1-0	4
3.	CS201	Digital Systems Design	DC	3-0-0	3
4.	CS202	Discrete Mathematics	DC	3-1-0	4
5.	CS203	Object Oriented Programming	DC	3-1-0	4
6.	CS204	Data Structures Lab	DC	0-0-3	2
7.	CS205	Digital Systems Design Lab	DC	0-0-3	2
8.	CS206	Object Oriented Programming Lab	DC	0-0-3	2
Total Credits					**24**

IV Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	IE250	Innovation & Entrepreneurship	OT	1-0-0	1
2.	CS250	Database Systems	DC	3-1-0	4
3.	CS251	Software Engineering	DC	3-0-0	3
4.	CS252	Computer Organization and Architecture	DC	3-1-0	4
5.	CS253	Theory of Computation	DC	3-1-0	4
6.	CS254	Microprocessors and Microcontrollers	DC	3-1-0	4
7.	CS255	Database Systems Lab	DC	0-0-3	2
8.	CS256	Microprocessors and Microcontrollers Lab	DC	0-0-3	2
Total Credits					**24**

Detailed Syllabus of Courses

in

Higher Semesters

III Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA201	Probability, Statistics and Queuing Theory	BS	2-1-0	3
2.	CS200	Data Structures	DC	3-1-0	4
3.	CS201	Digital Systems Design	DC	3-0-0	3
4.	CS202	Discrete Mathematics	DC	3-1-0	4
5.	CS203	Object Oriented Programming	DC	3-1-0	4
6.	CS204	Data Structures Lab	DC	0-0-3	2
7.	CS205	Digital Systems Design Lab	DC	0-0-3	2
8.	CS206	Object Oriented Programming Lab	DC	0-0-3	2
Total Credits					**24**

Course Code	Course Name	L	T	P	Credits
MA201	Probability, Statistics and Queuing Theory	2	1	0	3

Course Objective

The main objective of studying this course is to give overview on axiomatic definition of probability, random variable, distributions, moments, sampling distribution and hypothesis testing. It explains the concepts of probability theory and statistics which are needed for handling various real-world problems.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. To find mean and variance of a given probability distribution,

CO2. To test the hypothesis for small and large samples,

CO3. To find the coefficient of correlation and lines of regression,

CO4. To understand the characteristics of a queuing model.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H		M							L
CO2	H	H	H		M							L
CO3	H	H	H		M							L
CO4	H	H	H		M							L

Syllabus

Module 1 : Elements of Probability

Introduction to Probability; Sample Space and Events; Probabilities Defined on Events; Conditional Probabilities; Independent Events; Total Probability; Bayes' Formula

Module 2 : Random Variables and Distribution

Concept of Random Variables; Distribution and Density Function;; Jointly Distributed Random of Variables; Conditional and Joint Density Distribution function; Function of Random Variables; Expected Value: Mean, Variance and moments of random variable; Joint moments, conditional expectation; covariance and correlation;

Some special distributions: Uniform and Gaussian distributions; Bernoulli, Binomial, and Poisson distributions;

Module 3 : Statistics

The Sample Mean; The Central Limit Theorem; The Sample Variance; Sampling Distributions from a Normal Population; Sampling from a Finite Population;

Parameter Estimation; Maximum Likelihood Estimators; Interval Estimates; Estimating the Difference in Means of Two Normal Populations;

Hypothesis Testing; Significance Levels; Tests Concerning the Mean of a Normal Population; Testing the Equality of Means of Two Normal Populations; Hypothesis Tests Concerning the Variance of a Normal Population; Hypothesis Tests in Bernoulli Populations; Tests Concerning the Mean of a Poisson Distribution; Regression (Basic concepts only)

Module 4 : Queuing theory

Concepts, applicability, classification, birth and death process, Poisson queues, Characteristics of queuing models - single server (with finite and infinite capacities) model, multiple server (with infinite capacity only) model

Reference Books/Material

1. Ross, Sheldon M. “Introduction to probability and statistics for engineers and scientists”, Academic press, 2020.
2. Ross, Sheldon M. “Introduction to probability models”, Academic press, 2014.
3. Trivedi, Kishor S. “Probability & statistics with reliability, queuing and computer science applications”, John Wiley & Sons, 2008.
4. Ross, Sheldon M. “Stochastic processes”, John Wiley & Sons, 1995.

5. R. A. Johnson, Miller and “Freund’s Probability and Statistics for Engineers”, Pearson Publishers, 9th Edition, 2017.

6. John E. Freund, Benjamin M. Perles, “Modern Elementary Statistics”, 12th Edition, Pearson, 2013.

7. Hamdy A. Taha, “Operations Research: An Introduction”, Pearson, 2017, Tenth Edition.

8. S.C.Gupta and V.K.Kapoor, “Fundamentals of Mathematical Statistics”, 12th Edition, S.Chand & Co, 2020.

9. Kantiswarup, P.K.Gupta and Manmohan Singh, “Operations Research”, Sultan Chand & Sons, 2014.

Course Code	Course Name	L	T	P	Credits
CS200	Data Structures	3	1	0	4

Course Objective

The objective of the course is to familiarize oneself with basic data structures and to develop skills to analyze how the choice of data structures impacts the performance of programs.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. To identify how the choice of data structures and algorithm design methods impacts the performance of programs,

CO2. To select the appropriate data structure and algorithm design method for any application,

CO3. To solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, binary search trees, and graphs and writing programs for these solutions,

CO4. To solve problems using algorithm design methods such as the greedy method, divide and conquer, dynamic programming, backtracking, branch and bound and writing programs for these solutions.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**	**H**	**H**	**M**							
CO2	**H**	**H**	**H**	**H**	**H**							
CO3	**H**	**H**	**H**	**H**	**H**							
CO4	**H**	**H**	**H**	**H**	**H**							

Syllabus

Module 1: Introduction to data structures and algorithms, asymptotic notation for complexity analysis, Time and space complexity analysis; Arrays: one dimensional, multi-dimensional, Elementary operations.

Module 2: Stacks: Representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching, Queues: Simple queue, circular queue, dequeue, elementary operations and applications.

Module 3: Linked lists: Linear, circular and doubly linked lists, elementary operations and applications, linked list implementation of stacks and queues.

Module 4: Trees: Binary tree representation, tree traversal, complete binary tree, heap, binary search tree, height balanced trees: AVL tree, Red-Black tree; Rotations, Search and Update Operations on Balanced BSTs, Tries. Hashing: Implementation of Dictionaries, Hash Function, Collisions in Hashing, Separate Chaining, Open Addressing.

Module 5: Graphs: Representation, adjacency list, graph traversals: DFS, BFS, and their applications; Minimum spanning tree: Kruskal's, and Prim's algorithms; Shortest Path Problem- Dijkstra's, Bellman Ford, and Floyd-Warshall algorithms; algorithms on sorting: Selection sort, bubble sort, quick sort, merge sort, heap sort, searching: linear and binary search.

Reference Books/Material

1. Alfred V Aho, John E Hopcroft, Jeffrey D. Ullman, “Data Structures & Algorithms”, Pearson, 2013.
2. Aaron M. Tenenbaum, Yedidyah Langsam, Moshe J. Augenstein, “Data Structures using C”, Third Edition, Pearson, 2009.
3. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson, 2006.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, “Introduction to algorithms”, Third Edition, MIT Press, 2009.
5. Michael T.Goodrich and Roberto Tamassia, “Algorithm Design: Foundations, Analysis and Internet Examples”, Second Edition, Wiley-India, 2006.

Course Code	Course Name	L	T	P	Credits
CS201	Digital Systems Design	3	0	0	3

Course Objective

To understand the working of digital systems. Hardware components of the computer can be studied in greater depth.

Course Outcomes

At the completion of this course, the student shall acquire following knowledge and ability:

CO1. Identify the various number systems and application of these number systems to solve the basic digital arithmetic and logic operation

CO2. Simplification of Boolean logics & expression and to design basic problems using k-map applications.

CO3. Solve problems using various digital arithmetic and logic blocks like adders, subtractor etc. and implementation using various methods of logics optimizing for delays.

CO4. Design a sequential circuit using latches & Flip flops such as various types counters and their applications in real time scenario.

CO5. To identify the infernal structure of digital gates and designing of various types logic gates, their propagation delays, power dissipation and fanout/fan in issues

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	L							
CO2	H	H	H	H	M							
CO3	H	H	H	H	M							
CO4	M	H	H	H	H	L						
CO5	H	H	H	M	M							

Syllabus

Module 1: Number Systems And Boolean Algebra: Review of binary, octal & hexadecimal number systems, representation of signed numbers, floating point number representation BCD, ASCII, EBCDIC, excess 3 codes, gray code-error detecting & correcting codes.

Boolean algebra: Postulates & theorems of boolean algebra, canonical forms, simplification of logic functions using Karnaugh map, Quine McCaskey method.

Module 2: Combinational Logic Design: Logic gates, implementation of combinational logic functions, encoders & decoders, multiplexers & demultiplexers, code converters, comparator, half adder, full adder, parallel adder, binary adder, parity generator/checker, implementation of logical functions using multiplexers.

Module 3: Sequential Logic Design-I : RS, JK, JK master, slave, D&T flip flops, level triggering and edge triggering, excitation tables, asynchronous & synchronous counters, modulus counters, shift register, Johnson counter, ring counter, timing waveforms, counter applications.

Module 4: Sequential Logic Design-II: Basic models of sequential machines, concept of state table, state diagram, state reduction through partitioning & implementation of synchronous sequential circuits, Introduction to asynchronous sequential logic design.

Module 5: Programmable Logic Devices: Semi Custom design, introduction to PLD's, ROM, PAL, PLA, FPGA, Implementation of digital functions. MOS inverters, CMOS inverters, comparison of performance of various logic families.

Reference Books/Material

1. Alan B.Marcovitz, "Introduction to logic design", 3rd Edition, McGraw-Hill Professional, 2009.
2. Giovanni De Micheli, "Synthesis and optimization of digital circuits", Tata McGraw- Hill Education 2003.
3. Zvi Kohavi, Niraj K. Jha, "Switching and finite automata theory", 3 rd Edition Cambridge University Press, 2011.
4. Douglas A. Pucknell &Kamran Shrayhian, "Basic VLSI design systems and circuits", Prentice Hall 2000.
5. ParagK.Lala, "Fault tolerant & fault testable hardware design", B.S publications, 2002.

Course Code	Course Name	L	T	P	Credits
CS202	Discrete Mathematics	3	1	0	4

Course Objective

This course introduces proof strategies and structures, Counting and combinatorics, elements of graph theory, introduction to abstract algebra and number theory.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

CO1. Explain basic concepts of mathematical reasoning. Also understand the different types of proven techniques like mathematical induction.

CO2. Understand the concepts of set theory, i.e., countable and uncountable sets, various types of functions and applications.

CO3. Understand the concepts of relations, partial ordering and equivalence relations. Apply the concepts of generating functions to solve the recurrence relations.

CO4. Apply the concepts of divide and conquer method and principle of inclusion and exclusion to solve some simple algorithms in discrete mathematics.

CO5. Understand various definitions in graph theory and study their properties. Also, understand the basic concept of abstract algebra and number theory

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H		H	M	L							
CO2	H		H	M								
CO3	H		M		L							
CO4	H			H	L							
CO5	H		M	H	L							

Syllabus

Module 1: Proof strategies:

Introduction, propositions, predicates, examples of theorems and proofs. Types of proof techniques. Axioms. Mathematical induction, Well-ordering principle, Strong Induction.

Module 2: Basic mathematical structures:

Sets, Russell's paradox, infinite sets, functions, comparing infinite sets using functions. Countable and countably infinite sets.

Module 3: Relations and functions:

Cartesian products and relations, equivalence relations and partitions of a set. More on equivalence relations, partial order relations, Posets. chains, anti-chains, topological sort, applications to (parallel) task scheduling. Lattices, Product and sum principles, Bijection principle, double counting, Handshake lemma, the binomial theorem, Pascal's triangle. Counting techniques: permutations and combinations with and without repetitions, estimating factorials, solving recurrence relations. Pigeon-hole principle (PHP), its variants and its applications

Module 4: Introduction to graph theory:

Basic terminology, Konigsberg bridge problem, Eulerian graphs, Bipartite graphs, Representation of graphs, Graph isomorphism, Subgraphs, cliques and independent sets. Connected components, cut edges. Matchings, Perfect and maximum matchings, Minimum vertex covers.

Module 5: Abstract algebra:

Definition of an abstract group, subgroups, isomorphism, and cyclic groups, order of subgroups of a group, Lagrange's theorem, Modular arithmetic and applications to cryptography.

Reference Books/Material

1. Kenneth Rosen, “Discrete mathematics and its applications”, TMH, 2011
2. R. P. Grimaldi, “Discrete and Combinatorial Mathematics”, Pearson Education, Fifth Edition, 2007
3. Introduction to Graph Theory, 2nd Edition, by Douglas B West. Eastern Economy Edition published by PHI Learning Pvt Ltd.
4. Discrete Mathematics, 2nd Edition, by Norman L Biggs. Indian Edition published by Oxford University Press.

Course Code	Course Name	L	T	P	Credits
CS203	Object Oriented Programming	3	1	0	4

Course Objective

The objective of the course is to introduce students the concept of object oriented programming and to develop programming skills to apply different object oriented concepts to solve problems.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

CO1. Develop an understanding of fundamental concepts of object-oriented programming

CO2. Develop an understanding of object-oriented design and their mapping to object- oriented programming

CO3. Illustrate the object oriented concepts and develop solutions using C++ and Java

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M							
CO2	H	H	H	H	M							
CO3	H	H	H	H	H							

Syllabus

Module 1: Principles of OOP: Programming paradigms, basic concepts, benefits of OOP, applications of OOP

Introduction to C++: History of C++, structure of C++, basic data types, type casting, type modifiers, operators and control structures, input and output statements in C++.

Classes and objects: class specification, member function specification, scope resolution operator, access qualifiers, instance creation.

Functions: Function prototyping, function components, passing parameters, call by reference, return by reference, inline functions, default arguments, overloaded function.

Pointers: Array of objects, pointers to objects, this pointer, dynamic allocation operators, dynamic objects.

Module 2 : Constructors: Constructors, parameterized constructors, overloaded constructors, constructors with default arguments, copy constructors, static class members and static objects.

Operator overloading: Overloading unary and binary operator, overloading the operator using friend function, stream operator overloading and data conversion.

Module 3: Inheritance: Defining derived classes, single inheritance, protected data with private inheritance, multiple inheritance, multi-level inheritance, hierarchical inheritance, hybrid inheritance, multipath inheritance, constructors in derived and base class, abstract classes, virtual function and dynamic polymorphism, virtual destructor.

Module 4: Exception Handling: Principle of Exception handling, exception handling mechanism, multiple catch, nested try, rethrowing the exception. Streams in C++: Stream

classes, formatted and unformatted data, manipulators, user defined manipulators, file streams, file pointer manipulation, file open and close.

Templates: Template functions and Template classes.

Module 5: Object oriented programming using Java: Introduction to Java, bytecode, virtual machines, basic data types, operators, control structures, classes and objects, using Javadoc, packages, arrays, strings, inheritance, interfaces, exception handling, multithreaded programming, Java streams, developing user interfaces in Java.

Reference Books/Material

1. Bjarne Stroustrup, "The C++ Programming Language", 4th Edition, Addison-Wesley, 2013.
2. Stanley B Lippman, "The C++ Primer", 5th Edition, Addison-Wesley, 2012.
3. Herbert Schildt, “C++: the Complete Reference”, 4th Edition, McGraw Hill, 2002.
4. Patrick Naughton and Herbert Schildt, “Java 2: The Complete Reference”, 5th Edition, McGraw Hill, 2017.
5. Paul. Deitel, Harvey Deitel, “Java: How to program”, 8th Edition, Pearson, 2017.

Course Code	Course Name	L	T	P	Credits
CS204	Data Structures Lab	0	0	3	2

Course Objective

The objective of the course is to illustrate the implementation of basic data structures and to develop programming skills to apply appropriate data structures for problem solving.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

CO1. Implement linear and non-linear data structures for problem solving.

CO2. Design and implement algorithms using the appropriate data structure.

CO3. Implement and analyze searching and sorting techniques.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	M							
CO2	H	H	H	H	H							
CO3	H	H	H	H	H							

Syllabus

List of Experiments

1) Implementation of array operations, Structures & Unions
2) Stacks, Queues, Circular Queues, Priority Queues, Multiple stacks and queues
3) Infix to postfix expression using stack
4) Implementation of linked lists: stacks, queues
5) Implementation of doubly linked lists
6) Tree traversals
7) Open Addressing for Collision handling in Hashing
8) Implementation of DFS and BFS
9) Implementation of Kruskal's, and Prim's algorithms
10) Implementation of sorting algorithms: Bubble Sort, Insertion Sort, Quick Sort, Selection Sort, Merge Sort, Heap Sort

Reference Books/Material

1. Aaron M. Tenenbaum, Yedidyah Langsam, Moshe J. Augenstein, "Data Structures using C", Third Edition, Pearson, 2009.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Second Edition, PHI, 2009.

3. Alfred V Aho, John E Hopcroft, Jeffrey D. Ullman, “Data structures & algorithms”, Pearson, 2013.
4. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson Education, 2006.
5. Michael T.Goodrich and Roberto Tamassia, “Algorithm Design: Foundations, Analysis and Internet Examples”, Second Edition, Wiley-India, 2006.

Course Code	Course Name	L	T	P	Credits
CS205	Digital Systems Design Lab	0	0	3	2

Course Objective

The course provides practical knowledge in designing the digital logic systems and their verification for the desired output.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

CO1. Implementation of Boolean expression, Universal gates, Arithmetic block , code conversion using basic/ universal gates and ICs.

CO2. Design and implement combinational/ sequential circuits and computation of delays.

CO3. Implement and analyze arithmetic/sequential logic circuit using simulation tool.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	L							
CO2	H	H	H	H	H	M						
CO3		H	H	H	H	H						

Syllabus

List of Experiments

1) Simplification, realization of boolean expressions using logic gates/universal gates
2) Realization of half/full adder & half/full subtractors using logic gates
3) Realization of parallel adder/subtractors using 7483 chip, BCD to Excess-3code conversion & vice versa, binary to gray code conversion & vice versa
4) MUX/DEMUX – use of 74153,74139 for arithmetic circuits & code converter
5) Realization of one/two bit comparator and study of 7485 magnitude comparator
6) Use of a) Decoder chip to drive LED display & b) Priority encoder
7) Truth table verification of flip-flops: i) JK Master Slave ii) T type iii) D type
8) Realization of 3 bit counters as a sequential circuit & MOD-N counter design (7476,7490,74192,74193)
9) Writing & testing of sequence generator
10) Hardware modeling using Verilog/VHDL; Laboratory exercises and assignments to supplement the lab

Reference Books/Material

1. Morris Mano, “Digital Design”, Pearson Education India,5th Edition, 2013
2. Charles. H. Roth, Jr., “Fundamentals of Logic Design”, Fifth Edition, Thomson Brooks /Cole, 2005.
3. R. J. Tocci, “Digital Systems Principles and Applications”, Prentice Hall
4. D. D. Givone, “Digital Principles and Design”, Tata McGraw Hill.
5. S. Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”, Second Edition, Pearson Education, 2004.
6. J. Bhasker, “A VHDL primer”, 3rd edition, Addison Wesley Longmen, 1999.
7. Douglas Perry, “VHDL: Programming by example”, 4 th ed. McGraw Hill International, 2002.
8. Peter Ashenden, “The Designer Guide to VHDL”,Morgan Kaufmann, 1998

Course Code	Course Name	L	T	P	Credits
CS206	Object Oriented Programming Lab	0	0	3	2

Course Objective

The objective of the course is to introduce students to fundamental programming concepts and methodologies which are essential to build good C++/Java programs.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

CO1. Demonstrate fundamental programming methodologies in the C++/Java programming language via laboratory experiences.

CO2. Demonstrate the ability to build programs for complex problems.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	H							
CO2	H	H	H	H	H							

Syllabus

List of experiments

1) Simple programs in C++
2) Matrix multiplication in C++
3) Operator overloading exercises
4) Matrix manipulation using dynamic memory allocation
5) Overloading dynamic memory allocation operators
6) Practice on templates
7) Implementation of linked list using templates
8) Implementation of sorting algorithms using templates

9) Implementation of stack and queue using exception handling

10) Inheritance based exercise

11) File handling using streams

12) Practice of Java programming

13) File handling using Java streams

14) Multithreaded programming using Java

15) Developing graphical user interfaces using Java

Reference Books/Material

1. BJarne Stroustrup, "The C++ Programming Language", 4th Edition, Addison Wesley, 2013.
2. Stanley B Lippman, "The C++ Primer", 5th Edition, Addison Wesley, 2012.
3. Ira Pohl, "Object Oriented Programming using C++", 2nd Edition, Pearson, 2003.
4. Patrick Naughton and Herbert Schildt, "Java 2: The Complete Reference", 5th Edition, McGraw Hill, 2017.
5. Paul. Deitel, Harvey Deitel, "Java: How to program", 8th Edition, Pearson, 2017.

IV Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	IE250	Innovation & Entrepreneurship	OT	1-0-0	1
2.	CS250	Database Systems	DC	3-1-0	4
3.	CS251	Software Engineering	DC	3-0-0	3
4.	CS252	Computer Organization and Architecture	DC	3-1-0	4
5.	CS253	Theory of Computation	DC	3-1-0	4
6.	CS254	Microprocessors and Microcontrollers	DC	3-1-0	4
7.	CS255	Database Systems Lab	DC	0-0-3	2
8.	CS256	Microprocessors and Microcontrollers Lab	DC	0-0-3	2
Total Credits					**24**

Course Code	Course Name	L	T	P	Credits
IE250	Innovation & Entrepreneurship	1	0	0	1

Course Objective

- To introduce to a project-based learning approach from Ideation to Innovation and Entrepreneurship will be the key process considered here.
- To learn the essential concepts of innovation and entrepreneurship through hands-on activities and the best and most relevant practical examples
- The course is designed to provide the tools necessary for starting independent innovation and businesses
- To give students practical experience in market survey, commercialization, IPR and proactively work in projects in risky market environments

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

CO1. To comprehend the basic theories and concepts that underlie a survey study of Innovation, Entrepreneurship and Social Business/ Entrepreneurship

CO2. To understand how to generate good large company or startup business ideas / societal ideas, and refine these ideas, to substantially increase chances for success in the marketplace

CO3. The students will be exposed to the thoughts and strategies of some very effective real-life innovators and entrepreneurs through videos and small cases.

CO4. To understand about IPR, prototyping and financial management.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	H	L	H	M	H	H	L	H	H	H	H
CO2	L	H	L	H	H	H	H	L	H	H	H	H
CO3	L	H	L	H	H	H	H	L	M	H	H	H
CO4	L	H	L	H	H	H	H	H	L	L	H	H

Syllabus

Module 1: Introduction

Creative thinking, blocks to creativity, factors that influence creative design, engineering design and creative design, influence of society, market pull & technology push, attribute of a creative person Three levels of Design – Viceral, Behavioral and Reflective design.

Qualities and skills required for entrepreneurship, Functions of an entrepreneur, Importance of entrepreneur in economic development.

Module 2: Ideas for Entrepreneurship

Need or identification of a problem, market survey, data collection, review & analysis, problem definition, challenge statement, problem statement initial specifications, Brain storming, analogy technique or Synectic, check list, trigger words, morphological method, interaction matrix method, analysis of interconnected decision making.

Module 3: Theory of Inventive Problem Solving (TRIZ)

20 key TRIZ principles – multifunction, compensation, nested doll, blessing in disguise, segmentation, separation, symmetry change, opaque & porous, inflate and deflate, recycle & recover, phase transformation, energy, imaging, environment, composition, economical, surface response, static & dynamic, continuous & intermittent, dimensions.

Module 4: Product Design, IPR & Finance

Detail design, prototyping, product deployment, useful life assessment and recycling and sustainability; patent act, patent laws, Types of entrepreneurs- Based on type of business, based on use of technology, based on motivation, based on stages of development, based on motive, Based on capital ownership, Business Plan, Finance and Funding.

Reference Books/Material

1. C.B.Gupta & N.P.Srinivasan, ‘Entrepreneurial Development’, Sultan Chand & Sons, 2020, ISBN: 978-93-5161-132-5
2. Floyd Hurt, Rousing Creativity: Think New Now, Crisp Publ Inc. 1999, ISBN 1560525479,
3. Kalevi Rantanen & Ellen Domb, ‘Simplified TRIZ’ – II edn., Auerbach Publications, Taylor & Francis Group, 2010, ISBN: 978-142-0062-748
4. John Adair, ‘The Art of Creative Thinking’, Kogan Page Publication, 2011, ISBN 978-0-7494-5483-8

Course Code	Course Name	L	T	P	Credits
CS250	Database Systems	3	1	0	4

Course Objective

This course covers the relational database systems RDBS - the predominant system for business, scientific and engineering applications at present. The topics are reinforced using tools such as Oracle server in labs. The course includes entity-relation model, normalization, relational model, relational algebra, and data access queries as well as an introduction to SQL.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

CO1. Model Entity-Relationship diagrams for enterprise level databases

CO2. Formulate Queries using SQL and Relational Formal Query Languages

CO3. Apply different normal forms to design the Database

CO4. Uses formal design techniques to produce a database schema

CO5. Summarize concurrency control protocols and recovery algorithms

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	M	M	L	L	H	M	M	M
CO2	H	H	H	H	H	M	L	L	H	M	H	M
CO3	H	H	H	M	M	M	L	L	M	M	M	M
CO4	H	H	H	M	M	M	L	L	M	M	M	M
CO5	H	H	M	M	M	M	L	L	M	L	M	M

Syllabus

Module 1 : Introduction: An overview of database management system, database system vs file system, database system concept and architecture, data model schema and instances, data independence and database language and interfaces, (DDL,DML,DCL), overall database structure, database users. Data modelling using the Entity Relationship model: ER model concepts, notation for ER diagram, mapping constraints, keys, specialization,

generalization, aggregation, reduction of an ER diagrams to tables, extended ER model, relationship of higher degree.

Module 2 : Relational data Model and Language: Relational data model concepts, integrity constraints, entity integrity, referential integrity, key constraints, domain constraints, relational algebra, relational calculus, tuple and domain calculus.Introduction on SQL: Characteristics of SQL, advantage of SQL, SQL data type and literals, types of SQL commands, SQL operators and their procedure, tables, views and indexes, queries and sub queries, aggregate functions, insert, update and delete operations, joins, unions, intersection, minus, cursors, triggers, procedures in SQL/PL SQL.

Module 3 : Data Base Design & Normalization: Functional dependencies, primary key, foreign key, candidate key, super key, normal forms, first, second, third normal forms, BCNF, 4th Normal form,5th normal form, loss less join decompositions, canonical cover, redundant cover, synthesis the set of relation , MVD, and JDs,inclusion dependence, transaction processing concept, transaction system, testing of serializability, serializability of schedules, conflict & view serializable schedule, recoverability, Recovery from transaction failures, log based recovery, deadlock handling.

Module 4 : Concurrency Control Techniques: Concurrency control, locking techniques for concurrency control, 2PL, time stamping protocols for concurrency control, validation based protocol, multiple granularity, multi version schemes and recovery with concurrent transaction. Storage: Introduction, secondary storage devices, tertiary storage, buffering of blocks, structure of files, file organization, indexing and hashing, types of single level ordered indexes, multilevel indexes, dynamics multilevel indexes using B-trees and B+-Trees, database security.

Reference Books/Material

1. Korth, Silberschatz, “Database System Concepts”, 4th ed., TMH, 2003.
2. Elmsari and Navathe, “Fundamentals of Database Systems”, 4th ed., A. Wesley, 2004
3. Raghu Ramakrishnan , Johannes Gehrke, “ Database Management Systems”, 3rd Edition, McGraw- Hill, 2003.
4. J D Ullman, “Principles of database systems”, Computer Science Press, 2001.

Course Code	Course Name	L	T	P	Credits
CS251	Software Engineering	3	0	0	3

Course Objective

To introduce the software development life cycles models, analyse the software requirements, introduce various design methods for software development and to develop an ability and skill to test software systems.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

CO1. Understand the basic concepts of software engineering, software project management, software designs and software testing.

CO2. Choose the appropriate software development models and methodologies and plan the design and testing strategies to manage given software applications.

CO3. Analyze the role, advantages and disadvantages of various software development models, methodologies, design strategies, testing strategies and software project management methods.

CO4. Build a software application for a given real life problem incorporating all the phases of the software development life cycle.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	L	M	L	L	M	H	H	H	H
CO2	H	H	H	M	H	M	L	M	H	H	H	H
CO3	H	H	H	H	H	H	M	M	H	H	H	H
CO4	H	H	H	H	H	H	M	H	H	H	H	H

Syllabus

Module 1 : Introduction, Software development life cycle: software requirements specification, formal requirements specification and verification - axiomatic and algebraic specifications, function-oriented software design. Software life-cycle models and their comparison.

Module 2 : Software Requirement and Analysis: Data dictionary, Data flow diagrams. IEEE standards for software requirements.

Techniques: feasibility analysis, requirements elicitation, validation, rapid prototyping, OO paradigms vs. structured paradigm - OO analysis.

Effort estimation and scheduling: LOC, Function point analysis and Basic COCOMO model. Basic design concepts: Cohesion and its various types, Coupling and its various types.

Module 3 : Software Specifications :Specification document, specification qualities, uses, system modelling: context, interaction, structural, behavioural, DFD, specification techniques using UML, ER diagrams, logic, algebraic specifications: comparison of various techniques, formal specifications – model checking, introduction to binary decision diagrams.

Module 4 : Object Oriented Methodology :Introduction to objects, relationships, unified approach to modelling, use-case modelling, activity, state and interaction diagrams, classification approaches, cohesion, coupling, reuse, case studies - object oriented paradigm, software design: architectural - distributed - data oriented design & object-oriented design - real-time systems design techniques. Object modeling using UML: UML overview, nature and purpose of models. Use case diagrams, class diagrams, activity diagram, sequence diagram, interaction diagram.

Sample Tool- Argo UML, an open-source tool.

Module 5: Taxonomy of software testing, types of S/W test, black box testing, testing boundary conditions, structural testing, test coverage criteria based on data flow mechanisms, regression testing, unit testing, integration testing, validation testing, system testing and debugging. Testing: Software quality Assurance, Walkthroughs, Inspections, Attributes to be tested,

Software reliability and fault-tolerance, software project planning, monitoring, and control, software maintenance, computer-aided software engineering (CASE), software reuse, component-based software development, extreme programming.

Reference Books/Material

1. Roger S Pressman: "Software Engineering – A Practitioner's Approach", 7th Edition, McGraw-Hill, 2009.
2. Rajib Mall, "Fundamentals of Software Engineering", 5th Edition, PHI, 2018.
3. Ian Sommerville: "Software Engineering". 9th Edition, Pearson Education, 2011.
4. S.L. Pfleeger, Software Engineering – Theory and Practice, 2nd Edition, Pearson Education, 2015
5. Paul Ammann, and Jeff Offutt, "Introduction to Software Testing", 1st Edition, Cambridge University Press, 2008.
6. Eric Gamma, "Design Patterns: Elements of Reusable Object-Oriented Software", 1st Edition, Addison-Wesley Longman Publishing, 1995
7. K. C. Shet, "Software Engineering & Quality Assurance", BPB Publications, New Delhi
8. Waman S. Jawadekar, "Software Engineering, Principles and Practice", Tata McGraw Hill

Course Code	Course Name	L	T	P	Credits
CS252	Computer Organization and Architecture	3	1	0	4

Course Objective

To understand the basic hardware and software issues of computer organization to provide an overview on the design principles of digital computing systems. The course also focusses on understanding how the data is represented at machine level and computations are performed at machine level.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

CO1. To understand how a program gets executed at machine level.

CO2. To understand the basic hardware aspects of a computer system.

CO3. To build various functional units of computer system

CO4. To workout tradeoff involved in designing a modern computer system

CO5. To identify problems in various components of computer systems and comprehend and differentiate various computer architectures and hardware.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	M	L		L						M	
CO2	H	M	H									
CO3	H		H	L								
CO4	H	H	H	L								
CO5	H	H	M	L	M							

Syllabus

Module 1 : Overview of Computer Architecture & Organization, contrast between computer architecture & organization, logical organization of computers; basic operational concepts, bus structures, performance, processor clock, basic performance equation, clock rate, performance measurement, Von Neumann machine, instruction format, execution cycle; instruction types and addressing modes.

Module 2 : Computer Arithmetic: representation of integers and real numbers, fixed point arithmetic, arithmetic and logical unit design, addition and subtraction of signed numbers, design of fast adders, multiplication of positive numbers, signed operand multiplication, fast multiplication, integer division, floating-point numbers and operations.

Module 3 : Basic Concepts of Memory System: Semiconductor RAM memories, ROM memories, speed, size, and cost, cache memories mapping functions, replacement algorithms, performance considerations, virtual memories, secondary storage.

Module 4 : Control Unit Design: Instruction sequencing, instruction interpretation, control memory, hardwired control, microprogrammed control and microprogrammed computers. I/O organization, bus control, Serial I/O (study of asynchronous and synchronous modes, USART

& VART), parallel data transfer Program controlled: asynchronous, synchronous & interrupt driven modes, DMA mode, interrupt controller and DMA controller.

Module 5: Organization of CPU: Single vs. multiple data path, ISA, control unit, instruction pipelining, trends in computer architecture, CISC, RISC, VLIW, introduction to ILP, pipeline hazards: structural, data and control, reducing the effects of hazards.

Reference Books/Material

1. Carl Hamacher, ZvonkoVranesic and SafwatZaky, "Computer organization", 5th Edition, Tata McGraw Hill, 2002.
2. Patterson and Hennessy, "Computer Organization and Design", 5th Edition, Morgan Kaufman, 2013
3. Patterson and Hennessy, "Computer architecture: A quantitative approach", Morgan Kaufmann, 2000.
4. J. P. Hayes, "Computer architecture and organization", 3rd Edition, McGraw Hill, 1998.
5. Hwang and Briggs, "Computer architecture and parallel processing", McGraw Hill, 1985.

Course Code	Course Name	L	T	P	Credits
CS253	Theory of Computation	3	1	0	4

Course Objective

This course introduces models of computation: Regular languages models, context-free languages models. Also, this course emphasizes computability and computational complexity theory. Topics include decidable and undecidable problems, reducibility, recursive function theory, completeness, hierarchy theorems, inherently complex problems, and interactive proof systems.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

CO1. Describe concept of theorem proofing, finite automata, different type of automata, etc.

CO2. Be familiar with Regular and Non regular Language, i.e., context-free language. Understand the concept of Context Free Grammars and Pushdown Automata. Also, Understanding the Context free languages and grammars, and also Normalizing CFG.

CO3. Examine the properties of formal language and automata, their equivalence and conversion techniques.

CO4. Understand basic properties of Turing machines and computing with Turing machines

CO5. Know the concepts of tractability and decidability, the concepts of NP-completeness and NP-hard problem.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	H	M	H	H	L	M	M	H	H	M	H
CO2	H	H	H	H	H	M	L	M	H	H	M	H
CO3	H	M	M	H	H	L	M	M	H	H	H	H
CO4	H	M	H	M	H	M	L	M	H	H	H	H
CO5	H	H	H	M	H	L	L	M	H	M	L	L

Syllabus

Introduction to Automata: Introduction to formal proof, additional forms of proof, inductive proofs, finite automata (FA), deterministic finite automata (DFA), non-deterministic finite automata (NFA), Finite Automata with Epsilon transitions.

Regular expression and languages: Introduction to regular expression, building regular expression, converting DFA to a regular expression, converting regular expression to DFA, pumping lemma and its applications to prove languages not to be regular, closure properties of regular languages, minimization of automata.

Context free grammars (CFG) and languages: Definition, derivations, parse trees, ambiguity in grammars and languages, pushdown automata (PDA): Definition, Graphical notation, deterministic and nondeterministic, instantaneous descriptions of PDAs, language acceptance by final states and by empty stack, equivalence of the CFG and PDAs, pumping lemma for CFLs, closure properties of CFLs, decision problems for CFLs.

Computability Theory: Introduction to Turing machines, language acceptance by Turing machines, Turing machine transition diagrams, Church-Turing hypothesis, Chomsky hierarchy, recursively enumerable sets, existence of non-recursively enumerable notion of undecidable problems, universality of Turing machine, separation of recursive and recursively enumerable classes, notion of reduction, undecidable problems of Turing machines.

Complexity Theory: Notion of tractability/feasibility, the classes NP and co-NP, polynomial time many-one reduction, completeness under this reduction, NP-completeness of propositional satisfiability, other variants of satisfiability, NP-complete problems from other domains: graphs (clique, vertex cover, independent sets, Hamiltonian cycle), number problem (partition), set cover.

Reference Books/Material

1. J.E. Hopcroft and J.D. Ullman. "Introduction to Automata Theory, Languages of Computations", Addison-Wesley, 2008.
2. Michael Sipser, "Introduction to the Theory of Computation", Books/Cole Thomson Learning, 2014.
3. H. R. Lewis and C. Papadimitriou, "Elements of Theory of Computation", Prentice-Hall, 2015.
4. D. C. Kozen, Automata and Computability, Addison Wesley, 1994.
5. J. C. Martin, Introduction to Languages and the Theory of Computation, McGraw Hill, 2002

Course Code	Course Name	L	T	P	Credits
CS254	Microprocessors and Microcontrollers	3	1	0	4

Course Objective

To introduce microprocessor architecture, interfacing and programming with 80x86 microprocessors. To familiarize the architecture of Microcontrollers using 8051 microcontroller., and also for high end processors as: ARM/PIC.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to.

CO1. Understand the organization and design of microcomputer and programming.

CO2. Understand the design of architecture of 80x86 family, its interfacing with peripherals and programming

CO3. Understand the design of architecture of 8051 microcontroller, its interfacing with peripherals and programming in assembly and C language

CO4. Understand the architecture and programming with high end processors

CO5. Design and Develop interfacing models according to applications.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H	M	L	M	L		M		H
CO2	H	H	H	H	H	L	L	L		M	L	H
CO3	H	H	H	H	H	M	L	L	L	M	L	H
CO4	H	H	M	H	M	L	M	M	L	L	L	M
CO5	H	H	H	H	H	L	L	L		M	L	H

Syllabus

Module 1: Organization of microcomputer: Von Neumann and Harvard architecture, Instruction set architectures, data transfer operations and their hardware implementation, addressing schemes, instruction set design, general purpose register organization, basic operational concepts of CPU and GPU, multiprocessors, multicore processors, fixed point and floating point arithmetic, overview on assembly language

Module 2: Arithmetical algorithms, pipelining, 80x86 Architecture, programming models, segmentation, addressing modes of 80x86, instructions sets of 80x86, I/O addressing in 80x86, programming with 80x86, interfacing with 80x86: interfacing with RAMs, ROMs, peripheral ICs and key-boards, use of 80x86 in electrical engineering

Module 3: Intel 8051 Microcontroller-Architecture, Assembly language of 8051, programmable keyboard/display interface, interface programmable peripheral interface,

programmable communication interface, serial and parallel bus (RS232, IEEE488), use of 8051 in electrical engineering, overview of architecture of 8096 16-bit microcontroller.

Module 4 : Introduction to High end Processors: ARMx processors, ARMx Architecture, registers and internal modules, JTAG, GPIO, ADC in ARMx processors, overview on Raspberry Pi/PIC microcontroller.

Reference Books/Material

1. M. Morris Mano, "Computer System Architecture", Pearson, 3 rd edition, 1992
2. Barry B. Brey, "The Intel Microprocessors: Architecture, Programming and Interface", PHI, 1997.
3. Sivarama P. Dandamudi, "Introduction to Assembly Language Programming: From 8086 to Pentium Processors", Springer, 1998.
4. . Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D Mckinlay," 8051 Microcontroller and Embedded systems", Pearson Education, 2005.
5. Krishna Kant, "Microprocessors and Microcontrollers, Architecture, Programming, and System Design-8085,8086,8051,8096", PHI Publication,
6. Andrew N Sloss, Dominic Symes and Chris Wright, ARM System developers guide-Designing and developing system software, Elsevier 2004

Course Code	Course Name	L	T	P	Credits
CS255	Database Systems Lab	0	0	3	2

Course Objective

To obtain working knowledge of a database management system and developing applications using the databases**.**

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability.

CO1. Ability to design and implement a database schema for given problem

CO2. Apply the normalization techniques for development of application software to realistic Problems

CO3. Ability to formulate queries using SQL DML/DDL/DCL commands.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	M	M	L	L	H	M	M	M
CO2	H	H	H	M	M	M	L	L	M	M	M	M
CO3	H	H	H	H	H	H	M	L	H	M	M	M

Syllabus

List of Experiments

1. Defining schemas for applications.
2. Creating tables, Renaming tables, Data constraints (Primary key, Foreign key, Not Null), Data insertion into a table.
3. Grouping data, aggregate functions, Oracle functions (mathematical, character functions).
4. Sub-queries, Set operations, Joins.
5. Creation of databases, writing SQL and PL/SQL queries to retrieve information from the databases.
6. Procedures, Functions, Cursors, Triggers, Packages, views, Assertions.
7. Deployment of Forms, Reports Normalization, Query Processing Algorithms in the above application project;
8. Assignment in Design and Implementation of Database systems or packages for applications such as office automation, hotel management, hospital management;

Reference Books/Material

1. Ramez Elmasri, Shamkant B Navathe, “Fundamentals of database systems”, 5th ed., 2003.
2. Avi Silberschatz, Henry Korth and S. Sudarshan, “Database Systems Concepts”, 5th Edition, TMH, 2005

Course Code	Course Name	L	T	P	Credits
CS256	Microprocessors and Microcontrollers Lab	0	0	3	2

Course Objective

To provide hands on experience on programming and interfacing micro controllers

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to.

CO1. To write, debug and execute assembly level program for 8051.

CO2. To obtain practical experience on interfacing I/O devices with 8051.

CO3. To write, debug and execute problems using Embedded C programming.

CO4. To perform mini projects on a real-time problem

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L		L							L
CO2	H	H	M		L							L
CO3	H	H	H		L							L
CO4	M	L	H		L					M		L

Syllabus

List of Experiments:

1. Assembly Level programs for arithmetic (addition, subtraction, multiplication) and logic operations
2. Assembly Level Programs for sorting of numbers
3. Embedded C programs for arithmetic and logic operations
4. Embedded C program for sorting and searching of numbers

5. I/O interface experiments using Assembly Level Program and Embedded C program, Interfacing with A/D and D/A converters
6. Interfacing with stepper motors
7. LCD interfacing to 8051
8. Design and execute programs to generate square wave / Sine Wave/ Pulses/ triangular wave
9. Design and execute a I/O interface problem using Keyboard/push button as input and LED as output device.
10. Mini project

Reference Books/Material

1. M. Morris Mano, “Computer System Architecture”, Pearson, 3 rd edition, 1992
2. Barry B. Brey, “The Intel Microprocessors: Architecture, Programming and Interface”, PHI, 1997.
3. Sivarama P. Dandamudi, “Introduction to Assembly Language Programming: From 8086 to Pentium Processors”, Springer, 1998.
4. . Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D Mckinlay,“ 8051 Microcontroller and Embedded systems”, Pearson Education, 2005.
5. Krishna Kant, “Microprocessors and Microcontrollers, Architecture, Programming, and System Design-8085,8086,8051,8096”,PHI Publication,
6. Andrew N Sloss, Dominic Symes and Chris Wright, ARM System developers guide-Designing and developing system software, Elsevier 2004

Course Curriculum

for

Bachelor of Technology Programme

in

Electronics and Communication Engineering

http://www.nitgoa.ac.in

राष्ट्रीय प्रौद्योगिकी संस्थान गोवा

NATIONAL INSTITUTE OF TECHNOLOGY GOA

कोट्टामल प्लाटू, कुंकोलिम, सालसेट, दक्षिण गोवा, गोवा - ४०३७०३, इंडिया

Kottamoll Plateau, Cuncolim, Salcete, South Goa, Goa- 403703, India

Programme Structure Summary

Sl. No.	Classifications	Course Type	Credits For CGPA	Courses
1	Basic Sciences	**BS**	21	MA→11, PH→5, CY→5
2	Basic Engineering Sciences and Technical Arts	**ES**	21	EM→3, BMC→3, BES→6, CPPS→4, ED→3, WP→2
3	Humanities and Social Sciences	**HU & HS**	7	PC →4, ECO→ 3
4	Indian Knowledge Systems	**IKS**	5	HH →2 and an Open Elective Course →3
5	Others: Liberal Arts, Innovation & Entrepreneurship	**OT**	2	LA→1, IE→1
6	Mandatory Learning Courses	**MLC**	2	PE→0, ES→ 1, PEHV→ 1
7	Department Core	**DC**	83 - 86	Core Theory and Lab courses, Comprehensive Examination →1, Seminar→1, Summer Internship→1, Project Work→5
8	Department Elective (including MOOCs or any other as approved by the Institute)	**DE**	21-27	7-9 Electives
9	Open Elective (including MOOCs or any other as approved by the Institute)	**OE**	0-6	Upto 2 Open Electives
Total Credits			**168**	
10	Minor Program	**MR**	**18**	

Semester-wise Credits Distribution

Sl. No.	Year	Semester-wise Credits		Year-wise Credits
		Semester	**Credits**	
1	First Year	I	23	46
		II	23	
2	Second Year	III	21	44
		IV	23	
3	Third Year	V	23	47
		VI	24	
4	Fourth Year	VII	19	31
		VIII	12	
Total Credits				**168**

Semester-Wise Distribution of the Courses

I Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA100	Matrices and Advanced Calculus	BS	3-1-0	4
2.	PH100	Engineering Physics	BS	3-0-0	3
3.	CS100	Computer Programming and Problem Solving	ES	3-0-0	3
4.	EE100	Basics of Electrical Engineering	ES	2-0-0	2
5.	ME100	Engineering Mechanics	ES	3-0-0	3
6.	HU100	Liberal Arts	OT	0-0-2	1
7.	PH101	Engineering Physics Lab	BS	0-0-3	2
8.	CS101	Computer Programming Lab	ES	0-0-2	1
9.	EE101	Basics of Electrical Engineering Lab	ES	0-0-3	1*
10.	ME101	Engineering Drawing	ES	1-0-3	3
	Total Credits				**23**

II Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA150	Differential Equations and Vector Calculus	BS	3-1-0	4
2.	CY150	Engineering Chemistry	BS	3-0-0	3
3.	HU150	Professional Communication	HU	2-0-3	4
4.	EC150	Basics of Electronics Engineering	ES	2-0-0	2
5.	ME150	Basics of Mechanical and Civil Engineering	ES	3-0-0	3
6.	HU151	Health & Happiness	IKS	2-0-0	2
7.	CY151	Engineering Chemistry Lab	BS	0-0-3	2
8.	EC151	Basics of Electronics Engineering Lab	ES	0-0-3	1*
9.	ME151	Workshop Practices	ES	0-0-3	2
10.	PE150	Physical Education	MLC	1-0-2	0#
	Total Credits				**23**

***: Half-Semester Course, #: Non credit Course**

III Semester

Sl.No	Course Code	Name of the Course	Type	L-T_P	Credits
1	MA202	Mathematical Methods for Communication Engineering	BS	2-1-0	3
2	EC200	Electromagnetic Theory	DC	3-1-0	4
3	EC201	Network Theory and Synthesis	DC	3-1-0	4
4	EC202	Digital System Design	DC	3-0-0	3
5	EC203	Signals & Systems	DC	3-0-0	3
6	EC204	Digital System Design Laboratory	DC	0-0-3	2
7	EC205	Signals & Systems Laboratory	DC	0-0-3	2
Total Credits					**21**

IV Semester

Sl.No	Course Code	Name of the Course	Type	L-T_P	Credits
1	IE250	Innovation & Entrepreneurship	OT	1-0-0	1
2	EC250	Numerical Methods for ECE	DC	3-0-2	4
3	EC251	Analog Electronics	DC	3-0-0	3
4	EC252	Principle of Communication Systems	DC	3-1-0	4
5	EC253	Sensor Technologies	DC	3-0-0	3
6	EC254	Semiconductor Devices	DC	3-1-0	4
7	EC255	Analog Electronics Laboratory	DC	0-0-3	2
8	EC256	Communication Systems Laboratory	DC	0-0-3	2
Total Credits					**23**

Detailed Syllabus of Courses

in

Higher Semesters

III Semester

Sl.No	Course Code	Name of the Course	Type	L-T_P	Credits
1	MA202	Mathematical Methods for Communication Engineering	BS	2-1-0	3
2	EC200	Electromagnetic Theory	DC	3-1-0	4
3	EC201	Network Theory and Synthesis	DC	3-1-0	4
4	EC202	Digital System Design	DC	3-0-0	3
5	EC203	Signals & Systems	DC	3-0-0	3
6	EC204	Digital System Design Laboratory	DC	0-0-3	2
7	EC205	Signals & Systems Laboratory	DC	0-0-3	2
Total Credits					**21**

Course Code	Course Name	L	T	P	Credits
MA202	Mathematical Methods for Communication Engineering	2	1	0	3

Course Objective

This course is crafted to provide engineers and scientists with a comprehensive grasp of probability, random variables, statistics and complex analysis. Further, with a focus on key principles such as probability, complex variables and their practical applications, students will develop a deep understanding of applied mathematics and its real-world implications.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

- **CO1.** Acquire a solid comprehension of probability distributions and apply them to address challenging engineering problems.
- **CO2.** Comprehend the significance and analytical solving methods for statistical and their applications in communication engineering problems.
- **CO3.** Grasp the fundamentals of complex variables, complex functions, and the processes of complex differentiation and integration.

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M			L	L	M		H
CO2	H	H	H	H	H			L	L	M		H
CO3	H	H	H	H	H			L	L	M		H

Syllabus

Module 1: Elements of Probability

Introduction to Probability; Sample Space and Events; Probabilities Defined on Events; Conditional Probabilities; Independent Events; Total Probability; Bayes' Formula.

Module 2: Random Variables and Distribution

Random Variables : Concept of Random Variables; Distribution and Density Function; Jointly Distributed Random of Variables; Conditional and Joint Density Distribution function; Function of Random Variables; Expected Value: Mean, Variance and moments of random variable; Joint moments, conditional expectation; covariance and correlation; Some special distributions: Uniform and Gaussian distributions; Bernoulli, Binomial, and Poisson distributions.

Module 3: Statistics

Statistics :The Sample Mean; The Central Limit Theorem; The Sample Variance; Sampling Distributions from a Normal Population; Sampling from a Finite Population; Parameter Estimation; Maximum Likelihood Estimators; Interval Estimates; Significance Levels; Tests Concerning the Mean of a Normal Population; Testing the Equality of Means of Two Normal Populations; Hypothesis Tests Concerning the Variance of a Normal Population.

Module 4: Complex Analysis

Complex Numbers, geometric representation, powers and roots of complex numbers, Functions of a complex variable, Analytic functions, Cauchy-Riemann equations; elementary functions, Conformal mapping (for linear transformation); Contours and contour integration, Cauchy's theorem, Cauchy integral formula; Power Series and properties, Taylor series, Laurent series, Zeros, singularities, poles, essential singularities, Residue theorem, Evaluation of real integrals and improper integrals.

Texts/References:

(1) E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999).
(2) Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", 5th Edition, Academic Press.
(4) Sheldon M. Ross, "Introduction to Probability Models", 11th Edition, Academic Press.
(5) "Probability, Random Variables, and Stochastic Processes"- Athanasios Papoulis, S. Unnikrishna Pillai, McGraw-Hill, 2002.

Course Code	Course Name	L	T	P	Credits
EC200	Electromagnetic Theory	3	1	0	4

Course Objective

1. Understand electromagnetic fields and wave propagation.
2. Explore vector calculus, electrostatic and magneto static fields.
3. Analyze electromagnetic systems.
4. Learn about transmission lines and wave propagation in different media.
5. Apply Maxwell's Equations and use boundary conditions to solve problems in electromagnetics.

Course Outcomes

CO1. Grasp fundamental electromagnetic principles, including vector calculus, electrostatic and magnetostatic fields.

CO2. Apply Maxwell's Equations effectively to analyze and solve practical problems in electromagnetic fields and wave propagation.

CO3. Develop adept problem-solving skills for diverse electromagnetism scenarios.

CO4. Gain practical insight into transmission lines, including parameters, equations, and design considerations.

CO5. Cultivate critical thinking for evaluating and applying electromagnetic principles to various real-world scenarios.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	M	H	L	M	L	M	L	L	H
CO2	M	H	L	M	H	L	M	L	M	L	L	M
CO3	M	H	H	L	M	L	M	L	M	L	M	L
CO4	L	M	L	H	M	L	M	L	M	L	L	M
CO5	M	H	H	L	M	L	M	L	M	L	M	L

Syllabus

Module 1: Vector Calculus (10 Hrs)

Coordinate Systems and Transformation, Vector Calculus: Line, Surface, and Volume Integrals, Gradient of a Scalar, Divergence of a Vector and Divergence Theorem, Curl of a Vector and Stokes's Theorem, Laplacian of a Scalar.

Module 2: Electrostatic Fields (16 hours)

Electrostatic Fields: Coulomb's Law and Field Intensity, Electric Fields due to Continuous Charge Distributions, Electric Flux Density, Gauss's Law, An Electric Dipole, Flux Lines.

Electric Fields in Material Space: Convection and Conduction Currents, Dielectric Constant and Strength, Continuity Equation and Relaxation Time, Boundary Conditions, Electrostatic Boundary-Value Problems: Poisson's and Laplace's Equations, Uniqueness Theorem

Module 3: Magnetostatic Fields (12 hours)

Biot-Savart's Law, Ampere's Circuit Law, Magnetic Flux Density, Maxwell's Equations for Static EM Fields, Magnetic Scalar and Vector Potentials, Magnetic Forces: Forces due to Magnetic Fields, Magnetic Torque and Moment, A Magnetic Dipole, Magnetic Boundary Conditions.

Module 4: Wave Propagation and Transmission Lines (18 hours)

Faraday's Law, Transformer and Motional EMFs, Displacement Current, Maxwell's Equations in Final Forms, Time-Varying Potentials, Time-Harmonic Fields, Wave Propagation in Lossy Dielectrics, Plane Waves in Lossless Dielectrics, Plane Waves in Free Space, Plane Waves in Good Conductors, Skin effect, Power and the Poynting Vector, Reflection of a Plane Wave at Normal Incidence, Reflection of a Plane Wave at Oblique Incidence.

Textbook:

1.Matthew N. O. Sadiku, *Principles of Electromagnetics*, 4th Edition, oxford university press, 2010.

2.David k. Cheng, *Field and Wave Electromagnetics*, 2nd Edition, Pearson Education India, 2014.

Reference book:

1.W.H. Hayt, J A Buck and M Jaleel Akthar, *Engineering Electromagnetics*, Eighth Edition, McGraw Hill Education, 2017.

2.David J. Griffith, *Introduction to Electrodynamics*, 4-th edition, Pearson Education India Learning Private Limited, 2015.

Course Code	Course Name	L	T	P	Credits
EC201	Network Theory and Synthesis	3	1	0	4

Course Objective

1. To expose the students to the basic concepts of electric circuits and its use
2. To understand the analysis of electrical circuits in time domain
3. Use of Laplace transform in network analysis for frequency domain analysis
4. To expose the students to the use of two-port networks and its applications
5. To introduce the techniques of network realizability and synthesis

Course Outcomes

CO1. Understanding the basic concepts of electrical circuits and their analysis in time domain

CO2. Analyze the circuit in frequency domain by using Laplace transform.

CO3. Understanding the network functions and their stability. Analyzing the concepts of resonance and impedance matching.

CO4. Understanding the elementary theory of realizability of a network function.

CO5. Understanding the concept of network synthesis with given network functions.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	M	H	M	M	M	L	L	M
CO2	M	H	H	M	H	M	M	M	M	L	L	M
CO3	H	M	H	L	M	M	M	L	M	L	L	M
CO4	M	H	H	M	H	M	M	L	M	L	L	M
CO5	H	H	M	M	H	H	H	M	H	L	L	L

Syllabus

Module 1: Network Theory (16 hours)

Conventions for describing the Networks: Network equations, Number of network Equations, Source transformations, Loop variable analysis and Node variable analysis, Duality. First-order differential equations: General and Particular solutions, Time Constants, Initial conditions in networks, Second-order Differential Equations.

Module 2: Frequency domain analysis and network functions (14 hours)

The Laplace Transformation: Basic Theorems for the Laplace Transformation, Examples of the Solutions of Problem with Laplace Transformations, Partial Fraction Expansion, transforms of other Signal Waveforms, Shifted Unit Step, Ramp, Impulse Functions, Waveform Synthesis, Impedance Functions; Network functions: Poles and Zeros, Restrictions on Pole and Zero Locations for driving point Impedance. Stability of Active networks.

Module 3: Two-port network (12 hours)

Two-Port Parameters: Short-Circuit Admittance and Open-Circuit Impedance Parameters, Transmission and Hybrid Parameters, Relationship between Parameter sets. Sinusoidal Steady State Analysis: The Sinusoidal Steady State, Phasor Diagrams.

Module 4: Network synthesis (12 hours)

Network Synthesis: Elements of Realizability theory, Causality and Stability, Hurwitz polynomial, Positive Real Functions. Synthesis of One-port Network with two kinds of Elements- Properties of L-C Immittance functions, Synthesis of L-C Driving point Immittance functions, Properties of R-C Driving point Impedance function, Synthesis of R-C Driving point Impedance function, Properties of R-L Impedance and R-C Admittance function, Synthesis of R-L Impedance and R-C Admittance function. Properties of RC network functions - Foster and Cauer forms of RC and RL networks

Books

Textbooks:

1. Van Valkenberg, "Network Analysis", Prentice Hall of India.
2. Franklin F. Kuo, "Network Analysis and Synthesis", Wiley International Edition
3. Roy Choudhary, "Network and Systems", Wiley Eastern, 2nd Ed., 1988.

Reference Books:

1. William H. Hayt Jr, Jack E Kemmerly and Steven M Durbin, "Engineering Circuit Analysis" Mc Graw Hill, 8th Edition, 2012

Course Code	Course Name	L	T	P	Credits
EC202	Digital System Design	3	0	0	3

Course Objective

1. To understand and apply the principles of Boolean algebra for the simplification of logic functions.
2. To design and implement various combinational logic circuits.
3. To analyze and design sequential logic circuits including counters and registers.
4. To comprehend the basics of memory operations and different logic families.

Course Outcomes

CO1. Demonstrate the ability to minimize Boolean functions.
CO2. Design and implement combinational logic circuits such as adders, subtractors, multiplexers, and encoders.
CO3. Analyze and construct sequential circuits including latches, flip-flops, and different types of counters.

CO4. Develop state machines using state diagrams and tables, and implement state minimization techniques.

CO5. Explain the operation of various memory types and logic families.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	L	M	L	M	L	L	L	M
CO2	H	H	H	M	M	M	M	M	M	M	M	M
CO3	H	H	H	M	M	M	M	M	M	M	M	M
CO4	H	H	H	H	M	M	M	M	M	M	M	M
CO5	H	M	M	M	H	M	M	M	M	H	M	H

Syllabus

Module 1: Minimization of Boolean function (06 hours)

Number systems and binary codes, error detecting & correcting codes, Boolean algebra and Logic Gates, simplification of logic functions using Karnaugh map, Quine McCaskey method.

Module 2: Combinational Logic Design (08 hours)

Sensitivity and Selectivity of a receiver, Superheterodyne Receiver, Image Frequency and its Rejection, Mixer, Automatic Gain Control (AGC), FM Receivers: FM Discriminator, Stereo FM Receiver.

Module 3: Sequential Logic Design (12 hours)

Sequential circuits, latches and flip-flops: SR-latch, D-latch, D flip-flop, JK flip-flop, T flip-flop, timing hazards and races, edge-triggered flip-flops, register, shift register, universal shift register; application of shift register: ring counter, Johnson counter, sequence generator and detector, up- and down counter, asynchronous ripple counter, synchronous counters, counter design using flip flops, counter design with asynchronous reset or preset, applications of counters

Module 4: State Machine (08 hours)

Canonical model of a state machine, types of state machines, state diagram, state table, state assignment, Moore and Mealy model, state minimization.

Hardware modeling using Verilog/VHDL; Laboratory exercises and assignments to supplement the course.

Module 5: Memory and Logic families (08 hours)

Read-only memory, read/write memory - SRAM and DRAM. TTL, ECL, MOS Inverters, CMOS, CMOS inverters.

Books

Textbooks:

1. M. Morris Mano, Michael D. Ciletti, *Digital Design: With an Introduction to Verilog HDL*, 5-th edition, Pearson Education India, 2013..

2. Stephen Brown, Zvonko Vranesic, *Fundamentals of Digital Logic with VHDL Design*, Third edition, McGraw Hill Education, 2017.

3. Ronald J. Tocci, *Digital Systems*, 10-th edition, Pearson, 2009.

Reference Books:

1. Vahid, *Digital Design, with RTL Design, VHDL, and Verilog*, 2nd Edition, John Wiley and Sons Publishers, 2010..

2. S. Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Second Edition, Pearson Education, 2004.

Course Code	Course Name	L	T	P	Credits
EC203	Signals & Systems	3	0	0	3

Course Objective

1. The main objective of studying this course is to know the basics and theoretical concepts of generation of signals and its characteristics.
2. To know the importance of signals and systems by analysing it by time domain.
3. To understand the behaviour of the signals and systems by converting from time domain to frequency domain.
4. To observe the impact of LTI system by convolving the signal with it and how it works as filtering.
5. To understand the use of Fourier series and Fourier transform for signals analysis.
6. To know the impact of Laplace and Z transform for the analysis of CT and DT signal respectively.

Course Outcomes

After completing this course, the student can able to

CO1. Know how to generate the signal and perform the mathematical operation on it.

CO2. Understand the characteristics of test signals like impulse, step, ramp, complex exponential and arbitrary.

CO3. Observe the effect of signal operations like shifting, folding, scaling etc.,

CO4. Get the significance of time domain and frequency domain analysis of signals and systems.

CO5. Know the importance of LTI system and its properties and how to use it for filtering operation in signal processing.

CO6. Understand the use of Laplace transform for continuous time signals and systems analysis.

CO7. Know the importance of Z transform the discrete time signals and systems analysis.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	M	M	H	L	L	L	L	M	L	L	M
CO2	H	M	M	H	L	L	L	L	M	L	L	M
CO3	H	M	M	H	L	L	L	L	M	L	L	M
CO4	H	H	H	H	L	L	L	L	M	L	M	M
CO5	H	H	H	H	L	L	L	L	M	L	M	M
CO6	H	H	H	H	L	L	L	L	M	L	M	M
CO7	H	H	H	H	L	L	L	L	M	L	M	M

Syllabus

Module 1: Introduction to Signals and Systems (8 hours)

Definition of Signals and Systems, Classification of Signals, Operations on signals, Singularity functions and related functions. Analogy between vectors and signals - orthogonal signal space, complete set of orthogonal functions, Parseval's relations.

Module 2: Analysis of Signals (12 hours)

Fourier series representation of continuous time periodic signals -Trigonometric and Exponential Fourier series- Properties of Fourier series. Fourier transform of aperiodic signals, standard signals and periodic signals - Properties of Fourier transforms. Hilbert transform and its properties. Laplace transforms-RoC-properties. Inverse Laplace transform.

Module 3: Analysis of Systems (8 hours)

Continuous-time Systems and its properties. Linear time invariant (LTI) system-Impulse response. Convolution. Analysis of LTI System using Laplace and Fourier transforms.

Module 4: Sampling and Quantization (4 hours)

Sampling and reconstruction of band limited signals. Low pass and band pass sampling theorems. Aliasing. Anti-aliasing filter. Practical Sampling-aperture effect. Quantization.

Module 5: Analysis of DT Signals and Systems (10 hours)

Discrete-time signals and systems. Discrete Fourier series, DTFT, Z-transform and its properties. Analysis of LSI systems using Z – transform.

Text books:

1. Alan V. Oppenheim, Alan S. Willsky, and S. Hamid Nawab, “Signals and Systems”, 2nd Edition, PHI, 2003.
2. Simon Haykin, and Barry Van Veen, “Signals and Systems”, 2nd Edition, John Wiley, 2012.

Reference Books:

1. Alan V. Oppenheim and Ronald W. Schafer "Discrete-Time Signal Processing", 3rd Edition, Pearson, 2010.
2. Sanjit K Mitra, “Digital Signal Processing: A Computer based Approach”, 3rd Edition, Tata McGraw Hill, India, 2009.
3. S. Esakkirajan, T. Veerakumar, and B N Subudhi, “Digital Signal Processing”, Tata McGraw Hill, India, 2021.

Course Code	Course Name	L	T	P	Credits
EC204	Digital System Design Laboratory	0	0	3	2

Course Objective

1. To teach the fundamentals of designing digital logic systems using Boolean algebra and logic gates.
2. To enable students to implement and verify various digital circuits such as adders, subtractors, and comparators.
3. To familiarize students with different coding schemes and their conversions in digital circuits.
4. To provide practical experience in designing and simulating digital systems, emphasizing societal, health, safety, and environmental considerations.

Course Outcomes

CO1. Simplify and realize Boolean expressions using logic gates and universal gates.

CO2. Design and implement arithmetic circuits such as adders and subtractors using discrete logic components and ICs.

CO3. Convert between different number systems including BCD, Excess-3, binary, and Gray codes.

CO4. Utilize multiplexers, demultiplexers, decoders, and encoders for various applications in digital circuits.

CO5. Implement and verify sequential circuits including flip-flops, counters, and sequence generators.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	L	L	L	L	L	L	L	L	L	M
CO2	H	H	H	M	M	L	L	L	M	M	M	M
CO3	H	H	H	M	M	L	L	L	M	M	M	M
CO4	H	H	M	M	M	M	M	M	M	M	M	M
CO5	H	M	M	M	H	L	L	L	M	M	M	M

Syllabus

List of Experiments

(1) Simplification, realization of boolean expressions using logic gates/universal gates

(2) Realization of half/full adder & half/full subtractors using logic gates, Realization of parallel adder/subtractors using 7483 chip.

(3) BCD to Excess-3code conversion & vice versa, binary to gray code conversion & vice versa.

(4) MUX/DEMUX – use of 74153,74139 for arithmetic circuits & code converter.

(5) Realization of one/two bit comparator and study of 7485 magnitude comparator.

(6) Use of a) Decoder chip to drive LED display & b) Priority encoder.

(7) Truth table verification of flip-flops: i) JK Master Slave ii) T type iii) D type.

(8) Realization of 3 bit counters as a sequential circuit & MOD-N counter design (7476,7490,74192,74193).

(9) Writing & testing of sequence generator.

(10) Hardware modeling using Verilog/VHDL; Laboratory exercises and assignments to supplement the lab.

Books

1. M. Morris Mano, Michael D. Ciletti, *Digital Design: With an Introduction to Verilog HDL*, 5-th edition, Pearson Education India, 2013..

2. Stephen Brown, Zvonko Vranesic, *Fundamentals of Digital Logic with VHDL Design*, Third edition, McGraw Hill Education, 2017.

3. Ronald J. Tocci, *Digital Systems*, 10-th edition, Pearson, 2009.

Course Code	Course Name	L	T	P	Credits
EC205	Signals & Systems Laboratory	0	0	3	2

Course Objective

1. To generate the signals and process the signals using simulation tool like MATLAB/Python.
2. To verify the system operations on signal.
3. To visualize characteristics of signals and systems and understand the concepts of signals and systems in time domain and frequency domain.
4. To analyse the effect of reconstructions from sampled signal.

Course Outcomes

CO1. Use simulation software like MATLAB/Python to study the behavior of signals and systems as they arise in a variety of contexts.

CO2. Use the simulation tool to visualize the effect of convolution in signals and systems

CO3. Use the simulation tool to understand the effect of sampling process on continuous time signal while converting it into discrete time signal.

CO4. Analyze the discrete time signals and systems in both time and frequency domains

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	H	L	M	H	L	L	L	M	L	L	M
CO2	H	H	L	M	H	L	L	L	M	L	L	M
CO3	H	H	L	M	H	L	L	L	M	L	L	M
CO4	H	H	H	M	M	M	L	L	M	M	L	M

List of Experiments

1. Generation of signals and systems
2. Operations on signal and system
3. Analysis of signals and systems in time domain
4. LTI systems analysis
5. Perform the Convolution operation between signals and systems
6. Fourier series or transform representation of signals and systems
7. Sampling and Quantization
8. Reconstruction of analog signal from discrete time signal
9. Effects of sampling and quantization
10. Analysis of DT signal and system using Z-Transform

Text Books/Reference Books:

1. A.V. Oppenheim, A. Willsky, S. Hamid Nawab, “Signals and Systems”, Pearson 2018.
2. S. Haykin and B.Van Veen “Signals and Systems, Wiley, 1998.
3. S. Esakkirajan, T. Veerakumar and B. N. Subudhi, “Digital Signal Processing”, Tata McGraw Hill, 2021.
4. S. Esakkirajan, T. Veerakumar and B. N. Subudhi, “Digital Signal Processing Illustration Using Python”, Springer, 2024.

IV Semester

Sl.No	Course Code	Name of the Course	Type	L-T_P	Credits
1	IE250	Innovation & Entrepreneurship	OT	1-0-0	1
2	EC250	Numerical Methods for ECE	DC	3-0-2	4
3	EC251	Analog Electronics	DC	3-0-0	3
4	EC252	Principle of Communication Systems	DC	3-1-0	4
5	EC253	Sensor Technologies	DC	3-0-0	3
6	EC254	Semiconductor Devices	DC	3-1-0	4
7	EC255	Analog Electronics Laboratory	DC	0-0-3	2
8	EC256	Communication Systems Laboratory	DC	0-0-3	2
Total Credits					**23**

Course Code	Course Name	L	T	P	Credits
IE250	Innovation & Entrepreneurship	1	0	0	1

Course Objective

- To introduce to a project-based learning approach from Ideation to Innovation and Entrepreneurship will be the key process considered here.
- To learn the essential concepts of innovation and entrepreneurship through hands-on activities and the best and most relevant practical examples
- The course is designed to provide the tools necessary for starting independent innovation and businesses
- To give students practical experience in market survey, commercialization, IPR and proactively work in projects in risky market environments

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. To comprehend the basic theories and concepts that underlie a survey study of Innovation, Entrepreneurship and Social Business/ Entrepreneurship

CO2. To understand how to generate good large company or startup business ideas / societal ideas, and refine these ideas, to substantially increase chances for success in the marketplace

CO3. The students will be exposed to the thoughts and strategies of some very effective real-life innovators and entrepreneurs through videos and small cases.

CO4. To understand about IPR, prototyping and financial management.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	H	L	H	M	H	H	L	H	H	H	H
CO2	L	H	L	H	H	H	H	L	H	H	H	H
CO3	L	H	L	H	H	H	H	L	M	H	H	H
CO4	L	H	L	H	H	H	H	H	L	L	H	H

Syllabus

Module 1: Introduction

Creative thinking, blocks to creativity, factors that influence creative design, engineering design and creative design, influence of society, market pull & technology push, attribute of a creative person Three levels of Design – Viceral, Behavioral and Reflective design.

Qualities and skills required for entrepreneurship, Functions of an entrepreneur, Importance of entrepreneur in economic development.

Module 2: Ideas for Entrepreneurship

Need or identification of a problem, market survey, data collection, review & analysis, problem definition, challenge statement, problem statement initial specifications, Brain storming, analogy technique or Synectic, check list, trigger words, morphological method, interaction matrix method, analysis of interconnected decision making.

Module 3: Theory of Inventive Problem Solving (TRIZ)

20 key TRIZ principles – multifunction, compensation, nested doll, blessing in disguise, segmentation, separation, symmetry change, opaque & porous, inflate and deflate, recycle & recover, phase transformation, energy, imaging, environment, composition, economical, surface response, static & dynamic, continuous & intermittent, dimensions.

Module 4: Product Design, IPR & Finance

Detail design, prototyping, product deployment, useful life assessment and recycling and sustainability; patent act, patent laws, Types of entrepreneurs- Based on type of business, based on use of technology, based on motivation, based on stages of development, based on motive, Based on capital ownership, Business Plan, Finance and Funding.

Reference Books/Material

1. C.B.Gupta & N.P.Srinivasan, ‘Entrepreneurial Development’, Sultan Chand & Sons, 2020, ISBN: 978-93-5161-132-5
2. Floyd Hurt, Rousing Creativity: Think New Now, Crisp Publ Inc. 1999, ISBN 1560525479,
3. Kalevi Rantanen & Ellen Domb, ‘Simplified TRIZ’ – II edn., Auerbach Publications, Taylor & Francis Group, 2010, ISBN: 978-142-0062-748

Course Code	Course Name	L	T	P	Credits
EC250	Numerical Methods for ECE	3	0	2	4

Course Objective

This course is designed to offer engineers and scientists a thorough understanding of numerical methods. It emphasizes essential concepts, including numerical solutions for algebraic, transcendental, and differential equations, and explores their practical applications.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. Gain expertise in numerical solving techniques for single-variable equations and systems of equations, and then apply these principles to address intricate engineering challenges.

CO2. Understanding of the significance of curve fitting, interpolation, numerical differentiation and integration.

CO3. Foster a deep comprehension of the importance of numerically solving ordinary and partial differential equations (ODEs) and explore their wide-ranging applications across diverse fields.

CO4. Develop a profound understanding of the significance of employing numerical methods through the utilization of diverse programming languages.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M			L	L	M		H
CO2	H	H	H	H	H			L	L	M		H
CO3	H	H	H	H	H			L	L	M		H
CO4	H	H	H	H	H			L	L	M		H

Syllabus

Module 1: Numerical solution of equations and systems:

Equations in one variable: The Bisection method, fixed point iteration method, Secant method, Regular-Falsi method, Newton's method and its extensions, Convergence of Newtons's method.

System of equations: Jacobi and Gauss-Seidel iterative methods, sufficient conditions for convergence, Power method to find the dominant Eigen value and eigenvector.

Module 2: Interpolation, Numerical Differentiation and Integration:

Interpolation and Curve fitting: The Lagrange polynomial, divided differences, Method of least square approximations. **Numerical differentiation:** Difference formula, three and five point formula. **Numerical integration:** Open and closed Newton-Cotes formulae, Gaussian quadrature formula.

Module 3: Numerical solutions of ordinary differential equations

Euler's method, Euler's modified method, Taylor's method and Runge-Kutta method, Multi-step methods, Variables step-size multi step methods, Numerical methods for higher order and system of equations, Error analysis of all the methods, Stability.

Module 4: Numerical solutions of partial differential equations

Elliptic partial differential equations: Fine difference method for two dimensional equations. **Parabolic partial differential equations:** Forward difference method, backward difference method and the Crank-Nicolson method for one dimensional equations.

Hyperbolic partial differential equations: Central difference method for one dimensional equations.

Lab Experiments:

1. Basic operations on Matlab/Python.
2. Program to solve one variable equation using Bisection and Fixed point method.
3. Program to solve one variable equation using Newton Raphson, Regula-Falsi and Secant method.
4. Program to solve system of equations using Gauss-Jacobi Method
5. Program to solve system of equations using Gauss-Seidal Method
6. Program to find dominant eigenvalue using the Power Method
7. Program to fit a curve using method of least square.
8. Program to interpolate using the Lagrange polynomial method.
9. Program to evaluate differentiation and integration.
10. Programs to solve ordinary differential equations using Euler's and Taylor's method.
11. Programs to solve ordinary differential equations using R-K method of order four.
12. Programs to solve ordinary differential equations using multistep methods.

13. Programs to solve elliptic equations using the finite difference method.
14. Programs to solve parabolic equations using the finite difference method.
15. Programs to solve hyperbolic equations using the finite difference method.

Reference Books/Material

1. M. K. Jain, S. R. K Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering Computation," New Age Publishers, 6 th Edition, 2012.
2. 2. E. Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India Pvt. Ltd., 2010.
3. R. L. Burden and J. D. Faires, "Numerical Analysis", 9 th Edition, Brooks/Cole, 2012.
4. G.D Smith, "Numerical solution of Partial Differential Equations," Oxford University Press.

Course Code	Course Name	L	T	P	Credits
EC251	Analog Electronics	3	0	0	3

Course Objectives:

1. To develop the concepts for different transistors-analog and digital.
2. Importance of different amplifiers.
3. Exploration of the advanced transistors

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO 1: Understand BJTs, their behaviour, and analyze basic amplifier circuits.

CO 2: Analyze MOSFETs, their behaviour, and design differential amplifiers.

CO 3: Analyze high-frequency response of amplifiers using advanced techniques and design feedback amplifiers.

CO 4: Compare advanced transistor types for specific applications.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	-	L	-	-	-	M	L	-	-
CO2	H	M	H	-	L	-	-	-	M	L	-	-
CO3	H	H	H	L	M	-	-	-	M	L	-	-
CO4	M	M	L	L	L	-	-	-	M	L	-	-

Module 1- Diode circuits, Bipolar Transistors & Amplifiers (Hours12)

Series diode configurations with DC inputs, parallel and series-Parallel configuration, AND/OR gates using diodes, half wave rectification, full wave rectification, series and parallel clippers, clampers, Small and Large Signal Model, DC & Small Signal Analysis, Operating Point Analysis and Design: Simple Biasing and Resistive Divider Biasing, Ebers-Moll and Gummel-Poon Model, Common Emitter and Common Base Bipolar Amplifiers with Active Load, BJT Differential Pair, Heterojunction and Schottky Bipolar Transistor.

Module 2- MOSFETs & Differential Amplifiers (Hours10)

MOSFET Structure, I-V Characteristics, Channel Length Modulation, Velocity Saturation, Small & Large Signal Model, Current Source, Current Mirror Circuits, MOS Differential Amplifiers, Differential and Common Mode Gain, CMRR, MOS Differential Amplifiers with Active Load-Qualitative & Quantitative Analysis.

Module 3- Frequency Response & Feedback Amplifiers (Hours12)

Miller's Theorem, High Frequency Models of Transistors, Use of Miller's Theorem, Frequency Response of Followers, Cascode Stage and Differential Pairs. Voltage Amplifiers, Current Amplifiers, Series-Shunt Feedback Amplifiers, Series-Series Feedback Amplifiers, Shunt-Shunt Feedback Amplifiers, Shunt Series Feedback Amplifiers, Loop Gain Stability.

Module 4- Advanced Transistors (Hours 10)

Polysilicon Emitter Bipolar Transistor, Schottky Collector Bipolar Transistor, Heterojunction Bipolar Transistor, PN Junction FET, Metal-Semiconductor FET, Tunnel FET.

Text & References Books

1. Behzad Razavi, "Fundamentals of Microelectronics", John Wiley & Sons .2008.
2. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, 1991.
3. B.G. Streetman and S. K. Banerjee, Solid State Electronic Devices, Prentice Hall of India, New Delhi, 1995.
4. Donald Neamen. 2002. Semiconductor Physics And Devices (3rd. ed.). McGraw-Hill, Inc., USA.

Course Code	Course Name	L	T	P	Credits
EC252	Principles of Communication Systems	3	1	0	4

Course Objective

1. Realizing the time and frequency domain nature of all linear modulation schemes, their corresponding circuits, signals, and spectra.
2. Analysis of time and frequency domain description of angle modulation systems and their corresponding circuits, signals, and spectra.
3. Detail analysis, working, and comparative performance of AM/FM transmitters and receivers' circuits.
4. Understanding noise in communication systems and various types of noise. Noise performance in AM and FM systems, Figure of Merit calculation.

Course Outcomes

CO1. Understand and apply various analog modulation techniques like AM, FM, and PM, with the ability to analyze their time and frequency characteristics.

CO2. Analyze, design, and optimize transmitter and receiver circuits, including Superheterodyne Receivers, evaluating sensitivity, selectivity, and designing components like mixers and AGC circuits.

CO3. Analyze noise in communication systems, classify types, calculate SNR and Noise Figure, and assess noise performance in both AM and FM systems.

CO4. Demonstrate proficiency in pulse modulation techniques (PAM, PWM, PPM, PCM), applying them in communication systems, and understanding principles like line coding and delta modulation.

CO5. Apply learned principles to solve practical communication problems, including system design, analysis, troubleshooting, and informed decision-making..

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	M	L	M	H	M	H	M	M
CO2	M	H	H	M	H	L	M	M	M	H	M	M
CO3	H	L	H	L	M	M	H	H	L	M	M	H
CO4	M	H	H	M	M	M	L	L	M	H	M	M
CO5	L	M	M	M	H	H	M	M	H	L	M	H

Syllabus

Module 1: Analog Modulations (18 hours)

Amplitude Modulation (AM), Envelope Detection, Double Sideband Suppressed Carrier (DSB-SC) Modulation, Demodulation, Single Sideband Modulation (SSB), Demodulation of SSB.

Angle modulation: Frequency Modulation (FM), Phase Modulation (PM), Modulation Index, Spectrum of FM Signals, Carson's Rule for FM Bandwidth, Narrowband FM Generation, Wideband FM Generation via Indirect Method, FM Demodulation, PLL.

Module 2: Transmitters and Receivers in Analog Modulations (12 hours)

Sensitivity and Selectivity of a receiver, Superheterodyne Receiver, Image Frequency and its Rejection, Mixer, Automatic Gain Control (AGC), FM Receivers: FM Discriminator, Stereo FM Receiver.

Module 3: Noise Performance in Continuous-wave Modulation (12 hours)

Noise Sources and Classification, Thermal Noise, Power Spectral Density (PSD) of Thermal Noise, White Noise, Signal-to-Noise Ratio (SNR), Noise Figure, Figure of Merit, Figure of Merit for different AM systems, Noise performance FM systems, Figure of Merit of FM, Pre-Emphasis and De-Emphasis.

Module 4: Pulse modulation Techniques (14 hours)

Pulse Modulation: sampling process; pulse amplitude modulation (PAM); pulse width modulation (PWM); pulse position modulation (PPM); pulse code modulation (PCM); line coding; differential pulse code modulation; delta modulation; adaptive delta modulation.

Books:

Textbooks:

1. Herbut Taub, Donald L. Schilling, and Goutam Saha, Principles of Communication Systems, 4th Edition, .McGraw Hill Education, 2017

2. B. P. Lathi, Z. Ding Modern, Digital and Analog Communication Systems, Oxford University Press, 2010.

Reference Books:

1. S. Haykin, Communication Systems, Wiley India Edition, 2009.

2. Wayne Tomasi, Electronic Communications System: Fundamentals Through Advanced, Pearson Education, 5-th edition, 2008.

Course Code	Course Name	L	T	P	Credits
EC253	Sensor Technologies	3	0	0	3

Course Objective

This is a basic introductory course on Sensor Technology with an objective to understand and assimilate the importance of sensors, their properties, characteristics and applications from traditional sensors to Micro sensor Technologies and their applications.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. To obtain a basic understanding of the Sensor fundamentals and their importance, classification and characteristics and a overview of a spectrum of sensor types.

CO2. To gain insights into MEMS technology, its applications and micro fabrication principles and technologies involved in fabrication of sensors at miocroscale.

CO3. To analyze and understand future trends in Sensor Technologies namely Wearable Sensing to IoT and Sensors at Nano Scale

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M			L	L	M		H
CO2	H	H	H	H	H			L	L	M		H
CO3	H	H	H	H	H			L	L	M		H

Syllabus

Module 1: Introduction to Sensors

Definition of sensors, Importance and role of sensors in technology, Types and Classification of sensors based on resistive, capacitive, inductive, optical, sensing principles. Introduction to basic Transduction mechanisms, Sensor characteristics and performance parameters, accuracy, precision, resolution, sensitivity, linearity, and hysteresis. Principles of Calibration and compensation techniques. - 8 Hrs

Module 2: Physical Sensors and Transducers:

Types of sensors: active and passive sensors, Thermal sensors, Microwaves sensors, Atmospheric sensors, Sonar sensors, Cameras for remote sensing. Optical Sensors: Photodiodes, phototransistors, Fiber optic sensors and FBG sensors. Imaging sensors -CCD and CMOS. Transducer and classification: Primary & Secondary, active & passive transducers; analog & digital modes of operation; null & deflection methods. Capacitive transducer- various arrangements, Inductive transducer, LVDT, RTD temperature characteristics, thermistor characteristics, Thermocouple characteristics. - 12 Hrs

Module 3: Microsensors

MEMS- Introduction to MEMS, Definitions and classifications, history, applications, Miniaturization issues, Microsystems versus MEMS, Microfabrication and Integrated Microsystems (micromechanical structures, microsensors and micro actuators). Micromachining Technologies–Photolithography, Etching, Thin-film deposition (evaporation, sputtering and chemical vapor deposition), Classification of micro sensors and micro actuators, An overview of Silicon capacitive accelerometer, Piezoresistive pressure sensor, Electrostatic comb-drive. - 12 Hrs

Module 4: Emerging trends in Sensor Technology

Wearable Sensor Technology: Introduction to world of wearable, Textiles and Clothing Wearable applications Personal Health, and Sports. Wearable Bio and Chemical Sensors and Challenges in Chemical Biochemical Sensing.

Sensors at Nano Scale: Properties and applications of Carbon Nano tube (CNT), Graphene, Quantum dots in sensing applications. Soft-lithography based sensors and applications.

Internet of Things (IoT): Definition, vision, conceptual framework, Major components of IoT system. , IoT Sensing and Actuation, IoT .Case Studies and Introduction to future trends: Vehicular IoT, Healthcare IoT, IoT Analytics. - 10 Hrs

Texts/References:

1. A.K. Sawhney, 'Electrical and Electronic Measurements and Instrumentation., Dhanpat Rai, 2015
2. Alan S Morris Measurement and Instrumentation Principles, 3rd/e, Butterworth Hienemann (2001)
3. David A. Bell Electronic Instrumentation and Measurements 2nd/e, Oxford Press (2007)
4. Chang Liu 'Foundations of MEMS', Pearson Education Inc., 2012.
5. M.Madou "Fundamental of Microfabrication", CRC Press, 2nd edition
6. Raj Kamal Internet of Things: Architecture and Design Principles, 1st edition, Mc Graw Hill Education Pvt. Ltd., 2017.
7. Sudip Misra, Anandarup Mukherjee, Arijit Roy Introduction to IoT, Cambridge University Press 2021
8. T. Pradeep 'NANO: The Essentials: Understanding Nanoscience and Nanotechnology', 1st Edition,Tata McGraw-Hill(2007)
9. Maity, Asit Baran, .Optoelectronics and Optical Fiber Sensors' , PHI Learning, ISBN : 9788120347816

E-Resources:

1. https://nptel.ac.in/courses/108/108/108108147/
2. https://www.coursera.org/lecture/wearabletechnologies/introduction-to-wearable-technology-e0kP5
3. http://digimat.in/nptel/courses/video/108108147/L01.html

Course Code	Course Name	L	T	P	Credits
EC254	Semiconductor Devices	3	1	0	4

Course Objectives:

1. To understand the fundamental principles of various modern semiconductor devices.
2. To understand and describe the impact of solid-state device capabilities and limitation's on electronic circuit performance.

Course Outcomes:

CO1: Grasp semiconductor basics & carrier movement.

CO2: Analyze p-n junctions & their applications.

CO3: Understand BJT operation & amplification.

CO4: Explain MOSFETs & compare them to BJTs.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	-	M	-	-	-	-	M	-	M	H
CO2	M	H	M	M	-	-	-	-	M	-	M	H
CO3	H	H	M	M	-	-	-	-	M	-	M	H
CO4	H	H	M	M	-	-	-	-	M	-	M	H

Module 1 (Hours 10)

Semiconductor materials, Crystalline and organic semiconductors, Crystal Lattices; Cubic Lattices - Planes and Directions, Energy Bands and Charge Carries in Semiconductors: Equilibrium Carrier concentration, intrinsic semiconductor - Bond and Band models; Extrinsic semiconductor -Bond and Band models; Carrier transport.

Excess Carriers in Semiconductors: Injection level, Lifetime, Direct and Indirect Semiconductors, Diffusion and Drift of Carrier; Built-in Fields - Diffusion and Recombination, The Continuity Equation, Steady State Carrier Injection.

Module 2 (Hours 10)

P-N Junction: Device Structure, Equilibrium Picture, Band Diagram, DC Forward and Reverse Characteristics, Small-signal Equivalent Circuit, Switching Characteristics; Zener Breakdown; Graded Junctions, Metal -Semiconductor Junctions, Schottky Barriers, Other PN Junctions: Photodiodes, Solar cells, Light-Emitting Diode, Lasers, Semiconductor Lasers.

Module 3 (Hours 08)

Bipolar Junction Transistor: Device Structures, Doping levels, Band Diagram, Understanding - Injection efficiency & Base transport factor, Operation of BJT. Transistor action and

Amplification; Common Emitter DC characteristics, Small-signal Equivalent circuit; Ebers-Moll model, SPICE model.

Module 4 (Hours 14)

MOS Junction: Band diagram, C-V characteristics, Threshold voltage, Body effect. Metal Oxide Field Effect Transistor: Device Structures, Band Diagram, Operation, Common Source DC Characteristics, Small-signal Equivalent of MOSFET, SPICE level-1 model. Secondary effects of MOSFET: Hot Electron Effects, Drain-Induced Barrier Lowering, Short Channel Effect and Narrow Width Effect, Gate Induced Drain Leakage; Differences between a MOSFET and a BJT. FET Biasing: Fixed-Bias Configuration, Self-Bias Configuration, Voltage-Divider Biasing, Depletion- Type MOSFETs, Enhancement-Type MOSFETs, p-Channel FETs. FinFET Technology, Large and small geometry FinFET Device Operation, Leakage Currents in FinFETs, Challenges to FinFET Process and Device Technology.

Reference books

1. Ben. G. Streetman & Sanjan Banerjee, “Solid State Electronic Devices”, 5thEdition,PHIPrivate Ltd, 2003
2. Nandita Das Gupta & Aamitava Das Gupta, ”Semiconductor Devices; Modeling andTechnology”, PHI, 2004.
3. M.K.Achuthan and K.N.Bhat, “Fundamentals of Semiconductor Devices”, Tata McGraw-Hill, New Delhi, FirstPrint2007
4. Neaman, Donald A. Semiconductor physics and devices. Irwin, 1992.

Course Code	Course Name	L	T	P	Credits
EC255	Analog Electronics Laboratory	0	0	3	2

Course Objectives: To provide experience on design, testing, and analysis of basic.

Course Outcomes:

CO1: Design and analyze basic digital logic circuits using p-n junction diodes.

CO2: Analyze the characteristics and biasing techniques of Bipolar Junction Transistors (BJTs) in common-emitter configuration.

CO3: Design and analyze basic circuits using operational amplifiers (op-amps) for signal processing functions.

CO4: Apply simulation tools to analyze the behaviour of electronic circuits.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	M	L	-	-	-	-	M	L	-	-
CO2	H	H	M	-	L	-	-	-	M	L	-	-
CO3	M	M	H	L	M	-	-	-	M	L	-	-
CO4	L	M	L	-	H	-	-	-	M	L	-	-

List of Experiments

1. To realize positive AND & positive OR gate using p-n junction diode
2. To realize different clipping and clamping circuits and observe the waveforms Experiment
3. To study input and output characteristics of a NPN Bipolar Junction Transistor (BJT) in Common-emitter configuration.
4. Measure the current gain of the common emitter BJT amplifier
5. To study transfer and output characteristics of an n-channel MOSFET in common-source configuration.
6. Find out the threshold voltage of the N-type MOSFET & cut-in voltage of the NPN BJT
7. Determine the Q-point stability of base bias
8. Construct the dc load line and plot the Q-point of voltage divider bias
9. To design and set up an integrator circuit using op-amp
10. To design and set up differentiator circuit using op-amp
11. Simulating current mirror to extract DC response and plot of current mirror output Impedance.
12. Study and simulate the frequency response of the common emitter amplifier.

Text & Reference Books

1. Behzad Razavi, “Fundamentals of Microelectronics”, John Wiley & Sons .2008.
2. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, 1991.
3. B.G. Streetman and S. K. Banerjee, Solid State Electronic Devices, Prentice Hall of India, New Delhi, 1995.

Course Code	Course Name	L	T	P	Credits
EC256	Communication Systems Laboratory	0	0	3	2

Course Objectives:

1. Realization of AM transmitters and receivers using discrete components.
2. Realization of DSB-SC transmitters and receivers using discrete components.
3. Realization of FM transmitters and receivers using discrete components.
4. Detailed analysis of AM, FM, and PM signals through software modeling.

Course Outcomes

CO1. Develop proficiency in designing and implementing communication systems using discrete electronic components.

CO2. Design and generate signals by incorporating amplitude modulation (AM) through the use of discrete electronic elements.

CO3. Generate and analyze Double-Sideband Suppressed Carrier (DSB-SC) signals using discrete electronic components.

CO4. Design and evaluate Frequency Modulated (FM) transmitters and receivers employing discrete electronic components.

CO5. Utilize MATLAB software for the study and modeling of diverse signal types, including AM, FM, and PM.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	M	L	M	H	M	H	M	M
CO2	M	H	H	M	H	L	M	M	M	H	M	M
CO3	H	L	H	L	M	M	H	H	L	M	M	H
CO4	M	H	H	M	M	M	L	L	M	H	M	M
CO5	L	M	M	M	H	H	M	M	H	L	M	H

List of Experiments

Experiment No. 1: Generation of Amplitude Modulated (AM) signal using discrete components.

Experiment No. 2: Demodulation of AM Signal using discrete components.

Experiment No. 3: Generation of DSB-SC Modulated waveform using discrete components.

Experiment No. 4: DSB-SC Demodulation using discrete components.

Experiment No. 5: Generation of Frequency Modulated waveform using discrete components.

Experiment No. 6: Generation of PAM, PWM, PPM waveform.

Experiment No. 7: Demodulation of FM Signal using discrete components.

Experiment No. 8: Generation and Detection of AM using MATLAB.

Experiment No. 9: Generation and Detection of FM using MATLAB.

Experiment No. 10: Generation and Detection of PM using MATLAB.

Books

Textbooks:

1. Herbut Taub, Donald L. Schilling, and Goutam Saha, Principles of Communication Systems, 4th Edition, McGraw Hill Educati on, 2017.

B. P. Lathi, Z. Ding Modern, Digital and Analog Communication Systems, Oxford University Press, 2010.

Course Curriculum

for

Bachelor of Technology (BTech) Programme

in

Electrical and Electronics Engineering

http://www.nitgoa.ac.in

राष्ट्रीय प्रौद्योगिकी संस्थान गोवा

NATIONAL INSTITUTE OF TECHNOLOGY GOA

कोट्टामल प्लाटू, कुंकोलिम, सालसेट, दक्षिण गोवा, गोवा - ४०३७०३, इंडिया

Kottamoll Plateau, Cuncolim, Salcete, South Goa, Goa- 403703, India

Contents

Chapter 1

Credits Distribution : BTech (EEE)

1.1 Programme Structure Summary

Sl No	Classifications	Course Type	Credits For CGPA	Courses
1.	Basic Sciences	BS	21	MA → 11, PH → 5, CY → 5
2.	Basic Engineering Sciences and Technical Arts	ES	21	EM → 3, BMC → 3, BES → 6 CPPS → 4, ED → 3, WP → 2
3.	Humanities and Social Sciences	HU & HS	7	PC → 4, ECO → 3
4.	Indian Knowledge Systems	IKS	5	HH → 2, OE → 3
5.	Others: Liberal Arts, Innovation & Entrepreneurship	OT	2	LA → 1, IE → 1
6.	Mandatory Learning Courses	MLC	2	PE → 0, ES → 1, PEHV → 1
7.	Department Core	DC	83 - 86	Core Theory and Lab courses, Comprehensive Examination → 1 Seminar → 1, Summer Internship → 1 Project Work → 5
8.	Department Elective: (including MOOCs or any other as approved by the Institute)	DE	21 - 27	7-9 Electives
9.	Open Elective: (including MOOCs or any other as approved by the Institute)	OE	0 - 6	Upto 2 Open Electives
Total Credits			**168**	
10.	Minor Program	MR	18	

1.2 Semester-wise Credits Distribution

Sl No.	Year	Semester-wise Credit		Year-wise Credit
		Semester	Credits	
1.	First Year	I	23	46
		II	23	
2.	Second Year	III	22	45
		IV	23	
3.	Third Year	V	23	46
		VI	23	
4.	Fourth Year	VII	19	31
		VIII	12	
Total Credits				**168**

1.3 Overall Scheme of B. Tech. Programme (EEE)

Table 1.1: Four-Year BTech (EEE) Scheme

First Year				**Second Year**				**Third Year**				**Fourth Year**			
Odd (I) Semester		Even (II) Semester		Odd (III) Semester		Even (IV) Semester		Odd (V) Semester		Even (VI) Semester		Odd (VII) Semester		Even (VIII) Semester	
Subject Name	C	Subject Name	C	Subject Name	C	Subject Name	C	Subject Name	C	Subject Name	C	Subject Name	C	Subject Name	C
Matrices and Advanced Calculus	4	Differential Equations and Vector Calculus	4	Probability, Statistics and Complex Analysis	3	Innovation and Entrepreneurship	1	Environmental Studies	1	Professional Ethics and Human Values	1	Industrial Economics	3	Elective - VIII	3
Engineering Physics	3	Engineering Chemistry	3	Circuit Theory	4	Signals and Systems	3	Power Electronics	3	Electrical System Design	3	Elective - IV	3	Elective - IX	3
Basics of Electrical Engineering	2	Basics of Electronics Engineering	2	Electromagnetic Fields	3	Electrical Machines - I	3	Electrical Machines - II	3	Electrical Drives	3	Elective - V	3	Elective-X	3
Engineering Mechanics	3	Professional Communication	4	Analog and Integrated Circuits	3	Digital Systems	3	Power Systems - I	4	Power Systems - II	4	Elective - VI	3		
Computer Programming and Problem Solving	3	Basics of Mechanical and Civil Engineering	3	Electrical and Electronic Measurement	3	Control Systems	4	Microprocessor and Microcontroller	3	Elective - II (IKS)	3	Elective - VII	3		
Liberal Arts	1	Health and Happiness	2			Computational Methods	3	Elective - I	3	Elective - III	3				
Engineering Physics Laboratory	2	Engineering Chemistry Laboratory	2	Simulation Lab	2	Electrical Machine Laboratory - I	2	Electrical Machine Laboratory - II	2	Power Electronics and Drives Laboratory	2	Major Project - I	2	Major Project - II	3
Basics of Electrical Engineering Lab.	1	Basics of Electronics Engineering Lab.	1	Electrical and Electronic Measurement Lab	2	Analog and Digital Circuit Laboratory	2	Microprocessor Lab.	2	Power System Laboratory	2	Summer Project or Industrial Training	1		
Engineering Drawing	3	Workshop Practices	2	Tinkering Lab - I	2	Control System Laboratory	2	Tinkering Lab - II	1	Electrical and Electronic Design Laboratory	2	Comprehensive Examination	1		
Computer Programming Lab	1	Physical Education	0					Seminar	1						
Total Credits	23	Total Credits	23	Total Credits	22	Total Credits	23	Total Credits	23	Total Credits	23	Total Credits	19	Total Credits	12
Total Credits : 168															

1.4 Second Year B. Tech. Programme

Table 1.2: Third Semester Course

Sl No	Course Code	Course Name	Course Type	Nature of Course	L - T - P	Credit
1	MA203	Probability, Statistics and Complex Analysis	BS	Theory	2-1-0	3
2	EE200	Circuit Theory	DC	Theory	3-1-0	4
3	EE201	Electromagnetic Fields	DC	Theory	3-0-0	3
4	EE202	Analog and Integrated circuits	DC	Theory	3-0-0	3
5	EE203	Electrical and Electronics Measurements	DC	Theory	3-0-0	3
6	EE204	Simulation Lab	DC	Practical	0-0-3	2
7	EE205	Electrical and Electronics Measurements Lab	DC	Practical	0-0-3	2
8	EE206	Tinkering Lab - 1	DC	Practical	0-0-3	2
Total Credits						22

Table 1.3: Fourth Semester Course

Sl No	Course Code	Course Name	Course Type	Nature of Course	L - T - P	Credit
1	IE250	Innovation & Entrepreneurship	OT	Theory	1-0-0	1
2	EE250	Signals and Systems	DC	Theory	3-0-0	3
3	EE251	Electrical Machines - I	DC	Theory	3-0-0	3
4	EE252	Digital Systems	DC	Theory	3-0-0	3
5	EE253	Control Systems	DC	Theory	3-1-0	4
6	EE254	Computational Methods	DC	Theory cum Practical	2-0-2	3
7	EE255	Electrical Machines - I Lab	DC	Practical	0-0-3	2
8	EE256	Analog and Digital circuit Lab	DC	Practical	0-0-3	2
9	EE257	Control System Lab	DC	Practical	0-0-3	2
Total Credits						23

Part I

Course Content : Core Courses

Chapter 2

Third Semester Courses:

2.1 Probability, Statistics and Complex Analysis

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
MA203	Probability, Statistics and Complex Analysis	Theory	2 - 1 - 0	3	42

2.1.1 Objectives:

The objectives of studying this course are,

1. to provide a comprehensive grasp of probability, random variables, statistics and complex analysis.
2. to help to develop a deep understanding of applied mathematics.
3. to correlate the knowledge with its real time applications.

2.1.2 Course Outcome:

At the completion of this course, the student shall acquire knowledge and ability

1. CO1 : to grasp a solid comprehension of probability distributions and apply them to address challenging engineering problems.
2. CO2 : to comprehend the significance and analytical solving methods for statistical and their applications in communication engineering problems.
3. CO3 : to grasp the fundamentals of complex variables, complex functions, and the processes of complex differentiation and integration.

2.1.3 CO - PO Mapping:

Relationship of Course Outcomes to Program Outcomes												
CO ↓	**PO**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M			L	L	M		H
CO2	H	H	H	H	H			L	L	M		H
CO3	H	H	H	H	H			L	L	M		H
H = High correlation; M = Medium correlation; L = Low correlation												

2.1.4 Syllabus:

Module 1: **Elements of Probability:** Introduction to Probability, Sample Space and Events, Probabilities Defined on Events, Conditional Probabilities, Independent Events; Total Probability, Bayes' Formula.

Module 2: **Random Variables and Distribution:** Random Variables: Concept of Random Variables, Distribution and Density Function, Jointly Distributed Random of Variables, Conditional and Joint Density Distribution function, Function of Random Variables, Expected Value: Mean, Variance and moments of random variable, Joint moments, conditional expectation, covariance and correlation, Some special distributions: Uniform and Gaussian distributions, Bernoulli, Binomial, and Poisson distributions.

Module 3: **Statistics:** The Sample Mean, The Central Limit Theorem, The Sample Variance, Sampling Distributions from a Normal Population, Sampling from a Finite Population, Parameter Estimation, Maximum Likelihood Estimators, Interval Estimates; Estimating the Difference in Means of Two Normal Populations, Hypothesis Testing, Significance Levels, Tests Concerning the Mean of a Normal Population, Testing the Equality of Means of Two Normal Populations, Hypothesis Tests Concerning the Variance of a Normal Population, Hypothesis Tests in Bernoulli Populations, Tests Concerning the Mean of a Poisson Distribution, Regression (Basic concepts only).

Module 4: **Complex Analysis:** Complex Numbers, geometric representation, powers and roots of complex numbers, Functions of a complex variable, Analytic functions, Cauchy-Riemann equations; elementary functions, Conformal mapping (for linear transformation); Contours and contour integration, Cauchy's theorem, Cauchy integral formula; Power Series and properties, Taylor series, Laurent series, Zeros, singularities, poles, essential singularities, Residue theorem, Evaluation of real integrals and improper integrals.

2.1.5 Learning Resources:

2.1.5.1 Text Books:

1. E Kreyszig, "Advanced engineering mathematics", Wiley India Pvt. Ltd., 2006 (8^{th} Ed.)

2.1.5.2 Reference Books:

1. S M Ross, "Stochastic Processes", Wiley India Pvt. Ltd., 1995 (2^{th} Ed.)
2. S M Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Academic Press, 2021 (6^{th} Ed.)
3. S M Ross, "Introduction to Probability Models", Academic Press, 2014 (11^{th} Ed.)
4. R V Churchill and J W Brown, "Complex variables and applications", McGraw Hill Higher Education, 2003 (7^{th} Ed.)

2.2 Circuit Theory

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE200	Circuit Theory	Theory	3 - 1 - 0	4	56

2.2.1 Objectives:

The objectives of studying this course are,

1. to understand and analyse electrical circuits in both time and frequency domain.
2. to apply techniques learned in pure science courses (physics and mathematics) for solving electrical circuits.
3. to understand the similarity between electrical circuits with other linear systems.
4. to evaluate circuits using appropriate techniques based on the nature of the problem.
5. to get introduced with circuits used in engineering applications.

2.2.2 Course Outcome:

At the completion of this course, the student shall acquire knowledge and ability

1. CO1 : to analyse dynamic and steady state response of electrical circuits in time domain.
2. CO2 : to analyse dynamic and steady state response of electrical circuits in frequency domain.
3. CO3 : to apply circuit analysis techniques in different engineering systems.
4. CO4 : to evaluate electrical circuits using appropriate techniques based on the nature of problem.

2.2.3 CO - PO Mapping:

Relationship of Course Outcomes to Program Outcomes												
CO ↓	**PO**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M			L					M		
CO2	H	M			L					M		
CO3	H	M	M		L							L
CO4	H	M	M		L							L
H = High correlation; M = Medium correlation; L = Low correlation												

2.2.4 Syllabus:

Module 1: **Analysis of circuits and two port networks:** Review of circuits, Circuits with Linear Dependent Sources:- nodal analysis and mesh analysis – super node and super mesh-effect on the symmetry of nodal admittance matrix and mesh impedance matrix- Two Port Networks: characterization and inter relationships among parameter sets- Interconnection of Two port networks – Applications: feedback systems, transmission lines etc.

Module 2: **Steady-state analysis of three-phase circuits:** Review of network theorems for ac circuits, Polyphase working - 3 phase a.c systems - balanced and unbalanced system - Power concepts in three phase systems– symmetrical transformation – sequence components – power in sequence components. Dependent source equivalent circuits for coupled coils – steady-state analysis of coupled coils – two-winding transformer.

Module 3: **Circuit Analysis in Time-domain and s-domain:** Time Domain Analysis of Circuits: Solution of circuits by differential equation method - Determination of initial conditions– Laplace Transform and its properties - Solution of Differential Equations – s-domain Analysis of Circuits - Solution of circuits with mutual inductance. Generalization of Circuit theorems – Input and transfer immittance functions - Transfer functions - Impulse response and Transfer function- Poles and Zeros - Pole Zero plots – Stability and poles.

Module 4: **Sinusoidal Steady - State Frequency Response:** Frequency response: Properties - frequency response from s-domain transfer functions - Frequency response of first order circuits – filters, integrator, differentiator, signal coupling circuit etc. – frequency response for second order functions. Fourier series-Fourier Coefficients and its determination-Waveform Symmetry-Exponential Fourier Series - Discrete Amplitude and Phase Spectra – Applications: LC filters in Power Systems and power supplies, parallel RLC circuit in Communication circuits.

2.2.5 Learning Resources:

2.2.5.1 Text Books:

1. M E Van Valkenburg, "Network Analysis," Pearson Education, India, 2010 (3^{rd} Ed.)
2. W H Hayt, J E Kemmerly, S Durbin and J Phillips, "Engineering Circuit Analysis," McGraw Hill Education, 2012 (6^{th} Ed.)
3. C K Alexander and M N O Sadiku, "Fundamentals of Electric Circuits," McGraw Hill Education, 2022 (7^{th} Ed.)

2.2.5.2 Reference Books:

1. J D Ryder, "Networks, Lines and Fields," Prentice Hall India, 1989 (2^{nd} Ed.)
2. R C Dorf and J A Svoboda, "Introduction to Electric Circuits," John Wiley & Sons, 2004 (6^{th} Ed.)

2.3 Electromagnetic Fields

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE201	Electromagnetic Fields	Theory	3 - 0 - 0	3	42

2.3.1 Objectives:

The objectives of studying this course are,

1. to learn the fundamental concepts in Electromagnetic field.
2. to understand the Maxwell's equations and its applications.
3. to apply the principles of Electromagnetic Field Theory for the design and analysis of Power Transmission lines.

2.3.2 Course Outcome:

At the completion of this course, the student shall acquire knowledge and ability

1. CO1 : to familiarize with the electromagnetic field and its applications in electrical engineering.
2. CO2 : to understand the basic concept on electromagnetic field.
3. CO3 : to apply knowledge of vector calculus to describe Electric and Magnetic fields.
4. CO4 : to analyse the time varying fields using Maxwell's equations.
5. CO5 : to develop the concept behind Electrical machines and transmission lines.

2.3.3 CO - PO Mapping:

Relationship of Course Outcomes to Program Outcomes												
CO ↓	**PO**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H									
CO2	H	H	H									
CO3	H	H	H									
CO4	H	H	H	M	M							
CO5	H	H	H	M								L
H = High correlation; M = Medium correlation; L = Low correlation												

2.3.4 Syllabus:

Module 1: **Electrostatics:** Charge and Electric Forces, Electric Fields, Electric Dipoles, Continuous Charge Distributions, Gauss's Law, Electric Potential Difference, Work and Potential Energy, Conductors and Insulators, Dielectrics and Capacitors, Capacitors in Circuits.

Module 2: **Magnetic Fields and Forces:** Magnetic Fields and the Lorentz Equation, Biot-Savart and Force on a Wire, Magnetic Dipoles, Force and Torque on Magnetic Dipoles, Ampere's Law, Symmetries for Using Ampere's Law.

Module 3: **Maxwell's Equations:** Faraday's Law, Lenz's Law, Induced Electric Field, Inductors, Energy in Inductors, Displacement Current, Solution to Maxwell's Equations, Maxwell's Equations in Differential Form, Poynting Vector, Radiation Pressure, Momentum, and Power.

Module 4: **Transmission Lines:** Equations of current and voltage, Standing waves and impedance transformation, Power transfer on a transmission line, Loss-less and low-loss transmission lines, Discontinuity, Bounce diagram and Digital transmission lines.

2.3.5 Learning Resources:

2.3.5.1 Text Books:

1. W H Hayt, J A Buck and M J Akhtar, "Engineering Electromagnetics," McGraw Hill Education, 2017 (8^{th} Ed.)
2. M Sadiku and S V Kulkarni, "Elements of Electromagnetics", Oxford University Press, 2015, (6^{th} Ed.)

2.3.5.2 Reference Books:

1. John Kraus and Daniel Fleisch, "Electromagnetics with Applications," McGraw Hill Education, 2017 (5^{th} Ed.)
2. S M Ross and N N Rao, "Elements of Engineering Electromagnetics," Pearson Education, 2006 (6^{th} Ed.)

2.4 Analog and Integrated Circuits

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE202	Analog and Integrated Circuits	Theory	3 - 0 - 0	3	42

2.4.1 Objectives:

The objectives of studying this course are,

1. to analyze and design Circuits using MOSFET and op-amps.
2. to develop the applications using Op-Amps and special Integrated circuits.
3. to design and analyze various types of ADCs, DACs, and various applications using 555 timer.

2.4.2 Course Outcome:

At the completion of this course, the student shall acquire knowledge and ability

1. CO1 : to understand current mirrors, different MOSFET amplifier configurations and the frequency response of MOSFET.
2. CO2 : to describe the various ideal and practical characteristics of an op-amp.
3. CO3 : to design and analyze different op-amp circuits and other ICs for various applications.
4. CO4 : to analyse and design various types of ADCs and DACs and develop various application circuits using 555 timer.

2.4.3 CO - PO Mapping:

Relationship of Course Outcomes to Program Outcomes												
CO ↓	**PO**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	M	L						M
CO2	H	H	M	L								M
CO3	H	H	H	M	M	L						M
CO4	H	H	M	M	M							M
H = High correlation; M = Medium correlation; L = Low correlation												

2.4.4 Syllabus:

Module 1: **MOSFET Amplifiers:** Analysis and design of different configurations, thermal runway in MOS amplifiers, cascade stages and current mirrors, MOS differential pair, small and large signal analysis, differential pair with active loads, feedback amplifier, Oscillators.

Module 2: **Operational amplifiers:** Ideal and practical op-amps, concept of negative feedback and virtual ground, parameters of op-amps, inverting and non-inverting configurations, voltage to current converter, current to voltage converter, summing amplifier, differential amplifier, instrumentation amplifier.

Module 3: **Applications of op-amps:** Schmitt trigger, comparators, integrators, differentiators, peak detectors, sample and hold circuit, precision rectifier, generation of sine wave, triangular wave, sawtooth wave, Active filters.

Module 4: **Other Integrated circuits:** Timer circuits, IC 555 timer and its applications, astable and monostable multivibrator, saw-tooth wave generator, voltage regulators, VCO, phase locked loop, A/D and D/A converters, Oscillators.

2.4.5 Learning Resources:

2.4.5.1 Text Books:

1. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits," McGraw Hill Education, 2017 (3^{rd} Ed.)

2.4.5.2 Reference Books:

1. Ramakanth A. Gayakwad, "Op-Amps and Linear Integrated Circuits," Pearson Education, 2015 (4^{th} Ed.)
2. A S Sedra, K C Smith and Arun N. Chandorkar, "Microelectronic Circuits: Theory And Applications", Oxford University Press, 2017 (7^{th} Ed.)
3. Thomas L. Floyd, "Electronic Devices", Pearson Education Limited, 2013 (9^{th} Ed.)
4. Behzad Razavi, "Fundamentals of Microelectronics", John Wiley & Sons, 2021 (3^{rd} Ed.)

2.5 Electrical and Electronics Measurement

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE203	Electrical Measurements and Instrumentation	Theory	3 - 0 - 0	3	42

2.5.1 Objectives:

The objectives of studying this course are,

1. to understand the analog and digital measuring instruments.
2. to study principles, working, mathematical relation characteristics, advantages and limitations of various sensors and transducers.
3. to select appropriate sensor/transducer for specific application.

2.5.2 Course Outcome:

At the completion of this course, the student shall acquire knowledge and ability

1. CO1 : to understand the working principle of analog and digital measuring instruments.
2. CO2 : to define, list and analyse performance characteristic of different sensors and transducers for various applications.
3. CO3 : to analyze the operation and usage of oscilloscopes, detectors, alarms/annunciators for practical applications.
4. CO4 : to develop prototype for effective implementation of Instrumentation based system at zero level.

2.5.3 CO - PO Mapping:

Relationship of Course Outcomes to Program Outcomes												
CO ↓	**PO**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	L	L	L	L	L	L	L	M
CO2	H	H	H	H	M	L	L	L	L	L	L	M
CO3	H	H	H	M	L	L	L	L	L	L	L	M
CO4	H	H	H	H	M	L	L	L	L	L	M	M
H = High correlation; M = Medium correlation; L = Low correlation												

2.5.4 Syllabus:

Module 1: **Measuring Instruments:** Introduction to measurement system, block diagram of measurement system, Static and dynamic characteristics of an instrument, selection criteria for instruments, error and error analysis in measurements, Measurement standards, Classification, Electromechanical Instruments–deflecting, control and damping torques–Ammeters and Voltmeters– PMMC, moving iron type instruments, electrodynamometer type instruments.

Module 2: **Measurement of RLC, Power and Energy:** Measurement of resistance, inductance and capacitance using DC and AC bridges, Q meter, Dynamometer and induction instruments, kVAh and kVARh meters, Instrument transformers – Current and Potential transformers, Potentiometers.

Module 3: **Electronic Instruments:** Electronic multimeter, Digital voltmeters, ramp type voltmeter, quantization error, digital frequency meter/timer, distortion meter, wavemeter and spectrum analyzer, Digital Storage Oscilloscopes.

Module 4: **Sensors and Transducers:** Calibration and standards, classification, selection criterion, measurement of temperature, flow, pressure, level, displacement, specifications of transducers, optical sensors, opto-couplers, Hall effect sensor, LEM Current and Voltage Sensors, Rogowski coil, leak detector, flame detector, smoke detector, humidity, sound sensors, signal conditioning, Introduction to alarms and annunciators.

Module 5: **Smart and MEMS sensors:** Principles of smart sensing, classification and terminology of smart sensors. MEMS (Piezoresistive, capacitive, conductive, optical), Introduction to sensor modelling, IC based sensors, Case study on Instrumentation System Design with any one transducer.

2.5.5 Learning Resources:

2.5.5.1 Text Books:

1. A K Sawhney, "Electrical and Electronic Measurements and Instrumentation", Dhanpath Rai & Co., 2023
2. E O Doebelin, "Measurement Systems", McGraw Hill, 1990 (4^{th} Ed.)

2.5.5.2 Reference Books:

1. E W Golding, "Electrical Measurements & Measuring Instruments", Reem Publications, 2019 (6^{th} Ed.)
2. Kalsi H S, "Electronic Instrumentation", Tata McGraw Hill, 2019 (4^{th} Ed.)
3. David A. Bell, "Electronic Instrumentation and Measurements" Oxford University Press, 2013 (3^{rd} Ed.)
4. Bowens A J, "Digital Instrumentation", Tata McGraw Hill, 1996.
5. Cooper, "Electronic Instrumentation And Measurement Techniques", Prentice Hall, 1985
6. Rangan C S, "Instruments Devices And System", Tata McGraw Hill, 1998
7. V K Aatre, G K Ananthasuresh, K J Vinoy, S Gopalakrishnan, K N Bhat , "Micro and Smart Systems", Willey India Publiser, 2010

2.6 Simulation Laboratory

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE204	Simulation Laboratory	Theory	0 - 0 - 3	2	42

2.6.1 Objectives:

The objectives of studying this course are,

1. to understand basic block sets of different simulation platform used in electrical/electronic circuit design.
2. to understand use and coding in different software tools used in electrical/ electronic circuit design.
3. to understand the simulation of electric/electronic circuits for performance analysis.

2.6.2 Syllabus:

Module 1: **Introduction:** Introduction to basic matrix operations and generation of various signals & sequences using a suitable Simulation Platform.

Module 2: Using the suitable simulation platform,

1. Verify Mesh and Nodal analysis to find branch voltages and currents.
2. Verify various network theorems.
3. Analyse single–phase series and parallel AC circuits using R-L, R-C and R -L-C elements.
4. Simulate transient response of RLC Circuit to an input (i) Step, (ii) Pulse and (iii) Sinusoidal signals.
5. Simulate half wave and full wave bridge rectifiers with R-L, R-C and R-L-C Loads.
6. Verify the truth tables of basic gates.
7. Design the NAND and NOR gates as universal logic gates.
8. Simulate the Integrator and Differentiator circuits using OP-AMP.
9. Design and verify the truth tables of Half and Full adder circuits.
10. Design and verify the truth tables of Half and Full subtractor circuits.

2.7 Electrical and Electronics Measurement Lab

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE205	Electrical and Electronics Measurement Lab	Theory	0 - 0 - 3	2	42

2.7.1 Objectives:

The objectives of studying this course are,

1. to To be familiar with basic control configurations and also to be competent in mathematical modelling of physical systems and analyze their time and frequency response.
2. to understand the tools for the stability analysis of the closed loop system.
3. to understand the tuning of P, PI and PID controller.

2.7.2 Syllabus:

Module 1:

1. (a) Loading effects of Potentiometer.
   (b) Calibration of Voltmeters and Ammeters using Potentiometers.
2. (a) Measurement of Low Resistance by Kelvin's Double Bridge Method.
   (b) Measurement of resistance by Wheatstone bridge method.
3. Measurement of Self Inductance and Capacitance using Bridges.
4. Measurement of Power and Power Factor using wattmeter method.
5. Study of DSO control panel, its specifications. Find time constant of a relay using DSO.

Module 2:
(Any Three)

6. (a) Measurements using proximity sensors.
   (b) Characterize the Hall Effect sensor.
   (c) Characterize the temperature sensors (RTD, Thermocouple).
7. (a) Measurement of level in a tank using capacitive type level probe.
   (b) Measurement of pressure and displacement.
   (c) Measurement of strain and torque using strain gauges.
8. (a) Study of Opto-coupler using photoelectric transducers.
   (b) Characteristics of Micro pressure and Micro accelerometer sensing device.
9. (a) Study of Detectors (leak detector, flame detector, smoke detector etc.).
   (b) Study of smart transmitters.
   (c) Design of alarms and annunciators.
10. Signal Conditioning for any one transducer.

Module 3:

11. PCB design for any one signal conditioning application.
12. Enclosure design for circuit and measurement.
13. Simulation of Instrumentation System Design Using real-time suitable software.

2.8 Tinkering Lab - I

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE206	Tinkering Lab - I	Practical	0 - 0 - 3	2	42

2.8.1 Objectives:

The objectives of studying this course are,

1. to encourage the spirit of curiosity and innovation among young minds.
2. to gain hands-on experience by do-it-yourself (DIY) mode, learn from failures and acquire new skills.
3. to do studio projects based on the latest technology-based applications.

2.8.2 Syllabus:

Module 1: **Introduction:** Workshop attire briefing. Electric safety rules and unsafe practices. Precautions and first aid practices. Introduction to tools, electrical materials, meters, symbols and abbreviations

Module 2:

1. Basic Wiring
2. Control a fan using electronic regulator/calling bell/ buzzer/ alarm
3. Meter board for lighting installation using energy meter, fuse, Main Circuit Breaker (MCB), Double Pole (DP) switch, Earth-leakage circuit breaker (ELCB), open circuit, short circuit, polarity, insulation resistance and earth fault and indicator
4. Preparing an electrical extension board
5. Soldering exercise.
6. PCB Design.
7. UPS/Inverter Wiring.
8. Winding an Inductor of specified rating.
9. Earthing analysis .
10. Testing of Motors, Cables, Power Capacitors, Batteries, etc.
11. Arduino based projects .
12. Studio projects on state-of-art technologies. Ex: Drones, IoT applications, Robotics, Mobile technology, etc

Chapter 3

Fourth Semester Courses:

3.1 Innovation & Entrepreneurship

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
IE250	Innovation & Entrepreneurship	Theory	1 - 0 - 0	1	14

3.1.1 Objectives:

The objectives of studying this course are,

1. to introduce to a project-based learning approach from Ideation to Innovation and Entrepreneurship will be the key process considered here.
2. to learn the essential concepts of innovation and entrepreneurship through hands-on activities and the best and most relevant practical examples.
3. to provide the tools necessary for starting independent innovation and businesses.
4. give students practical experience in market survey, commercialization, IPR and proactively work in projects in risky market environments.

3.1.2 Course Outcome:

At the completion of this course, the student shall acquire knowledge and ability

1. CO1 : to comprehend the basic theories and concepts that underlie a survey study of Innovation, Entrepreneurship and Social Business/ Entrepreneurship.
2. CO2 : to understand how to generate good large company or startup business ideas / societal ideas, and refine these ideas, to substantially increase chances for success in the marketplace.
3. CO3 : to get exposed to the thoughts and strategies of some very effective real-life innovators and entrepreneurs through videos and small cases.
4. CO4 : to understand about IPR, prototyping and financial management.

3.1.3 CO - PO Mapping:

Relationship of Course Outcomes to Program Outcomes												
CO ↓	**PO**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	H	L	H	M	H	H	L	H	H	H	H
CO2	L	H	L	H	H	H	H	L	H	H	H	H
CO3	L	H	L	H	H	H	H	L	M	H	H	H
CO4	L	H	L	H	H	H	H	H	L	L	H	H
H = High correlation; M = Medium correlation; L = Low correlation												

3.1.4 Syllabus:

Module 1: **Introduction:** Creative thinking, blocks to creativity, factors that influence creative design, engineering design and creative design, influence of society, market pull & technology push, attribute of a creative person Three levels of Design - Viceral, Behavioral and Reflective design. Qualities and skills required for entrepreneurship, Functions of an entrepreneur, Importance of entrepreneur in economic development

Module 2: **Ideas for Entrepreneurship:** Need or identification of a problem, market survey, data collection, review & analysis, problem definition, challenge statement, problem statement initial specifications, Brain storming, analogy technique or Synectic, check list, trigger words, morphological method, interaction matrix method, analysis of interconnected decision making.

Module 3: **Theory of Inventive Problem Solving (TRIZ):** 20 key TRIZ principles – multifunction, compensation, nested doll, blessing in disguise, segmentation, separation, symmetry change, opaque & porous, inflate and deflate, recycle & recover, phase transformation, energy, imaging, environment, composition, economical, surface response, static & dynamic, continuous & intermittent, dimensions.

Module 4: **Product Design, IPR & Finance:** Detail design, prototyping, product deployment, useful life assessment and recycling and sustainability; patent act, patent laws, Types of entrepreneurs- Based on type of business, based on use of technology, based on motivation, based on stages of development, based on motive, Based on capital ownership, Business Plan, Finance and Funding.

3.1.5 Learning Resources:

3.1.5.1 Text Books:

1. C B Gupta and N P Srinivasan, "Entrepreneurial Development", Sultan Chand and Sons, 2020

3.1.5.2 Reference Books:

1. Floyd Hurt, "Rousing Creativity: Think New Now", Crisp Publications Inc., 1999
2. Kalevi Rantanen and Ellen Domb, "Simplified TRIZ", Auerbach Publications, Taylor & Francis Group, 2010 (2^{nd} Ed.)
3. John Adair, "The Art of Creative Thinking", Kogan Page Publication, 2011

3.2 Signals and Systems

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE250	Signals and Systems	Theory	3 - 0 - 0	3	42

3.2.1 Objectives:

The objectives of studying this course are,

1. to understand the characteristics of both continuous-time and discrete-time signals and systems.
2. to analyse electrical network in both the time and transform domains.
3. to provide the foundation to other courses that deal with signals and systems theory.

3.2.2 Course Outcome:

At the completion of this course, the student shall acquire knowledge and ability

1. CO1 : to understand the mathematical description and representation of continuous-time and discrete-time signals and to classify systems based on properties.
2. CO2 : to analyze the spectral characteristics of continuous-time and discrete-time periodic and aperiodic signals using Fourier analysis.
3. CO3 : to analyse system properties based on impulse response and Fourier analysis in continuous-time and discrete-time domain.
4. CO4 : to convert a continuous time signal into discrete time signal and reconstruct the continuous time signals back from its samples.
5. CO5 : to apply the Laplace transform and Z- transform respectively for the analysis of continuous time and discrete-time signals.

3.2.3 CO - PO Mapping:

Relationship of Course Outcomes to Program Outcomes												
CO ↓	**PO**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	L							M
CO2	H	H	H	H	L							M
CO3	H	H	H	M	L							M
CO4	H	H	H	H	L							M
CO5	H	H	H	H	L							M
H = High correlation; M = Medium correlation; L = Low correlation												

3.2.4 Syllabus:

Module 1: **Introduction to CT Signals and Systems:** Continuous-time signals, transformation of independent variables, some signals of importance: unit step, unit impulse, sinusoid, complex exponential etc., Classification of signals, Operations on Signals, Systems and its properties (linearity, shift-invariance, causality, stability etc.) with examples.

Module 2: **Analysis of CT signals and Systems in Time-domain:** Impulse response and step response of continuous-time linear time invariant systems, Convolution integral, characterization of causality and stability of linear time-invariant systems, system representation using differential equations with electrical networks, Analysis of Electrical circuits (First order and Second Order Circuits) using Laplace transform, state space representation in Laplace transform.

Module 3: **Analysis of CT signals and Systems in Frequency-domain:** Fourier Transform and its properties, magnitude and phase response computation for electrical networks, Fourier domain duality, harmonic analysis of simple electrical networks.

Module 4: **Sampling and Reconstruction:** Sampling theorem, Aliasing, Quantization, reconstruction of band limited signals, discrete-time signals and systems, difference equation, convolution sum, auto-correlation and cross-correlation.

Module 5: **Analysis of DT signals and systems in Frequency domain:** Z-transform and inverse Z-transform for some typical signals, solution of difference equation, stability analysis in z-domain. Discrete-time Fourier series and its properties, Discrete-time Fourier transform and its properties, applications of signals and system theory.

3.2.5 Learning Resources:

3.2.5.1 Text Books:

1. Alan V Oppenheim, Alan S Willsky and S Hamid Nawab, "Signals and Systems", Prentice Hall, 1983
2. Simon Haykin and Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, 1998

3.2.5.2 Reference Books:

1. M E Van Valkenberg, "Network Analysis", PHI Learning Publications, 2014 (3^{rd} Ed.)
2. B P Lathi, "Signal Processing and Linear Systems", Oxford University Press, 1998

3.3 Electrical Machines - I

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE251	Electrical Machines - I	Theory	3 - 0 - 0	3	42

3.3.1 Objectives:

The objectives of studying this course are,

1. to review the concepts of magnetic circuit fundamentals.
2. to have a comprehensive idea on electromechanical energy conversion.
3. to understand the working of transformers , DC and induction machines
4. to analyze the equivalent circuit model and performance characteristics of the electrical machines.

3.3.2 Course Outcome:

At the completion of this course, the student shall acquire knowledge and ability

1. CO1 : to familiarize the application of magnetic circuit fundamentals in the working of electrical machines.
2. CO2 : to understand the electromechanical energy conversion phenomenon in electrical machines.
3. CO3 : to understand how the transformers and rotating machines work.
4. CO4 : to analyze the equivalent circuit model of the machines.
5. CO5 : to analyze the performance characteristics of the machines.

3.3.3 CO - PO Mapping:

Relationship of Course Outcomes to Program Outcomes												
CO ↓	**PO**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2	M		L									
CO3	H	H										
CO4	M	H		M	M							
CO5	M	H		M								L
H = High correlation; M = Medium correlation; L = Low correlation												

3.3.4 Syllabus:

Module 1: **Basic Concepts:** Review of Magnetic Circuits, Flux, MMF, EMF, Force, exciting current, Hysteresis and eddy current loss, Sinusoidal excitation- Review of three phase AC circuits-Concept of Field energy and Co energy, Mechanical force in electromagnetic system- Linear and rotational, Rotating machines, Cylindrical machines, Concentrated and Distributed Winding – Winding factors-MMF distribution in windings, Pulsating and Rotating magnetic field, space and time harmonics, EMF generation, Torque Production.

Module 2: **DC Machines:** Classification of DC machines, Armature windings, EMF, Armature Reaction, Electromagnetic torque, Characteristic curves for DC machines, Losses and Efficiency , Speed control of DC motors, Braking of DC motors, PMDC motors

Module 3: **Transformer:** Single phase: Working principle, Ideal and practical transformer, Per unit concept Equivalent circuit and phasor diagrams, Determination of Equivalent circuit parameters, Voltage regulation, losses and efficiency, Tests on Transformer, Auto transformer, Distribution transformers. Three phase: Three phase winding connections, Vector grouping, Three winding transformers, Tap changing of transformers.

Module 4: **Induction Machines:** Introduction ,Modes of operation, Equivalent circuit model, Analysis of equivalent circuit- Torque-slip and Power slip characteristics, Determination of equivalent circuit parameters, Performance characteristics, Powerflow, Circle diagram, Starting methods of Induction motors, Speed control of induction motors

3.3.5 Learning Resources:

3.3.5.1 Text Books:

1. A E Fitzgerald, C Kingsley and S D Umans, "Electrical Machinery," Tata McGraw Hill, 2003 (6^{th} Ed.).
2. AE Clayton and NN Hancock, "Performance & Design Of DC Machines," CBS, 2001 (3^{rd} Ed.).
3. P C Sen, "Principles of Electric Machines," Wiley India Pvt Ltd., 2020 (3^{rd} Ed.).

3.3.5.2 Reference Books:

1. S J Chapman, "Electric Machinery Fundamentals," McGraw Hill, 2010 (4^{th} Ed.).
2. I J Nagarath and D P Kothari, "Electric Machines," Tata McGraw Hill, 2010 (4^{th} Ed.).
3. P S Bimbhra, "Electrical Machinery," Khanna Publishers, 2008 (7^{th} Ed.).

3.4 Digital Systems

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE252	Digital Systems	Theory	3 - 0 - 0	3	42

3.4.1 Objectives:

The objectives of studying this course are,

1. to design combinational and sequential digital circuits.
2. to study state machines for the design of digital systems.
3. to familiarize the Verilog concept for the development of digital circuits.

3.4.2 Course Outcome:

At the completion of this course, the student shall acquire knowledge and ability

1. CO1 : to apply the knowledge of Boolean algebra and other minimization schemes to deduce optimal digital circuits.
2. CO2 : to design combinational and sequential circuits for a given problem / case studies related to digital circuits.
3. CO3 : to analyse and develop digital networks using a state diagram.
4. CO4 : to code combinational and sequential circuits using Verilog HDL.

3.4.3 CO - PO Mapping:

Relationship of Course Outcomes to Program Outcomes												
CO ↓	**PO**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M		L						M
CO2	H	H	H	H		L						M
CO3	H	H	H	M		L						M
CO4	H	M	M	M	H				M			M
H = High correlation; M = Medium correlation; L = Low correlation												

3.4.4 Syllabus:

Module 1: Review of Number systems-representation-conversion, error detecting and correcting codes, review on Boolean algebra and logic gates, simplification of logic functions using Karnaugh map, Quine McCaskey method.

Module 2: Combinational logic Circuits: Adders, subtractors, parallel adder, BCD adder, binary multiplier, magnitude comparator, decoders, BCD to 7-segment decoder driver, encoders, priority encoders, code converters, parity generator/checker, multiplexers and de-multiplexers, implementation of logical functions using multiplexers.

Module 3: Sequential circuits, latches and flip-flops: SR-latch, D-latch, D flip-flop, JK flip-flop, T flip-flop, timing hazards and races, edge-triggered flip-flops, register, shift register, universal shift register; application of shift register: ring counter, Johnson counter, sequence generator and detector, up- and down counter, asynchronous ripple counter, synchronous counters, counter design using flip flops, counter design with asynchronous reset or preset; applications of counters.

Module 4: Canonical model of a state machine, types of state machines, state diagram, state table, state assignment, Moore and Mealy model, state minimization, timing a digital circuit, fundamentals of timing analysis, setup and hold time, Read-only memory, read/write memory – SRAM, DRAM, PLAs, PALs, ADC, DACs

Module 5: Introduction to VLSI design-Basic gate design, Design of general Boolean circuits using CMOS gates, Verilog concepts.

3.4.5 Learning Resources:

3.4.5.1 Text Books:

1. M. Morris Mano and Michael D. Ciletti, "Digital Design: With an Introduction to Verilog HDL", Pearson Education India, 2013 (5^{th} Ed.)
2. Wakerly J F, "Digital Design: Principles and Practices", Prentice-Hall, 2022 (2^{nd} Ed.)
3. D. D. Givone, "Digital Principles and Design", Tata Mc-Graw Hill, New Delhi, 2003

3.4.5.2 Reference Books:

1. Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with VHDL Design", McGraw Hill Education, 2017 (3^{rd} Ed.)
2. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, "Digital Systems: Principles and Applications", Pearson Education, 2009 (10^{th} Ed.)
3. Herbert Taub and Donald Schilling, "Digital Integrated Electronics", McGraw Hill Education, 2017
4. T. L. Floyd and Jain, "Digital Fundamentals", Pearson Education, 2003 (8^{th} Ed.)

3.5 Control Systems

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE253	Control Systems	Theory	3 - 1 - 0	4	56

3.5.1 Objectives:

The objectives of studying this course are,

1. to be familiar with basic control configurations and also to be competent in mathematic modelling of physical systems and analyze their time and frequency response.
2. to understand the tools for the stability analysis of the closed loop system.
3. to understand the tuning of P, PI and PID controller.

3.5.2 Course Outcome:

At the completion of this course, the student shall acquire knowledge and ability

1. CO1 : to develop mathematical model for electrical and mechanical systems.
2. CO2 : to compute and analyze the transient and steady state behaviour of the system.
3. CO3 : to analyze the stability of closed loop systems using various tools.
4. CO4 : to design the classical controllers such as P, PI, etc., for electrical systems.

3.5.3 CO - PO Mapping:

Relationship of Course Outcomes to Program Outcomes												
CO ↓	**PO**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	L	L	L	L	L	L	L	L	M
CO2	H	H	H	M	L	L	L	L	L	L	L	M
CO3	H	H	H	M	L	L	L	L	L	L	L	M
CO4	H	H	H	M	L	L	L	L	L	L	L	M
H = High correlation; M = Medium correlation; L = Low correlation												

3.5.4 Syllabus:

Module 1: **Mathematical Modelling:** Open loop and closed loop systems, mathematical modelling of physical systems, transfer functions, block diagram and Signal flow graph representation and Analysis of System, feedback characteristics of closed loop system. Control system components, Stepper motors, Tacho-generators, DC and AC Servomotors.

Module 2: **Time Response Analysis:** Standard test signals, time response of first and second order systems, steady-state errors and dynamic error coefficients, effect of addition of poles and zeros on response of system.

Module 3: **Concept of stability:** Routh-Hurwitz criterion, Root locus, gain margin and phase margin, effect of addition of poles and zeros on root locus.

Module 4: **Frequency domain Analysis:** Frequency response specifications, frequency and time domain correlation, Bode plot, Polar plot, Nyquist criterion, Compensation Techniques: Response of P, PI, PID controllers, Design of Lead, Lag, Lead-Lag Compensation.

Module 5: **State Space Analysis:** State space model, transfer function from the state space model, Eigen values, Eigen vector and diagonalisation of the state matrix, Jordan canonical form, Computation of state transition matrix, Transformation to phase to variable canonical form, The state diagram, decomposition of digital system, Concept of controllability and observability.

3.5.5 Learning Resources:

3.5.5.1 Text Books:

1. Katsuhiko Ogata, “Modern Control Engineering”, PHI, 5th Edition, 2020
2. M. Gopal, “Control Systems, Principles and Design”, Tata McGraw Hill, 2020

3.5.5.2 Reference Books:

1. I. J. Nagrath M. Gopal, “Control Systems Engineering”, New Age Int., 7th Edition,2021
2. Norman S. Nise, “Control System Engineering”, John Wiley and Sons, Inc, 2018

3.6 Computational Methods

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE254	Computational Methods	Theory cum Practical	2 - 0 - 2	3	56

3.6.1 Objectives:

The objectives of studying this course are,

1. to offer a thorough understanding of numerical methods.
2. to emphasize essential concepts, including numerical solutions for algebraic, transcendental, and differential equations, and explores their practical applications.

3.6.2 Course Outcome:

At the completion of this course, the student shall acquire knowledge and ability

1. CO1 : to gain expertise in numerical solving techniques for single-variable equations and systems of equations, and then apply these principles to address intricate engineering challenges.
2. CO2 : to understanding of the significance of curve fitting, interpolation, numerical differentiation and integration.
3. CO3 : to foster a deep comprehension of the importance of numerically solving ordinary and partial differential equations (ODEs) and explore their wide-ranging applications across diverse fields.
4. CO4 : to develop a profound understanding of the significance of employing numerical methods through the utilization of diverse programming languages.

3.6.3 CO - PO Mapping:

Relationship of Course Outcomes to Program Outcomes												
CO ↓	**PO**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M			L	L	M		H
CO2	H	H	H	H	H			L	L	M		H
CO3	H	H	H	H	H			L	L	M		H
CO4	H	H	H	H	H			L	L	M		H
H = High correlation; M = Medium correlation; L = Low correlation												

3.6.4 Syllabus:

Module 1: **Numerical solution of equations and systems:** Equations in one variable: The Bisection method, Fixed point iteration method; Secant method; Regular-Falsi method; Newton's method and its extensions; Convergence of Newtons's method. System of equations: Jacobi and Gauss-Seidel iterative methods; Sufficient conditions for convergence; Power method to find the dominant eigen value and eigenvector.

Module 2: **Interpolation, Numerical Differentiation and Integration:** Interpolation and Curve fitting: The Lagrange polynomial; Divided differences; Method of least square approximations. Numerical integration: Open and closed Newton-Cotes formula; Gaussian quadrature formula.

Module 3: **Numerical Methods for Differential Equations:** Ordinary Differential Equations: Euler's method; Euler's modified method; Taylor's method and Runge-Kutta method; Multistep methods. Elliptic partial differential equations: Finite difference method for two dimensional equations. Parabolic partial differential equations: Forward difference method, backward difference method and the Crank-Nicolson method for one dimensional equations. Hyperbolic partial differential equations: Central difference method for one dimensional equations.

Module 4: **Lab Experiments: 2 hrs per week**

1. Introduction on a standard simulation platform.
2. Program to solve one variable equation using Bisection, Fixed point, Newton Raphson, Regula-Falsi and Secant methods.
3. Program to solve system of equations using Gauss-Jacobi and Gauss-Seidal Method
4. Program to find dominant eigenvalue using the Power Method
5. Program to fit a curve using method of least square.
6. Program to interpolate using the Lagrange polynomial method.
7. Program to evaluate differentiation and integration.
8. Programs to solve ordinary differential equations using Euler's Method, Taylor's method, R-K method of order four, multistep methods.
9. Programs to solve elliptic equations using the finite difference method.
10. Programs to solve parabolic and hyperbolic equations using the finite difference method.

3.6.5 Learning Resources:

3.6.5.1 Text Books:

1. M K Jain, S R K Iyengar and R K Jain, "Numerical Methods for Scientific and Engineering Computation", New Age Publishers, 2012 (6^{th} Ed.)

3.6.5.2 Reference Books:

1. E Kreyszig, "Advanced engineering mathematics", Wiley India Pvt. Ltd., 2010 (8^{th} Ed.)
2. R L Burden and J D Faires, "Numerical Analysis", Brooks/Cole, 2012 (9^{th} Ed.)
3. G D Smith, "Numerical solution of Partial Differential Equations", Oxford University Press, 1985, (3^{rd} Ed.)
4. M B Patil, M C Chandorkar, V Ramanarayanan and V T Ranganathan, "Simulation of Power Electronic Circuits", Narosa, 2009, (1^{st} Ed.)

3.7 Electrical Machine Lab - I

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE255	Electrical Machine Lab - I	Practical	0 - 0 - 3	2	42

3.7.1 Objectives:

The objectives of studying this course are,

1. to provide an insight into the constructional details of dc machines and transformers with a view for better understanding of their working principles.
2. to test and evaluate the performance of various dc machines, tansformer and induction machines by conducting appropriate experiments.

3.7.2 Syllabus:

1. Determination of B-H curve for ferromagnetic core.
2. Performance Characteristics of DC generator.
3. Performance Characteristics of DC Motor.
4. Speed control of DC shunt Motor.
5. Open circuit and Short circuit test of 1-ph and 3-ph transformer.
6. Direct load test on 1-ph and 3-ph transformer.
7. No Load and Block rotor test on three phase Induction motor.
8. Performance Characteristics of three phase Induction motor.
9. Speed control of Slip ring Induction motor.

3.8 Analog and Digital Circuits Lab

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE256	Analog and Digital Circuits Lab	Practical	0 - 0 - 3	2	42

3.8.1 Objectives:

The objectives of studying this course are,

1. to demonstrate the knowledge of analog and digital circuits.
2. to design various analog and digital circuits.

3.8.2 Syllabus:

1. Characteristics of MOSFET in different configurations.
2. Characteristics of RC oscillator.
3. Adder and subtractor circuits.
4. Multiplexer and Demultiplexer.
5. Counters/registers using flip-flops.
6. Linear applications of op-amps.
7. Non-linear applications of op-amps.
8. Second order low pass, high pass, band pass filters implementation.
9. Monostable, Astable, and bistable multivibrators.
10. Phase locked loop.
11. ADCs and DACs.
12. Verilog/VHDL programing to realize logic gates, sequential and combinational circuits.

3.9 Control System Lab

Course Code	Courses Name	Course Type	L - T - P	Credits	Total Hours
EE257	Control System Lab	Practical	0 - 0 - 3	2	42

3.9.1 Objectives:

The objectives of studying this course are,

1. to demonstrate the knowledge of simulation tools for control system design.
2. to develop the mathematical model of a given physical system by conducting appropriate experiments.
3. to analyse the performance and stability of physical systems using classical and advanced control approaches.
4. to design controllers for physical systems to meet the desired specifications.

3.9.2 Syllabus:

1. Simulation of various control systems tools using suitable software.
2. Study of DC servo motors and Synchro pairs.
3. Study of rectilinear motion.
4. DC and AC position Control Systems.
5. (a) Closed-loop P, PI, PD, and PID controllers.
   (b) Design and validation of PID controller for speed and position control.
6. (a) Temperature Control Systems.
   (b) Two tank water Level Control Systems.
7. Study of Inverted Pendulum System.
8. (a) Study of 2-DoF ball on beam.
   (b) Study of Cascade Control using 3-DoF gyroscope.
9. Study and develop the ladder programs using PLC for different applications.
10. Study of Magnetic Levitation.
11. Microcontroller based Control System with any one application.

The End

Course Curriculum

for

Bachelor of Technology Programme

in

Mechanical Engineering

http://www.nitgoa.ac.in

राष्ट्रीय प्रौद्योगिकी संस्थान गोवा

NATIONAL INSTITUTE OF TECHNOLOGY GOA

कोट्टामल प्लाटू, कुंकोलिम, सालसेट, दक्षिण गोवा, गोवा - ४०३७०३, इंडिया

Kottamoll Plateau, Cuncolim, Salcete, South Goa, Goa- 403703, India

Programme Structure Summary

Sl. No.	Classifications	Course Type	Credits For CGPA	Courses
1	Basic Sciences	**BS**	21	MA→11, PH→5, CY→5
2	Basic Engineering Sciences and Technical Arts	**ES**	21	EM→3, BMC→3, BES→6, CPPS→4, ED→3, WP→2
3	Humanities and Social Sciences	**HU & HS**	7	PC →4, ECO→ 3
4	Indian Knowledge Systems	**IKS**	5	HH →2 and an Open Elective Course →3
5	Others: Liberal Arts, Innovation & Entrepreneurship	**OT**	2	LA→1, IE→1
6	Mandatory Learning Courses	**MLC**	2	PE→0, ES→ 1, PEHV→ 1
7	Department Core	**DC**	83 - 86	Core Theory and Lab courses, Comprehensive Examination →1, Seminar→1, Summer Internship→1, Project Work→5
8	Department Elective (including MOOCs or any other as approved by the Institute)	**DE**	21-27	7-9 Electives
9	Open Elective (including MOOCs or any other as approved by the Institute)	**OE**	0-6	Upto 2 Open Electives
Total Credits			**168**	
10	Minor Program	**MR**	**18**	

Semester-wise Credits Distribution

Sl. No.	Year	Semester-wise Credits		Year-wise Credits
		Semester	Credits	
1	First Year	I	23	46
		II	23	
2	Second Year	III	24	46
		IV	22	
3	Third Year	V	22	45
		VI	23	
4	Fourth Year	VII	19	31
		VIII	12	
Total Credits				**168**

Semester-Wise Distribution of the Courses

I Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA100	Matrices and Advanced Calculus	BS	3-1-0	4
2.	PH100	Engineering Physics	BS	3-0-0	3
3.	CS100	Computer Programming and Problem Solving	ES	3-0-0	3
4.	EE100	Basics of Electrical Engineering	ES	2-0-0	2
5.	ME100	Engineering Mechanics	ES	3-0-0	3
6.	HU100	Liberal Arts	OT	0-0-2	1
7.	PH101	Engineering Physics Lab	BS	0-0-3	2
8.	CS101	Computer Programming Lab	ES	0-0-2	1
9.	EE101	Basics of Electrical Engineering Lab	ES	0-0-3	1*
10.	ME101	Engineering Drawing	ES	1-0-3	3
	Total Credits				**23**

II Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA150	Differential Equations and Vector Calculus	BS	3-1-0	4
2.	CY150	Engineering Chemistry	BS	3-0-0	3
3.	HU150	Professional Communication	HU	2-0-3	4
4.	EC150	Basics of Electronics Engineering	ES	2-0-0	2
5.	ME150	Basics of Mechanical and Civil Engineering	ES	3-0-0	3
6.	HU151	Health & Happiness	IKS	2-0-0	2
7.	CY151	Engineering Chemistry Lab	BS	0-0-3	2
8.	EC151	Basics of Electronics Engineering Lab	ES	0-0-3	1*
9.	ME151	Workshop Practices	ES	0-0-3	2
10.	PE150	Physical Education	MLC	1-0-2	0#
	Total Credits				**23**

***: Half-Semester Course, #: Non credit Course**

III Semester

Sl. No	Sub. Code	Subject Name	Type	L-T-P	Credit
1	MA200	Advanced Differential Equations and Complex Analysis	BS	2-1-0	3
2	ME200	Mechanics of Solids	DC	3-0-0	3
3	ME201	Materials and Metallurgical Engineering	DC	3-0-0	3
4	ME202	Fluid Mechanics	DC	3-1-0	4
5	ME203	Mechanics of Machinery	DC	3-0-0	3
6	ME204	Basic Thermodynamics	DC	3-0-0	3
7	ME205	Machine Drawing and Computer Graphics	DC	1-0-3	3
8	ME206	Design Lab - I	DC	0-0-3	2
	Total Credits				**24**

IV Semester

Sl. No	Sub. Code	Subject Name	Type	L-T-P	Credit
1	IE250	Innovation & Entrepreneurship	OT	1-0-0	1
2	ME250	Computational Methods in Engineering	DC	2-0-2	3
3	ME251	Design of Machine Elements - I	DC	3-0-0	3
4	ME252	Manufacturing Technology - I	DC	3-0-0	3
5	ME253	Machine Dynamics and Vibrations	DC	3-0-0	3
6	ME254	Applied Thermodynamics	DC	3-0-0	3
7	ME255	Thermal Lab - I	DC	0-0-3	2
8	ME256	Machine Shop -I	DC	0-0-3	2
9	ME257	Design Lab - II	DC	0-0-3	2
	Total Credits				**24**

Detailed Syllabus of Courses

in

Higher Semesters

III Semester

Sl. No	Sub. Code	Subject Name	Type	L-T-P	Credit
1	MA200	Advanced Differential Equations and Complex Analysis	BS	2-1-0	3
2	ME200	Mechanics of Solids	DC	3-0-0	3
3	ME201	Materials and Metallurgical Engineering	DC	3-0-0	3
4	ME202	Fluid Mechanics	DC	3-1-0	4
5	ME203	Mechanics of Machinery	DC	3-0-0	3
6	ME204	Basic Thermodynamics	DC	3-0-0	3
7	ME205	Machine Drawing and Computer Graphics	DC	1-0-3	3
8	ME206	Design Lab - I	DC	0-0-3	2
	Total Credits				**24**

Course Code	Course Name	L	T	P	Credits
MA200	Advanced Differential Equations and Complex Analysis	2	1	0	3

Pre-requisites: **MA100 and MA150**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective

This course is crafted to provide engineers and scientists with a comprehensive grasp of series solutions for both ordinary differential equations and partial differential equations. Further, with a focus on key principles such as complex variables and their practical applications, students will develop a deep understanding of applied mathematics and its real-world implications.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Acquire a solid comprehension of advanced techniques for solving ordinary differential equations (ODEs) and apply them to address challenging engineering problems.
- **CO2.** Comprehend the significance and analytical solving methods for one-dimensional heat and wave equations, as well as two-dimensional elliptic equations.
- **CO3.** Grasp the fundamentals of complex variables, complex functions, and the processes of complex differentiation and integration.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M			L	L	M		H
CO2	H	H	H	H	H			L	L	M		H
CO3	H	H	H	H	H			L	L	M		H

Syllabus

Series Solutions of ODEs: Special Functions: Power series method, Legendre's equation, Legendre polynomials and its properties, Extended power series method: Frobenius method, Bessel's equation, Bessel functions and its properties, Bessel functions of the second kind, General solution of Bessel's equation. Sturm–Liouville Problems, Orthogonal Functions, Orthogonality of Legendre Polynomials, Orthogonal Series, Generalized Fourier Series

Advanced Partial Differential Equations: Vibrating string problem, Fourier series solutions for 1D wave equation, D'Alembert's solution of the wave equation, Fourier series solutions for 1D heat equation, Steady state 2D heat problems, Laplace equation in polar coordinates.

Complex Analysis: Functions of a complex variable, Analytic functions, Cauchy-Riemann equations, Elementary complex functions, Contours and contour integration, Cauchy's theorem, Cauchy integral formula; Power Series and properties, Taylor series, Laurent series, Zeros, Singularities, Poles, Essential singularities, Residue theorem, Evaluation of real integrals and improper integrals.

References/Text Materials:

1. E. Kreyszig, "Advanced Engineering Mathematics," 8th ed. John Wiley, 1999.
2. T. Myint-U and L. Debnath, "Linear Partial Differential Equations for Scientists and Engineers," Birkhäuser Boston, MA, 2006.
3. R. V. Churchill and J. W. Brown, "Complex Variables and Applications," 7th ed. McGraw-Hill, 2003.

Course Code	Course Name	L	T	P	Credits
ME200	Mechanics Of Solids	3	0	0	3

Pre-requisites: **Nil**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective
The course objective is to impart a fundamental understanding of the behavior of materials under applied loads and to develop analytical and problem-solving skills for analyzing and designing structures in the field of mechanics of solids.

Course Outcomes
At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Define 3D state of stress and strains, equilibrium, stress strain relationships, and compatibility.
- **CO2.** Calculate shear force, bending moment, deflection and slopes in various types of beams for different loading conditions.
- **CO3.** Analyze structures under combined loading conditions.
- **CO4.** Understand and compare various theories of failure, recognizing their limitations in practical applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H								M			
CO2	H	H							M			
CO3	H	H	H	H					M			
CO4	H	H		M					M			

Syllabus

Introduction: mathematical preliminaries, and notations, the concept of traction vector, concept of the stress tensor, stress-strain diagram, Hooke's law, analysis of composite section, thermal stresses, material constants for isotropic bodies.

Stress tensor: Basics and its representation in Cartesian coordinate system, Transformation of stress matrix, Equations of equilibrium, symmetry of stress tensor.

Principal Stresses and Mohr's Circle: State of stress in simple cases, Principal stress components and principal planes, Maximizing shear component of traction, Mohr's circle, Stress invariants, octahedral plane, Decomposition of stress tensor, concept of strain and stress tensor.

Strains: Longitudinal, shear, and volumetric strains, local infinitesimal rotation, strain compatibility condition.

Constitutive equations of linearly isotropic elastic bodies
Pressure Vessels: Thin and thin pressure vessels. Principal stresses and their planes.

Beam Theory: Shear force diagram and bending moment diagram, stresses in beam: pure bending, bending stresses in symmetrical and non-symmetrical cross-sections, Shear stresses in beams, Euler-Bernoulli beam theory, deflection and slopes of various beams.

Torsion: Derivation of torsion equation with the assumptions made in it, torsional shear stresses, Strength and rigidity criteria for the design of shaft, torque transmitted for solid and hollow circular shafts

Column and struts: Failure of long and short columns, slenderness ratio, assumptions made in Euler's column theory, end conditions for the column, Euler's critical load for different end conditions of column.

Combined Loading: Members subjected to combined extension, torsion, and bending.

Energy Methods: strain energy stored in a body when it is subjected to gradually applied load, suddenly applied loads, and impact loads, strain energy stored in bending and torsion. Reciprocal relations, Castigliano's theorem, Deflection of straight and curved beams using Energy method.

Theories of Failures: Understating, limitations, comparison, and application.

References/Text Material:

1. F. L. Singer, "Strength of Materials," 3rd ed. Harper and Row Publishers, New York, 1980.
2. F. P. Beer, E. R. Johnston, J. T. Dewolf, "Mechanics of Materials," 3rd ed. Tata McGraw Hill, New Delhi, 2007.
3. L. S. Srinath, "Advanced Mechanics of Solids," Tata McGraw Hill Publishing Company Ltd., 2009.
4. S. P. Timoshenko, J. N. Goodier, "Theory of Elasticity," 3rd ed. McGraw Hill Education, 2010.
5. I. Shames, "Introduction to Solid Mechanics," 3rd ed. Prentice Hall of India, 2003.
6. S. M. A. Kazimi, "Solid Mechanics," 1st ed. Tata McGraw Hill Education, 1982.
7. P. N. Singh, P. K. Jha, "Elementary Solid Mechanics," New Age International (P) Ltd., Delhi, 2011.
8. S. Ramamrutham, "Strength of Materials," Dhanpat Rai Publishing Co. (P) Ltd.
9. Prof. Ajeet Kumar, "Solid Mechanics," NPTEL.

Course Code	Course Name	L	T	P	Credits
ME201	Materials And Metallurgical Engineering	3	0	0	3

Pre-requisites: **ME2XX**
Overlaps with: **Nil**
Course Assessment Method: **Assignments, Quizzes, and Written Exams**

Course Objective
The objective of the course is to gain a deep understanding of materials engineering, from the atomic level to diverse material types and their applications, including metals, alloys, polymers, ceramics, and composites. It also aims to learn to select, process, and test materials for real-world engineering challenges, considering microstructure, heat treatment, failure mechanisms, and various testing procedures.

Course Outcomes
At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Impart knowledge on the atomic arrangement and structure of metals and alloys.
- **CO2.** Construct the phase diagram and using of iron-iron carbide phase diagram for microstructure formation.
- **CO3.** Select and apply various heat treatment processes and its microstructure formation.
- **CO4.** Illustrate the different types of ferrous and non-ferrous alloys and their uses in engineering field.
- **CO5.** Illustrate the different polymer, ceramics and composites and their uses in engineering field.
- **CO6.** Explain the various testing procedures and failure mechanism in engineering field.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H					M	H	M				H
CO2	H	H	M	L		M						M
CO3	H				M	M	H	M	L			M
CO4	H					M	L	L				M
CO5	H					M		L				M
CO6	H		M		H	M		H	M			M

Syllabus:

Introduction of Materials and Phase Diagrams: Introduction to materials and metallurgical engineering, Metals, Solidification, Constitution of alloys, phase diagrams, Iron – Iron carbide equilibrium diagram. Steel and cast-Iron microstructure, properties and application.

Heat Treatment: Various heat treatment processes, Isothermal transformation diagrams, continuous cooling Transformation (CCT) diagram, Hardenability, hardening

Ferrous and Non-Ferrous Metals: Steel, Effect of addition of various alloying elements on steel, Cast Iron, Copper, Aluminum and its alloy, Other important alloys, Properties and Applications, overview of materials standards

Non-metallic Materials: Polymers – types, Properties and applications, Engineering Ceramics – Properties and applications, Composites- Matrix and reinforcement Materials, Types and applications

Mechanical Properties and Deformation Mechanisms: Testing of Engineering materials, Fracture and failure of materials, failure mechanisms

References/Text Materials:

1. K. G. Budinski and M. K. Budinski, "Engineering Materials," 9th ed. Prentice Hall of India Private Limited, 2018.
2. S. H. Avner, "Introduction to Physical Metallurgy," McGraw Hill Book Company, 1994.
3. Alavudeen, N. Venkateshwaran, and J. T. Winowlin Jappes, "A Textbook of Engineering Materials and Metallurgy," Laxmi Publications, 2006.
4. S. Wadhwa and H. S. Dhaliwal, "A Textbook of Engineering Material and Metallurgy," University Sciences Press, 2008.
5. Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, 2nd Ed. Re print 2019.
6. G. S. Upadhyay and A. Upadhyay, "Materials Science and Engineering," Viva Books Pvt. Ltd, New Delhi, 2020.
7. V. Raghavan, "Materials Science and Engineering," 6th ed. Prentice Hall of India Pvt. Ltd., 2019.

Course Code	Course Name	L	T	P	Credits
ME202	Fluid Mechanics	3	1	0	4

Pre-requisites: **Nil**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective

The course aims to familiarize with the properties of fluids and the applications of fluid mechanics. It also intends to formulate and analyze problems related to the calculation of forces in fluid-structure interaction.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Explain fluid mechanics fundamentals, including concepts of mass and momentum conservation.
- **CO2.** Apply the Bernoulli equation and control volume analysis to solve problems in fluid mechanics.
- **CO3.** Discuss potential flow theory, laminar and turbulent boundary layer fundamentals
- **CO4.** Perform dimensional analysis for problems in fluid mechanics.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H								M			
CO2	H	H	H	M					M			
CO3	H								M			
CO4	H	H	H	M					M			

Syllabus

Introduction*:* Properties of fluids, viscosity, capillarity and surface tension, Fluid pressure and its measurement Pressure variation in compressible and incompressible fluids, Hydrostatics: Forces on plane and curved surfaces, Buoyancy, Stability of floating and submerged bodies, Relative equilibrium pressure distribution in liquid subjected to acceleration and rotation.

Flow Kinematics*:* Types of flows; steady and unsteady, rotational and irrotational, laminar and turbulent, etc. Translation of a Fluid Element, Streamlines, potential lines, flow net, vortex motion, Velocity and acceleration at a point, stream function, potential function, continuity equation, Conservation of Momentum: Momentum Theorem, Reynolds Transport Theorem,, Euler's Equation, Conservation of Energy, Steady Flow Energy Equation, Bernoulli's equation and its applications. Dimensional Analysis.

Measurement of Fluid Flow*:* Through ducts: Orifice meter, Venturimeter, rotameter, etc., Through open channels: Triangular notch, Rectangular notch, trapezoidal notch, etc., Through reservoirs: Orifice, mouthpiece, etc.

Viscous Flow*:* Through pipes and parallel plates (Hagen poiseuille and Plane poiseuille flow) Boundary layer concept, boundary layer thickness, wall shear, displacement thickness, momentum thickness and energy thickness, integral equation, Boundary layer separation, Flow around immersed bodies.

Flow through Pipes*:* Major and minor losses, friction chart, Pipes in series and parallel, Siphon, Power transmission, Hydraulic Gradient Line and Total Energy Line

Compressible Flows*:* Introduction to compressible flows, speed of sound wave, Mach number, Mach cone, one dimensional isentropic flows, stagnation properties, flow through nozzles, normal shock

References/Text Material:

1. S. K. Som, G. Biswas, and S. Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines," 3rd ed. McGraw Hill Education, 2017.
2. F. M. White and H. Xue, "Fluid Mechanics," Standard ed. McGraw Hill, 2022.
3. Y. A. Cengel and J. M. Cimbala, "Fluid Mechanics: Fundamental and Applications," 3rd ed. McGraw Hill Education, 2017.
4. R. K. Bansal, "A Textbook of Fluid Mechanics and Hydraulic Machines," 10th ed. Laxmi Publications, 2019
5. B. R. Munson, A. P. Rothmayer, T. H. Okiishi, and W. W. Huebsch, "Fundamentals of Fluid Mechanics," 7th ed. Wiley, 2017.

Course Code	Course Name	L	T	P	Credits
ME203	Mechanics Of Machinery	3	0	0	3

Pre-requisite: Engineering Mechanics, Drawing, Basic Math and Physics, Computer Programming
Overlaps with: Nil
Couse Assessment Method: Tutorials, Quizzes, DIY Projects, and Written Exams

Course Objective
The aim of the course is to equip students with the expertise to analyze and design mechanical systems. By delving into kinematics, motion analysis, mechanism synthesis, cams, gears, and force analysis, the course fosters essential skills for engineering applications and machinery design.

Course Outcomes
At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Understand of the fundamental concepts and principles of kinematics and dynamics of mechanisms, including the classification of links, pairs, and mobility.
- **CO2.** Perform graphical and analytical analysis of position, velocity, and acceleration of planar mechanisms.
- **CO3.** Synthesize planar mechanisms using graphical and analytical techniques, as well as computer-aided methods.
- **CO4.** Discuss the design and analysis of cams, gears, and gear trains, including their classification and terminology.
- **CO5.** Discuss static and dynamic force analysis principles and apply them to analyze four-bar and slider-crank mechanisms.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M										
CO2		H	M	H								
CO3		H	H	H					M	L		
CO4		H	H	H					M	L		
CO5		H	H	M					M	L		

Syllabus

Introduction: Introduction to kinematics of mechanisms - perspective on kinematics and kinetics, machine and mechanism. Kinematics fundamentals - mobility, classification of links, pairs, Number Synthesis, Planar mechanism and machines - Four-bar, and slider-crank linkage, inversions of mechanisms along with their practical applications.

Position and Motion Analysis of Mechanisms: Graphical and analytical position, velocity and acceleration analysis of planar mechanisms, Instantaneous center method, Coriolis acceleration, Klein’s construction, Computer-aided analysis.

Motion synthesis: Introduction to synthesis of mechanisms, Graphical methods of synthesis, Chebyshev spacing, two position synthesis, application to four bar mechanism, analytical synthesis using complex algebra, Freudenstein's method, Computer-aided synthesis.

Cams: Classification of different types of cams, types of motion curves and their analytical expressions, graphical construction of cam profiles for different types of followers, pressure angle and cams with specified contours.

Gears: Classification and Basic terminology, Fundamental law of gearing, Tooth profiles, Types of gears, Gear trains.

Static and Dynamic Force Analysis of Mechanisms: Review of basic principles of statics, Concept of free body and its equilibrium, Static force analysis of planar mechanism, D'Alembert's principle, dynamic force analysis of four-bar and slider crank mechanisms.

References/Text Material:

1. R. L. Norton, "Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines," 6th ed. McGraw Hill, 2020.
2. S. S. Rattan, "Theory of Machines," 4th ed. McGraw Hill, 2017.
3. J. J. Uicker Jr., G. R. Pennock, and J. E. Shigley, "Theory of Machines and Mechanisms," 5th ed. Oxford University Press, 2021.
4. N. Sclater and N. P. Chironis, "Mechanisms and Mechanical Devices Sourcebook," 5th ed. McGraw Hill, 2020.
5. J. Hannah and R. C. Stephens, "Mechanics of Machines," Viva Books Pvt Ltd, 2016.
6. W. L. Cleghorn and N. Dechev, "Mechanics of Machines," 2nd ed. Oxford University Press, 2018.
7. A. Ghosh and A. K. Mallik, "Theory of Mechanics and Machines," East West Pub., 2008.

Course Code	Course Name	L	T	P	Credits
ME204	Basic Thermodynamics	3	0	0	3

Pre-requisites: **Nil**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective

The objective of the course is to introduce and apply the laws of thermodynamics to various thermodynamic systems. The course also intends to introduce the topic of entropy and exergy analyses.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Explain the basic thermodynamic entities like laws, properties, systems.
- **CO2.** Apply the first and second law of thermodynamics to closed and open systems
- **CO3.** Analyze gas mixtures using diagrams and tables, understanding ideal and real gases.
- **CO4.** Conduct exergy analysis, applying the Second Law for efficient energy utilization.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H								L			
CO2		H	H						H			
CO3		H							H			
CO4		H	M	L					M			

Syllabus

Introduction and Fundamental Concepts: Application Areas of Thermodynamics, Systems and Control Volumes, Properties of a System, State and Equilibrium, Processes and Cycles, Temperature and the Zeroth Law of Thermodynamics, Pressure

Work and Heat Transfer: Definition of Thermodynamic Work, Forms of Work, Definition of Heat, Inter Convertibility of Heat/work into Work/heat, Governing Principles, Sign Convention.

First Law of Thermodynamics: Energy, Enthalpy, Specific heats, First law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, Reversible and Irreversible Engines and processes, Causes of Irreversibility, Internal and External Irreversibility

Entropy and Exergy: Clausius Theorem and Clausius Inequality, The Entropy of A Pure Substance, Entropy Change in Irreversible Process, Principle of Increase of Entropy, Calculation of Change in Entropy, Basic concepts of exergy and irreversibility, exergy for closed system and control volume, exegetic efficiency.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressabilities, Clapeyron equation.

Reference Books/Material

1. Y. A. Cengel and M. A. Boles, "Thermodynamics: An Engineering Approach," 5th ed. McGraw Hill, 2006.
2. R. E. Sonntag, C. Borgnakke, and G. J. Van Wylen, "Fundamentals of Thermodynamics," 6th ed. John Wiley, 2003.
3. P. K. Nag, "Engineering Thermodynamics," 3rd ed. Tata McGraw Hill, 2005.
4. H. N. Shapiro and M. J. Moran, "Fundamentals of Engineering Thermodynamics," 8th ed. Wiley, 2014.
5. Dincer and M. A. Rosen, "Exergy: Energy, Environment and Sustainable Development," 3rd ed. Elsevier, 2020.

Course Code	Course Name	L	T	P	Credits
ME205	Machine Drawing and Computer Graphics	1	0	3	3

Pre-requisites: **Engineering drawing**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective
To equip students with the skills to create assembly drawings for various machine sub-assemblies and assemblies using drafting software.

Course Outcomes
At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Demonstrate proficiency in utilizing commercial drafting software for machine drawing
- **CO2.** Conversion of pictorial views into orthographic projections and vice versa
- **CO3.** Gain competence in designing and detailing detachable fasteners
- **CO4.** Acquire skills in creating comprehensive assembly drawings for machine sub-assemblies and assemblies

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H		H				L			
CO2	H	H	H		H				H			
CO3	H	H	H		H				H			
CO4	H	H	H	H	H				M			

Syllabus

Introduction to machine drawing: Introduction to commercial drafting software available in the institute, principles of orthographic projections applied to machine drawing: first angle and third angle projections, sectional views, conversion of pictorial projections into orthographic projections, limits, fits, tolerances, surface quality symbols.

Detachable fasteners: Screw threads, approximate and conventional representations, bolts and nuts, specifications, locking arrangements for nuts, studs, screws, washers, pins, foundation bolts, keys, cotter joints, shaft couplings.

Permanent fasteners: Rivets, types of riveted joints, welds, types of welded joints, edge preparation, specifications and representation of welds on drawings.

Assembly drawings: Parts list, numbering of components and associated detail drawings, assembly drawings of various machine sub-assemblies and assemblies from detail drawings (for example: screw jack, connecting rod, square tool post, tailstock, etc.)

Practical sessions using Drafting Software to produce part and assembly drawings

References/Text Material:

1. N. D. Bhatt and V. M. Panchal, "Machine Drawing," Charotar Publishing House, 1991.
2. K. L. Narayana, P. Kannaiah, K. Venkat Reddy, "Machine Drawing," 3rd ed. New Age International Ltd, 2006.
3. K. R. Gopalkrishna, "Machine Drawing," Subhas Publications, 1985.
4. N. D. Junnarkar, "Machine Drawing," Pearson Education India, 2007.
5. G. Pohit, "Machine Drawing with AutoCAD," Pearson Education India, 2004.

Course Code	Course Name	L	T	P	Credits
ME206	Design Lab – I	0	0	3	2

Pre-requisites: **Engineering Mechanics, Material Science, Mechanics of Machinery**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective

This laboratory course aims to complement theoretical understanding with hands-on experience, enabling students to apply and experimentally validate principles of mechanics of solids, material properties, and mechanics of machine elements through demonstration, laboratory exercises and material testing.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to –

- **CO1.** Supplement the theoretical knowledge gained in Mechanics of Solids with practical testing for determining the strength of materials under externally applied loads.
- **CO2.** Characterize materials and have hands on experience in using different experimental setups.
- **CO3.** Implement various linkages and drives in dynamic systems for diverse needs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M				M	H	H		M
CO2	H	H	M	M	M			M	H	H		M
CO3	H	H	M	M				M	H	H		M

List of Experiments

1. Tension tests on mild steel and cast iron
2. Compression tests on mild steel and cast iron
3. Direct Shear tests on mild steel rod, timber specimen, and mild steel plate
4. Bending test on mild steel
5. Torsion test on mild steel
6. Brinell Hardness test, Rockwell Hardness test, Vickers Hardness test

7. Impact test – Charpy and Izod
8. Demonstration on fatigue test and springs.
9. To study creep behavior of a given specimen
10. Analysis of various mechanism- slider-crank mechanism, Cam, etc
11. Experiment using Gyroscope
12. Demonstration of various mechanisms like straight line mechanisms, etc. and gear drives and gear trains thorough prototypes and lab models.
13. Sample preparation and microstructure analysis of polished surface of various metals and alloys using optical microscope.

References/Text Material:

1. E. J. Hearn, "Mechanics of Materials," Pergamon Press, England, 1972.
2. E. R. Beer and E. R. Johnston, "Mechanics of Materials," 3rd ed. Tata McGraw Hill, New Delhi, 2007.
3. R. L. Norton, "Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines," 6th ed. McGraw Hill, 2020.
4. S. S. Rattan, "Theory of Machines," 4th ed. McGraw Hill, 2017.

IV Semester

Sl. No	Sub. Code	Subject Name	Type	L-T-P	Credit
1	IE250	Innovation & Entrepreneurship	OT	1-0-0	1
2	ME250	Computational Methods in Engineering	DC	2-0-2	3
3	ME251	Design of Machine Elements - I	DC	3-0-0	3
4	ME252	Manufacturing Technology - I	DC	3-0-0	3
5	ME253	Machine Dynamics and Vibrations	DC	3-0-0	3
6	ME254	Applied Thermodynamics	DC	3-0-0	3
7	ME255	Thermal Lab - I	DC	0-0-3	2
8	ME256	Machine Shop -I	DC	0-0-3	2
9	ME257	Design Lab - II	DC	0-0-3	2
	Total Credits				**24**

Course Code	Course Name	L	T	P	Credits
IE250	Innovation & Entrepreneurship	1	0	0	1

Pre-requisites: **Nil**

Course Objective

1. To introduce to a project-based learning approach from Ideation to Innovation and Entrepreneurship will be the key process considered here.
2. To learn the essential concepts of innovation and entrepreneurship through hands-on activities and the best and most relevant practical examples
3. To provide the tools necessary for starting independent innovation and businesses
4. To give students practical experience in market survey, commercialization, IPR and proactively work in projects in risky market environments

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. To comprehend the basic theories and concepts that underlie a survey study of Innovation, Entrepreneurship and Social Business/ Entrepreneurship

CO2. To understand how to generate good large company or startup business ideas / societal ideas, and refine these ideas, to substantially increase chances for success in the marketplace

CO3. The students will be exposed to the thoughts and strategies of some very effective real-life innovators and entrepreneurs through videos and small cases.

CO4. To understand about IPR, prototyping and financial management.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	H	L	H	M	H	H	L	H	H	H	H
CO2	L	H	L	H	H	H	H	L	H	H	H	H
CO3	L	H	L	H	H	H	H	L	M	H	H	H
CO4	L	H	L	H	H	H	H	H	L	L	H	H

Syllabus

Module 1: Introduction

Creative thinking, blocks to creativity, factors that influence creative design, engineering design and creative design, influence of society, market pull & technology push, attribute of a creative person Three levels of Design – Viceral, Behavioral and Reflective design.

Qualities and skills required for entrepreneurship, Functions of an entrepreneur, Importance of entrepreneur in economic development.

Module 2: Ideas for Entrepreneurship

Need or identification of a problem, market survey, data collection, review & analysis, problem definition, challenge statement, problem statement initial specifications, Brain storming, analogy technique or Synectic, check list, trigger words, morphological method, interaction matrix method, analysis of interconnected decision making.

Module 3: Theory of Inventive Problem Solving (TRIZ)

20 key TRIZ principles – multifunction, compensation, nested doll, blessing in disguise, segmentation, separation, symmetry change, opaque & porous, inflate and deflate, recycle & recover, phase transformation, energy, imaging, environment, composition, economical, surface response, static & dynamic, continuous & intermittent, dimensions.

Module 4: Product Design, IPR & Finance

Detail design, prototyping, product deployment, useful life assessment and recycling and sustainability; patent act, patent laws, Types of entrepreneurs- Based on type of business, based on use of technology, based on motivation, based on stages of development, based on motive, Based on capital ownership, Business Plan, Finance and Funding.

Reference Books/Material

1. C.B.Gupta & N.P.Srinivasan, ‘Entrepreneurial Development’, Sultan Chand & Sons, 2020, ISBN: 978-93-5161-132-5
2. Floyd Hurt, Rousing Creativity: Think New Now, Crisp Publ Inc. 1999, ISBN 1560525479.
3. Kalevi Rantanen & Ellen Domb, ‘Simplified TRIZ’ – II edn., Auerbach Publications, Taylor & Francis Group, 2010, ISBN: 978-142-0062-748
4. John Adair, ‘The Art of Creative Thinking’, Kogan Page Publication, 2011, ISBN 978-0-7494-5483-8

Course Code	Course Name	L	T	P	Credits
ME250	Computational Methods in Engineering	2	0	2	3

Pre-requisites: **MA200**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective
This course is designed to offer engineers and scientists a thorough understanding of numerical methods. It emphasizes essential concepts, including numerical solutions for algebraic, transcendental, and differential equations, and explores their practical applications.

Course Outcomes
At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Gain expertise in numerical solving techniques for single-variable equations and systems of equations, and then apply these principles to address intricate engineering challenges.
- **CO2.** Understanding of the significance of curve fitting, interpolation, numerical differentiation and integration.
- **CO3.** Foster a deep comprehension of the importance of numerically solving ordinary and partial differential equations (ODEs) and explore their wide-ranging applications across diverse fields.
- **CO4.** Develop a profound understanding of the significance of employing numerical methods through the utilization of diverse programming languages.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M			L	L	M		H
CO2	H	H	H	H	H			L	L	M		H
CO3	H	H	H	H	H			L	L	M		H
CO4	H	H	H	H	H			L	L	M		H

Syllabus

Lectures (28 hours):

Numerical solution of equations and systems: Equations in one variable - The Bisection method, Fixed point iteration method, Secant method, Regular-Falsi method, Newton's method and its extensions, Convergence of Newtons's method. System of equations - Jacobi and Gauss-Seidel iterative methods, Sufficient conditions for convergence, Power method to find the dominant Eigen value and eigenvector.

Interpolation, Numerical Differentiation and Integration: Interpolation and Curve fitting - The Lagrange polynomial, Divided differnces, Method of least square approximations; Numerical differentiation - Difference formula, Three and five point formule; Numerical integration - Open and closed Newton-Cotes formulae, Gaussian quadrature formula.

Numerical solution of ordinary differential equations: Euler's method, Euler's modified method, Taylor's method and Runge-Kutta method, Multistep methods. Elliptic partial differential equations - Fine difference method for two dimensional equations. Parabolic partial differential equations - Forward difference method, backward difference method and the Crank-Nicolson method for one dimensional equations. Hyperbolic partial differential equations - Central difference method for one dimensional equations.

Laboratory Experiments: (14 hours)

1. Basic operations on Matlab/Python.
2. Program to solve one variable equation using Bisection and Fixed point method.
3. Program to solve one variable equation using Newton Raphson, Regula-Falsi and Secant method.
4. Program to solve system of equations using Gauss-Jacobi Method
5. Program to solve system of equations using Gauss-Seidal Method
6. Program to find dominant eigenvalue using the Power Method
7. Program to fit a curve using method of least square.
8. Program to interpolate using the Lagrange polynomial method.
9. Program to evaluate differentiation and integration.
10. Programs to solve ordinary differential equations using Euler’s and Taylor's method.
11. Programs to solve ordinary differential equations using R-K method of order four.
12. Programs to solve ordinary differential equations using multistep methods.
13. Programs to solve elliptic equations using the finite difference method.
14. Programs to solve parabolic equations using the finite difference method.
15. Programs to solve hyperbolic equations using the finite difference method.

References/Text Material:

1. M. K. Jain, S. R. K. Iyengar, and R. K. Jain, "Numerical Methods for Scientific and Engineering Computation," 6th ed. New Age Publishers, 2012.
2. E. Kreyszig, "Advanced Engineering Mathematics," 8th ed. Wiley India Pvt. Ltd., 2010.
3. R. L. Burden and J. D. Faires, "Numerical Analysis," 9th ed. Brooks/Cole, 2012.
4. G. D. Smith, "Numerical Solution of Partial Differential Equations," Oxford University Press.

Course Code	Course Name	L	T	P	Credits
ME251	Design of Machine Elements – I	3	0	0	3

Pre-requisites: **Manufacturing Technology-I, Mechanics of Solids, Mechanics of Machinery**
Overlaps with: **Nil**
Course Assessment Method: **Tutorials, Quizzes, Projects, and Written Exams**

Course Objective

The aim of the course is to empower students with a thorough understanding of basics of machine design. Covering design procedures, force analysis, material selection, failure theories, and dynamic loading considerations, the course emphasizes on the fundamental understanding of underlying principles that becomes the basis of designing various machine elements like keys, fasteners, gears, shafts, etc.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Understand the design process, requirements, and force analysis concepts. Apply appropriate material selection methodologies for design applications.
- **CO2.** Analyze various failure modes, mitigate stress concentration, and ensure the reliability of machine designs.
- **CO3.** Comprehend the principles of dynamic loading and consider fatigue aspects for machine elements.
- **CO4.** Design and analyze an initial range of machine elements, including levers, shafts and keys, along with flexible drives.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H						M					
CO2	H	H	H	H								H
CO3	M	H	H	H								H
CO4	M	H	H	H		M	M	H	H	M	M	H

Syllabus

Introduction to Mechanical Engineering Design: Introduction to design procedure; design requirements; standards and codes; preferred sizes; discussion on materials, properties and processes from design perspective.

Static Failure Theories: Types of failures; theories of failures for ductile and brittle materials; factor of safety concepts, applications.

Fatigue Failure Theories: Stress concentration; stress concentration factors; mitigation of stress concentration, cyclic loading, endurance limit, effects of type of loading, size and surface finish; notch sensitivity; reliability considerations; Goodman and Soderberg diagrams; cumulative fatigue damage.

Design of Machine Elements: Design of levers, shafts, and keys, belt and chain drives.

References/Text Material:

1. R. L. Norton, "Machine Design – An Integrated Approach," 6th ed. Pearson Education, 2019.
2. R. G. Budynas and J. K. Nisbett, "Shigley's Mechanical Engineering Design," 10th ed. McGraw Hill, 2014.
3. V. B. Bhandari, "Design of Machine Elements," 5th ed. McGraw Hill, 2020.
4. K. Achhangham, "Design Data: Data Book of Engineers," PSG Tech, 2020.
5. R. C. Juvinall and K. M. Marshek, "Fundamentals of Machine Component Design," 7th ed. Wiley, 2020.
6. K. Mahadevan and K. B. Reddy, "Design Data Handbook for Mechanical Engineering," 4th ed. CBS Publishers, 2019.
7. V. B. Bhandari, "Machine Design Data Book," 2nd ed. McGraw Hill, 2019.

Course Code	Course Name	L	T	P	Credits
ME252	Manufacturing Technology – I	3	0	0	3

Pre-requisites: **Nil**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective

This course delves into metal shaping and joining, equipping students with manufacturing production techniques for casting, forming, and assembling metal components to craft functional and artistic creations. From understanding molten metal behavior to welding practices, the course aims to develop versatile skills to manipulate and connect metals with precision and purpose.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Understand the casting processes, including pattern making, moulding, gating systems, solidification, and casting defects.
- **CO2.** Discuss metalworking techniques, such as rolling, spinning, drawing, extrusion, forging, and surface coating.
- **CO3.** Develop skills in sheet metal working operations, including piercing, blanking, forming, drawing, and spinning.
- **CO4.** Gain knowledge of powder metallurgy, including metal powder production, compaction, sintering, and plastics processing.
- **CO5.** Elucidate metal joining techniques, including welding, soldering, brazing, and the use of mechanical fasteners

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H								M			
CO2	H	M		L					M			
CO3	H	M		L					M			
CO4	H			L					M			
CO5	H	M		L					M			

Syllabus

Introduction: Introduction to manufacturing processes, Types and need for manufacturing

Pattern Making: Casting Processes, Pattern, Moulding sand, Moulds, cores

Casting: Gating system, Solidification mechanisms, Melting Furnaces and melting practices, Casting Defects and Remedies. Special casting processes, Advantages and limitations of casting processes, selection, inspection and testing of casting process

Mechanical Working of Metals: Hot rolling, hot spinning, wire drawing. Metal Forming Processes, Extrusion Process, Punches and dies, sheet metal working operations

Forging Processes: Forging materials, classification of forging operations, types of forging operations. defects in forging, Rotary swaging.

Metal joining: welding processes, Arc welding, Resistance welding, Gas welding, solid state welding, thermo-chemical welding, Intense Energy welding, Weld defects, Other joining processes.

Manufacture of Plastic Components: Types and characteristics of plastics – Molding of polymers– working principles and typical applications

References/Text Material:

1. S. Kalpakjian, "Manufacturing Engineering and Technology," 4th ed. Pearson Education India, 2013.
2. P. N. Rao, "Manufacturing Technology Volume 1," 5th ed. McGrawhill Education, 2018.
3. M. P. Groover, "Introduction to Manufacturing Processes." Wiley, 2011.
4. W. A. J. Chapman, "Workshop Technology, Vol - II." Oxford & IBH Publishing Co. Ltd, 1986.
5. Lindberg Roy, "Processes and Materials of Manufacture." PHI / Pearson Education, 2006.
6. S. Gowri P. Hariharan and A. Suresh Babu, "Manufacturing Technology I." Pearson Education, 2008.
7. P. DeGarmo E., J.T. Black, and R.A. Kosher, "Materials and Processes in Manufacturing," 8th ed. Prentice-Hall of India, 1997.
8. S.K. Hajra Choudhary and A.K. Hajra Choudhary, "Elements of Workshop Technology," Volumes I and II. Media Promoters and Publishers Private Limited, Mumbai, 1997.
9. P.C. Sharma, "A Textbook of Production Technology." S. Chand and Co. Ltd., 2004.
10. Ghosh and A. B. Mallick, "Manufacturing Science." Prentice Hall PTR, 2001.
11. R. K. Jain, "Production Technology." Khanna Publishers, 2001.

Course Code	Course Name	L	T	P	Credits
ME253	Machine Dynamics and Vibrations	3	0	0	3

Pre-requisites: **Engineering Mechanics, Calculus, Newtonian Mechanics, Computer Programming**
Overlaps with: **Nil**
Course Assessment Method: **Tutorials, Quizzes, Programming Assignments, and Written Exams**

Course Objective

The aim of this course is to equip students with a profound understanding of dynamic aspects in machinery. Covering flywheels and governors for energy and speed control, balancing of rotating masses, friction devices like belt drives, and essential concepts of gyroscopes and mechanical vibrations, the course prepares students to analyze and design machines with consideration for dynamic forces, balancing, and vibration control.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Understand the vibration principles and effective techniques to control or mitigate vibrations in machines along with various analysis methodologies.
- **CO2.** Gain knowledge of the working principles of flywheels and governors, and understand their practical applications in mechanical systems.
- **CO3.** Explain the principles of gyroscopic action and discover various applications of gyroscopes in areas such as navigation, stabilization, and control systems.
- **CO4.** Acquire skills in balancing rotating masses to reduce dynamic forces, enhance stability, and improve overall machine efficiency.
- **CO5.** Elucidate the principles and applications of friction-based drives, with a focus on belt drive systems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H		H	H		M			M			L
CO2	H	H	H		M							
CO3	H	H	H									
CO4	H	H	H									
CO5	H	H			H							

Syllabus

Flywheels and Governors: Turning moment diagram, Fluctuation of energy and speed, coefficient of fluctuation of speed, use of crank effort diagram, calculation of flywheel size; Advantages of governors, Analysis of different types of governors, effect of sleeve friction, characteristic of governors, controlling forces curves, sensitivity, hunting phenomena in governors, stability, governor effort and power.

Balancing: Balancing of rotating masses in single plane and in different parallel planes, balancing of slider crank mechanisms, balancing of in-line, V- and locomotive engines.

Friction Devices: Advantages and disadvantages of belt drives system, belt drive system, friction in pivots and collars, power screws, plate and cone clutches, band and block brakes.

Gyroscope: Motion of rigid body in 3- dimensions, Angular momentum, Gyroscopic action, equation for regular precession and gyroscopic torque, applications of gyroscope.

Mechanical Vibrations: Basic terminology related to vibrations; Conservative systems; Free vibrations of systems without and with damping; Equilibrium and energy methods for determining natural frequency of vibratory system; Rayleigh's method, Free vibrations of system with viscous damping, over damped, critically and under damped systems, logarithmic decrement; Forced vibrations of systems with viscous damping, equivalent viscous damping; Impressed forces due to unbalanced masses and excitation of supports, vibration isolation, transmissibility, whirling of shaft; Introduction to multi degree of freedom system vibrations: Discrete and continuous systems, Numerical methods

References/Text Material:

1. R. L. Norton, "Design of Machinery – An Introduction to the Synthesis and Analysis of Mechanisms and Machines," 6th Ed, McGraw Hill, 2020.
2. S. S. Rattan, "Theory of Machines," 4th Ed, McGraw Hill, 2017.
3. S. S. Rao, "Mechanical Vibrations," 6th Ed, Pearson Education, 2018.
   A. K. Grover, "Mechanical Vibrations," 8th Ed, Nem Chand & Bros, 2009.
4. L. Meirovitch, "Elements of Vibration Analysis," 2nd Ed, McGraw Hill, 1975.
5. N. Sclater and N. P. Chironis, "Mechanisms and Mechanical Devices Sourcebook," 5th Ed, McGraw Hill, 2020.
6. S. Singh, "Theory of Machines," 3rd Ed, Pearson Education, 2012.
7. W. T. Thomson, "Theory of Vibration with Applications," 3rd Ed., CBS Publishers and Distributors, 2003.

Course Code	Course Name	L	T	P	Credits
ME254	Applied Thermodynamics	3	0	0	3

Pre-requisites: **Nil**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective

The course aims to discuss the various thermodynamic cycles including power generation refrigeration systems, air-conditioning and analyze them.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Discuss the components in vapor and gas power cycles
- **CO2.** Analyze and evaluate efficiency in steam power plants and IC engines, considering various factors.
- **CO3.** Assess the suitability of different gas turbine engines and combined cycles.
- **CO4.** Solve practical problems on psychrometry, refrigeration, and air-conditioning

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L		L					M			
CO2	H	H	L	H					M			
CO3	H	M	L	M					M			
CO4	H	H	L	H					M			

Syllabus

Vapour power cycles: Steam Power Plant – Reheat, regenerative steam power cycles, Types of boilers and their attachments. Nozzles; Steam Turbine types and analysis, condensers.

Gas power cycles: IC Engines: SI, CI, two and four-stroke engines, mean effective pressure, efficiency and specific fuel consumption. Conventional and alternative fuels. Pressure-crank angle diagram. Carburettor and fuel injection systems;

Gas Turbine Engines: Types of gas turbine engines. Reheat, intercooling and regenerative cycles. Combined cycles. Introduction to jet propulsion.

Compressors: Reciprocating air compressors: work transfer, volumetric efficiency, isothermal efficiency, multistage compression with intercooling,

Refrigeration and Air-conditioning: Vapour compression and vapour absorption cycles, Air-conditioning Systems. Properties of moist air: psychrometry and psychrometric charts, condensers, and cooling towers.

References/Text Material:

1. Cengel, Y. A. and Boles, M. A., Thermodynamics: An engineering approach, McGraw Hill, 5th ed., 2006
2. Sonntag, R. E., Borgnakke, C. and Van Wylen, G. J., Fundamentals of Thermodynamics, John Wiley, 6th ed., 2003
3. Nag, P. K., Engineering Thermodynamics, Tata McGrawHill, 3rd Ed., 2005
4. Shapiro H.N. and Moran M. J., Fundamentals of Engineering Thermodynamics, Wiley, 8th ed., 2014
5. Eastop and McConkey, Applied Thermodynamics for Engineering Technologists, Pearson, 5th ed., 2020

Course Code	Course Name	L	T	P	Credits
ME255	Thermal Lab – I	0	0	3	2

Pre-requisites: **Nil**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective

The course aims to make the students exposed to practical applications of fluid mechanics and fluid machinery.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Understand fundamental fluid mechanics principles, through practical observations like Bernoulli's and Reynolds experiments.
- **CO2.** Develop practical skills in flow measurement techniques.
- **CO3.** Analyze and characterize fluid machinery devices including turbines, pumps, and blowers.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H								M	M		
CO2	H	H	M	M				M	H	M		
CO3	H	H		M				M	H	M		

List of Experiments

Fluid Mechanics

1. To study and verify the Bernoulli‟s equation
2. Reynold's experiment,
3. Determination of Metacentric Height
4. To determine the co-efficient of friction (losses) in pipes.
5. To determine minor losses in pipe elements/ arrangements (sudden contraction, sudden enlargement, bend etc.)
6. To determine the flow rate using orifice plate flow meter and measuring nozzle, Venturi nozzle, rotameter
7. To determine the co-efficient of discharge through Venturimeter, Orificemeter, Notch
8. To determine the coefficient of impact of jet on vanes

I.C Engines

1. Function and Working Principle of Ignition System of S.I Engine
2. Function and Working Principle of Injection system (Carburetor and Injector)
3. Function and Working Principle of Lubrication System of IC Engine
4. Detection of Valve Timing Diagram For SI & CI Engines
5. Function and Working Principle of cooling System of IC Engine
6. Measurement of Brake Power, Brake Specific Fuel Consumption by Rope Brake Dynamometer
7. Morse test on IC engine
8. Performance and Emission test on 2 stroke petrol engine (Computerized)
9. Performance and Emission test on 4 stroke MPFI petrol engine, 4 stroke CRDI diesel engine (Computerized)
10. Measurement of viscosity – Redwood viscometer, Saybolt viscometer, Torsion viscometer
11. Measurement of calorific value of fuel using Bomb calorimeter, Junker's gas calorimeter
12. Measurement of flash and fire point – Abel's, Cleveland apparatus

References/Text Material:

1. White, Frank M. Fluid Mechanics. Publisher: McGraw-Hill. Year: 2016.
2. Bansal, R.K. A Textbook of Fluid Mechanics and Hydraulic Machines. Publisher: Laxmi Publications. Year: 2017.
3. Modi, P.N., and Seth, S.M. Hydraulics and Fluid Mechanics Including Hydraulics Machines. Publisher: Standard Publishers Distributors. Year: 2017.
4. Dixon, S.L., and Cesare Hall. Fluid Mechanics and Thermodynamics of Turbomachinery. Publisher: Butterworth-Heinemann. Year: 2014.

Course Code	Course Name	L	T	P	Credits
ME256	Machine Shop – I	0	0	3	2

Pre-requisites: **Nil**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective

The course aims to equip the students with hands-on skills in shaping metal through molding, forging, welding, and lathe operation, mastering tools and techniques for practical projects.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to -

- **CO1.** Understand the appropriate tools, materials, instruments required for specific operations in workshop.
- **CO2.** Apply techniques to perform basic operations with molding, forging, plumbing and Pipe fitting
- **CO3.** Understand the figures of the hand tools used for advanced operation in lathe machines

POs → / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H				H	M		M		M		H
CO2	H				M	M	L		M	L		L
CO3	H				M	M	L		M	L		H

List of Experiments

1. Study on Sand Mold Preparation using single piece pattern, two piece pattern and three piece patterns.
2. Study on different types of joint by TIG welding and MIG welding.
3. Preparation of models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring.
4. Machining operations on Shaper/Slotter: Flat and bevel surfaces, grooves, slots, guide ways, key ways, etc.
5. Grinding operations using surface grinder

References/Text Material:

1. W. A. J. Chapman, Workshop Technology, Volumes I and II. Oxford & IBH Publishing Co. Ltd., 1986.
2. S. Kalpakjian and S. R. Schmid, Manufacturing Engineering and Technology; 7th ed. Pearson, 2014.
3. Amitabha Ghosh "Manufacturing Science; Publisher: Affiliated East-West Press Pvt. Ltd. Year of Publication: 2010
4. P. N. Rao, Manufacturing Technology- Volume I and II, Metal Cutting and Machining Tools; 4th ed. TMH, 2018.
5. HMT, Production Technology; Tata McGraw Hill Pvt. Ltd., 1998.

Course Code	Course Name	L	T	P	Credits
ME257	Design Lab – II	0	0	3	2

Pre-requisites: **Mechanical Vibrations, Machine Dynamics, and Machine Design**
Overlaps with: **Nil**
Course Assessment Method: **As per Academic Rule Book**

Course Objective

This lab course aims to determine forces and analyze dynamic systems including vibrations and design aspects through hands-on experimentation and analysis.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to -

CO1. Gain knowledge of mass balancing, friction, and journal bearings.
CO2. Acquire competence of vibration analysis of systems
CO3. Design basic machine elements from scratch

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M						M	M		
CO2	H	M	M						M	M		
CO3	H	M	M						M	M		

List of Experiments

1. Determination of natural frequency of single DOF systems (With Matlab, and Simulink)
2. Determine the damping ratio in a damped single degree of freedom system (Simulink Model)
3. Torsional vibration of rotor system
4. Static and dynamic balancing of rotating masses
5. Verification of Gyroscopic rule
6. Study of dynamic frictio
7. Pressure distribution in a hydrodynamic bearing
8. Principal stress and strain using strain gauge rosette
9. Stress distribution using photo-elasticity
10. Whirling of shaft

11. Design of shafts
12. Design of couplings

References/Text Material:

1. S. S. Rao, "Mechanical Vibrations." Addison-Wesley, 2010.
2. R. L. Norton, "Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines," 6th ed. McGraw Hill, 2020.
3. S. S. Rattan, "Theory of Machines," 4th ed. McGraw Hill, 2017.
4. V. B. Bhandari, "Design of Machine Elements," 5th ed. McGraw Hill, 2020.
5. V. B. Bhandari, "Machine Design Data Book," 2nd ed. McGraw Hill, 2019.

Course Curriculum

for

Bachelor of Technology Programme

in

Civil Engineering

http://www.nitgoa.ac.in

राष्ट्रीय प्रौद्योगिकी संस्थान गोवा

NATIONAL INSTITUTE OF TECHNOLOGY GOA

कोट्टामल प्लाटू, कुंकोलिम, सालसेट, दक्षिण गोवा, गोवा - ४०३७०३, इंडिया

Kottamoll Plateau, Cuncolim, Salcete, South Goa, Goa- 403703, India

Programme Structure Summary

Sl. No.	Classifications	Course Type	Credits For CGPA	Courses
1	Basic Sciences	**BS**	21	MA→11, PH→5, CY→5
2	Basic Engineering Sciences and Technical Arts	**ES**	21	EM→3, BMC→3, BES→6, CPPS→4, ED→3, WP→2
3	Humanities and Social Sciences	**HU & HS**	7	PC →4, ECO→ 3
4	Indian Knowledge Systems	**IKS**	5	HH →2 and an Open Elective Course →3
5	Others: Liberal Arts, Innovation & Entrepreneurship	**OT**	2	LA→1, IE→1
6	Mandatory Learning Courses	**MLC**	2	PE→0, ES→ 1, PEHV→ 1
7	Department Core	**DC**	83 - 86	Core Theory and Lab courses, Comprehensive Examination →1, Seminar→1, Summer Internship→1, Project Work→5
8	Department Elective (including MOOCs or any other as approved by the Institute)	**DE**	21-27	7-9 Electives
9	Open Elective (including MOOCs or any other as approved by the Institute)	**OE**	0-6	Upto 2 Open Electives
Total Credits			**168**	
10	Minor Program	**MR**	**18**	

Semester-wise Credits Distribution

Sl. No.	Year	Semester-wise Credits		Year-wise Credits
		Semester	**Credits**	
1	First Year	I	23	46
		II	23	
2	Second Year	III	24	46
		IV	22	
3	Third Year	V	23	45
		VI	22	
4	Fourth Year	VII	19	31
		VIII	12	
Total Credits				**168**

Semester-Wise Distribution of the Courses

I Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA100	Matrices and Advanced Calculus	BS	3-1-0	4
2.	PH100	Engineering Physics	BS	3-0-0	3
3.	CS100	Computer Programming and Problem Solving	ES	3-0-0	3
4.	EE100	Basics of Electrical Engineering	ES	2-0-0	2
5.	ME100	Engineering Mechanics	ES	3-0-0	3
6.	HU100	Liberal Arts	OT	0-0-2	1
7.	PH101	Engineering Physics Lab	BS	0-0-3	2
8.	CS101	Computer Programming Lab	ES	0-0-2	1
9.	EE101	Basics of Electrical Engineering Lab	ES	0-0-3	1*
10.	ME101	Engineering Drawing	ES	1-0-3	3
	Total Credits				**23**

II Semester

Sl. No.	Course Code	Course Name	Type	L-T-P	Credits
1.	MA150	Differential Equations and Vector Calculus	BS	3-1-0	4
2.	CY150	Engineering Chemistry	BS	3-0-0	3
3.	HU150	Professional Communication	HU	2-0-3	4
4.	EC150	Basics of Electronics Engineering	ES	2-0-0	2
5.	ME150	Basics of Mechanical and Civil Engineering	ES	3-0-0	3
6.	HU151	Health & Happiness	IKS	2-0-0	2
7.	CY151	Engineering Chemistry Lab	BS	0-0-3	2
8.	EC151	Basics of Electronics Engineering Lab	ES	0-0-3	1*
9.	ME151	Workshop Practices	ES	0-0-3	2
10.	PE150	Physical Education	MLC	1-0-2	0#
	Total Credits				**23**

***: Half-Semester Course, #: Non credit Course**

III Semester

Sl.No.	Course Code	Course Name	Type	L-T-P	Credits
1	MA200	Advanced Differential Equations and Complex Analysis	BS	2-1-0	3
2	CV200	Mechanics of Solids	DC	3-0-0	3
3	CV201	Mechanics of Fluids	DC	3-0-0	3
4	CV202	Surveying	DC	3-0-0	3
5	CV203	Engineering Geology	DC	2-1-0	3
6	CV204	Building and Construction Materials	DC	3-0-0	3
7	CV205	Material Testing Laboratory	DC	0-0-3	2
8	CV206	Fluid Mechanics Laboratory	DC	0-0-3	2
9	CV207	Surveying Laboratory	DC	0-0-3	2
Total Credits					**24**

IV Semester

Sl.No.	Course Code	Course Name	Type	L-T-P	Credits
1	IE250	Innovation & Entrepreneurship	OT	1-0-0	1
2	CV250	Computational Methods in Civil Engineering	DC	2-0-2	3
3	CV251	Structural Analysis	DC	3-0-0	3
4	CV252	Geotechnical Engineering	DC	3-0-0	3
5	CV253	Environmental Engineering	DC	3-0-0	3
6	CV254	Highway Engineering	DC	3-0-0	3
7	CV255	Concrete Technology Laboratory	DC	1-0-3	3
8	CV256	Building Design and Drafting Studio	DC	1-0-3	3
Total Credits					**22**

Detailed Syllabus of Courses

in

Higher Semesters

III Semester

Sl.No.	Course Code	Course Name	Type	L-T-P	Credits
1	MA200	Advanced Differential Equations and Complex Analysis	BS	2-1-0	3
2	CV200	Mechanics of Solids	DC	3-0-0	3
3	CV201	Mechanics of Fluids	DC	3-0-0	3
4	CV202	Surveying	DC	3-0-0	3
5	CV203	Engineering Geology	DC	2-1-0	3
6	CV204	Building and Construction Materials	DC	3-0-0	3
7	CV205	Material Testing Laboratory	DC	0-0-3	2
8	CV206	Fluid Mechanics Laboratory	DC	0-0-3	2
9	CV207	Surveying Laboratory	DC	0-0-3	2
Total Credits					**24**

Course Code	Course Name	L	T	P	Credits
MA200	Advanced Differential Equations and Complex Analysis	2	1	0	3

Pre-requisites: Nil

Course Objectives

This course is crafted to provide engineers and scientists with a comprehensive grasp of series solutions for both ordinary differential equations and partial differential equations. Further, with a focus on key principles such as complex variables and their practical applications, students will develop a deep understanding of applied mathematics and its real-world implications

Course Outcomes

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

CO1: Acquire a solid comprehension of advanced techniques for solving ordinary differential equations (ODEs) and apply them to address challenging engineering problems.

CO2: Comprehend the significance and analytical solving methods for one-dimensional heat and wave equations, as well as two-dimensional elliptic equations.

CO3: Grasp the fundamentals of complex variables, complex functions, and the processes of complex differentiation and integration.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M	-	-	L	L	M	-	H
CO2	H	H	H	H	H	-	-	L	L	M	-	H
CO3	H	H	H	H	H	-	-	L	L	M	-	H

Syllabus

Module 1: Series Solutions of ODEs: **Special Functions**: Power series method, Legendre's equation, Legendre polynomials and its properties, Extended power series method: Frobenius method, Bessel's equation, Bessel functions and its properties, Bessel functions of the second

kind, General solution of Bessel's equation. Sturm–Liouville Problems, Orthogonal Functions, Orthogonality of Legendre Polynomials, Orthogonal Series, Generalized Fourier Series

Module 2: Advanced Partial Differential Equations: Vibrating string problem, Fourier series solutions for 1D wave equation, D'Alembert's solution of the wave equation, Fourier series solutions for 1D heat equation, Steady state 2D heat problems, Laplace equation in polar coordinates.

Module 3: Complex analysis: Functions of a complex variable, Analytic functions, Cauchy-Riemann equations, Elementary complex functions, Contours and contour integration, Cauchy's theorem, Cauchy integral formula; Power Series and properties, Taylor series, Laurent series, Zeros, Singularities, Poles, Essential singularities, Residue theorem, Evaluation of real integrals and improper integrals.

Reference Books/Material

1. Advanced Engineering Mathematics, E. Kreyszig, 8th Edition, John Wiley,1999.
2. Linear Partial Differential Equations for Scientists and Engineers, T. Myint-U and L. Debnath, Birkhäuser Boston, MA, 2006.
3. Complex variables and applications, Churchill R V, Brown J W, 7th Edition, McGraw-Hill, 2003

Course Code	Course Name	L	T	P	Credits
CV200	Mechanics of Solids	3	0	0	3

Pre-requisites: Engineering Mechanics

Course Objectives

1. Estimate solutions for elementary problems of mechanics of solids.
2. Understand the behavior of complex stresses on plane stress problems.
3. Acquire all necessary fundamentals needed for pursuing courses on Structural Analysis and Structural Design.
4. Understand the behavior of beams under the action of bending & torsion.
5. Develop the ability to check the stability of the columns & pressure vessels.

Course Outcomes

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

CO1: Analyze the elementary problems of mechanics of solids.

CO2: Estimate the normal and tangential stresses developed on plane stress problems.

CO3: Fulfill the basic requirements for upcoming courses like structural Analysis & Structural Design.

CO4: Compute the bending and torsional stresses of the beam problem.

CO5: Analyze the stability parameters of columns & pressure vessels under the action of loads.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	H	M	L	L	L	L	L	L	L	M
CO2	H	H	M	H	L	L	L	L	L	L	L	M
CO3	M	H	H	M	L	L	L	L	L	L	L	M
CO4	H	H	H	H	L	L	L	L	L	L	L	M
CO5	H	H	M	M	L	L	L	L	L	L	L	M

Syllabus

Module 1 Stress & Strain: Introduction to material properties, Types of forces, Concept of stress & strain, Stress tensor & strain tensor, plane stress & Plane strain, differential equations of stress equilibrium, Saint Venant's equation of compatibility, Stress-strain diagram of ductile and brittle material, Generalized Hooke's law, Principle of superposition, compound and composite bars, thermal stresses and strain, statically determinate and indeterminate problems, Stresses due to lack of fit or pre-strain, strain rosettes, Elastic Constant, Normal stress & tangential stress, Analytical & Graphical methods of stress analysis, Concept of principal stress, principal plane and its computation; Normal strain & tangential strain, Analytical & Graphical methods of strain analysis, Concept of Principal strains, principal strain in three dimensions, computation of principal stresses from the principal strains; Theory of Elastic failure, Octahedral Shear stress theory, Superposition of yield surfaces; Concept of Strain Energy, Elastic strain energy.

Module 2 Shear Force & Bending Moment: Beams and support conditions, Types of supports and loads, shear force and bending moment, their diagrams for simply supported beams, cantilevers and overhanging beams.

Module 3 Stresses in Beam (Bending & Shear Stresses): Theory of simple bending–Stress distribution at a cross section due to Bending Moment and Shear Force, Curved bars, Unsymmetrical bending, Product moment of inertia, shear center.

Module 4 Torsion: Torsion of circular elastic bars, torsion equation, introduction to warping of non-circular bars, power transmitted by shaft and hollow circular sections, Springs: Close coiled helical spring subjected to axial load and axial torque.

Module 5 Columns: Short and Long Column, stability of a long column, Euler's Theory of Columns, differential equations of beam- columns, Derivation of Buckling Load for different end conditions, Rankine's Formula.

Module 6 Pressure Vessels: Thin and Thick cylinders subjected to internal pressures, Concept of stresses & strains, Hoop stress, Longitudinal stress in a cylinder, principal stresses in sphere and change in diameter and internal volume.

Reference Books/Material

Text books:

1. Mechanics of Materials, Timoshenko and Gere, CBS Publishers, New Delhi, 2004, 2nd Edition.
2. Mechanics of Materials, Beer and Johnston, McGraw Hill India Pvt. Ltd., 2020, 8th Edition (SI Units).
3. Mechanics of Structures Vol 1 (Strength of Material), S. B. Junarkar and H. J. Shah, Charotar Publishing House Pvt. Ltd., 2012.

Reference books:

1. Advanced Mechanics of Solids, L.S Srinath, McGraw Hill Education, 2017, 3rd Edition.
2. Engineering Mechanics of Solids, E.P.Popov, Pearson, 2015, 2nd Edition.

3. Strength of Materials - Fundamentals andApplications, T.D.Gunneswara Rao and Mudimby Andal, Cambridge University Press, 2018, 1st Edition
4. Strength of Materials - Pytel & Singer, Harper & Row Publishers, 2018, 4th Edition.

Online resources:

1. https://nptel.ac.in/courses/105/105/105105108/

Course Code	Course Name	L	T	P	Credits
CV201	Mechanics of Fluids	3	0	0	3

Pre-requisites: Nil

Course Objectives

1: Estimate hydrostatic forces on structures.

2: Determine discharges in closed conduits and open channels.

3: Design and analyze piping systems and pipe-networks.

4: Plan experimental studies in fluid mechanics using the principles of similitude.

5: Formulate necessary equations required for the solution of fluid flow problems.

Course Outcomes

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

CO1: Calculate hydrostatic forces on various structures submerged in fluid.

CO2: Assess the discharge in closed and open channels.

CO3: Design and assess piping systems for efficient fluid flow.

CO4: Apply principles of dimensional analysis to design experiments.

CO5: Solve fluid flow problems with development of necessary formulae and appropriate boundary conditions.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	L	L	L	L	L	L	L	L
CO2	H	H	M	M	L	L	L	L	L	L	L	L
CO3	H	H	H	L	L	L	L	L	L	L	L	L
CO4	H	M	M	M	L	L	L	L	L	L	L	L
CO5	H	M	H	L	M	L	L	L	L	L	L	L

Syllabus

Module 1 Properties of Fluid: Surface tension, Viscosity, Ideal and real fluids, Newtonian and non- Newtonian fluids, Incompressible and compressible fluids. Fluid pressure and Hydrostatics, Pressure measuring devices, Total pressure and centre of pressure, Buoyancy, Centre of buoyancy, Metacentric height, Equilibrium analysis.

Module 2 Kinematics of Fluid Flow: Lagrangian and Eulerian approaches, Types of fluid flow, Continuity equation, Velocity potential function and Stream Function.

Module 3 Dynamics of Fluid Flow: Euler's Equation of motion, Momentum equation, Bernoulli's equation, Applications of Bernoulli's equation, Flow through Orifice, Mouth piece, Notches and weirs. Flow through pipes, friction and losses.

Module 4 Open Channel Flow: Critical depth, Concepts of Specific Energy and Specific Force, Chezy's and Manning's equations for uniform flow, Velocity distribution, Most efficient channel section, Hydraulic Jump, Evaluation of the jump elements in rectangular and non- rectangular channels on horizontal and sloping beds.

Module 5 Dimensional Analysis and Hydraulic Similitude: Dimensional Analysis, Buckingham's theorem, important dimensionless numbers and their significance.

Reference Books/Material

Text books:

1. Fluid Mechanics, F M White, McGraw Hill Education India Private Limited, 2017, 8th Edition.
2. Introduction to Fluid Mechanics, Robert W. Fox, Philip J. Pritchard, Alan T. McDonald, Student Edition Seventh, Wiley India Edition, 2011.
3. Fluid Mechanics and Machinery, C. S. P. Ojha, P. N. Chandramouli, R. Berndtsson, Oxford University Press, 2010.
4. Fluid Mechanics and Hydraulic Machines, Bansal R K, Laxmi Publication Pvt. Ltd, 2019.

Reference books:

1. Mechanics of Fluids, Shames, McGraw Hill Book Co., New Delhi, 1988.
2. Fluid Mechanics, Streeter V.L., Benjamin Wylie, McGraw Hill Book Co., New Delhi, 1999.
3. Introduction to Fluid Mechanics, Robert W. Fox, Alan T. McDonald, John W. Mitchell, Wiley, 2020.
4. Fluid Mechanics Through Problems, R. J. Garde, New Age International, 2006.
5. An Introduction to Fluid Mechanics, Chung Fang, Springer International Publishing, 2018.
6. Open Channel Hydraulics, Chow V.T., Blackburn Press, 2009.
7. Theory and Applications of Fluid Mechanics, Subramanya, K., McGraw Hill, New York, 1993

Online Resources:

1. https://nptel.ac.in/courses/105/103/105103192/
2. https://nptel.ac.in/courses/105/101/105101082/
3. https://nptel.ac.in/courses/112/105/112105269/
4. https://nptel.ac.in/courses/112/105/112105171/

Course Code	Course Name	L	T	P	Credits
CV202	Surveying	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Carry out field surveys for location, design and construction of engineering projects
2. Adopt suitable survey technique and select equipment based on the required level of accuracy and prevailing field conditions.
3. Carry out profiling and grid leveling, for generation of profiles, contour maps for earth works computations.
4. Work effectively with modern surveying equipment to improve the quality of surveys.
5. Analyze and synthesize survey data.

Course Outcomes

After completion of the course the students will be able to:

CO1: Classify the various types of surveys.

CO2: Understand the principles involved in the compass surveying

CO3: Know the various method in leveling

CO4: Find out the distances using a Theodolite

CO5: Know the various advanced survey instruments

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	L	L	L	L	L	L	L	L
CO2	H	M	M	M	L	L	L	L	L	L	L	L
CO3	H	M	M	M	L	L	L	L	L	L	L	L
CO4	H	M	M	H	H	L	L	L	L	L	L	L
CO5	H	H	M	M	L	L	L	L	L	L	L	L

Syllabus

Module 1 Surveying - Basic Concepts: Surveying definition - principles of surveying - plane surveying - geodetic surveying – Types of errors. Distance Measurement: Measurement methods (Tape, Tacheometry, EDM) - Taping Equipment - Taping on smooth level ground and sloping ground – Ranging - Systematic errors in taping and corrections (Tape standardization, Temperature, Tension, Sag, Slope and Alignment) – Electronic Distance Measurement – Principle of EDMs – Systematic errors and accuracy of EDM systems.

Module 2 Angle and Direction Measurement: Definitions (True meridian, Magnetic meridian, Bearings, Azimuths, Interior angles, Deflection angles) – Methods of determining angles and directions (Magnetic compass, Theodolite, Total station) – Prismatic compass – WCB system – Magnetic declination – Local attraction. Traversing: Traverse – Traverse stations – Types of traverse – Closed traverse computations and adjustments. Triangulation and Trilateration: Triangulation – Principle – Classification of triangulation

Module 3 Combined Distance and Angular measurement: Tacheometric surveying - Stadia method – Stadia constants – Elevation difference - Staff held vertical - Tangential tacheometry – Trigonometric levelling Total station systems - Features and functions – applications. Route surveying – Curves: Curves - Types - Elements of a curve - Simple curves - Setting out of curves using various methods – Geometry of compound curves and reverse curves – Introduction to transition and vertical curves.

Reference Books/Material

Text books:

1. Surveying I & II, B.C. Punmia, Ashok Kumar Jain, Ashok Kr. Jain, Arun Kr. Jain., Laxmi Publications, 2015
2. Higher Surveying, Chandra A. M., New Age International Publishers, 2015
3. Surveying and Levelling – Part 1, Kanetkar T.P., and Kulkarni S.V., Surveying and Levelling – Part 1, Pune Vidyarthi Griha Prakashan, Pune, 1994.

Reference books:

1. Surveying Theory and Practice, James, M Anderson & Edward M., Tata Mc Graw Hill, 2012
2. Elementary Surveying, Charles D Ghilani, Paul R Wolf, prentice Hall, 2012
3. Engineering Surveying, Schofield W and M Breach, , Elsevier, CBSPD, 6th edition, 2007.
4. Surveying and Levelling, Subramanian R, Oxford University Press, 2nd edition, 2012

Online Resources:

1. https://nptel.ac.in/courses/105/107/105107122/
2. https://nptel.ac.in/courses/105/104/105104101/

Course Code	Course Name	L	T	P	Credits
CV203	Engineering Geology	2	1	0	3

Pre-requisites: Nil

Course Objectives

1. Understand the dynamic nature of earth, the associated surface and subsurface processes and appreciate the importance of geology in civil engineering projects.
2. Provide basic knowledge about different minerals, various rocks and their classification schemes and their engineering properties with their significance in civil engineering.
3. Understand the process involved in rock deformation and formation of various geological structures such as folds, faults, and joints unconformities.
4. Understand the significance of various geological principles in planning, designing and construction of various civil projects and mitigation measures for natural hazards.

Course Outcomes

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

CO1: Identify and classify minerals based on physical, optical and chemical properties.

CO2: Classify weathering processes and mass movement.

CO3: Identify geological formations such as folds, faults, joints unconformities and assess their critical aspects in the stability of civil engineering structures.

CO4: Perform geophysical investigations to develop subsurface profile and locate groundwater potential sites.

CO5: Apply geological principles in planning, designing and construction of various civil projects and make critical decisions and strategies to mitigate the impact of geohazards on stability of civil structures.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	L	L	M	L	L	L	L	L	L	L
CO2	L	L	L	M	L	L	L	L	L	L	L	L
CO3	M	M	L	M	L	L	L	L	L	L	L	L
CO4	M	M	H	H	H	L	L	L	L	L	L	L
CO5	M	M	M	H	M	L	L	L	L	L	L	L

Syllabus

Module 1: Introduction to Geology: Relevance of geology in Civil Engineering, Branches and scope of geology, Earth surface features and internal structure, rock weathering processes.

Module 2: Mineralogy: Minerals, mineral classifications and identification based on physical, optical, and chemical properties.

Module 3: Petrology: Rock formation and their classification- igneous, sedimentary, and metamorphic rocks, rock structures and textures. Exploration and testing of Rock, Rock Quality Designation (RQD), Borehole problems.

Module 4: Structural geology: Geological Map, outcrop, attitude of beds, geological features- folds, faults, unconformities, their types and classifications.

Module 5: Hydrogeology: Ground water table, aquifers, subsurface distribution of groundwater, groundwater in different geological formations, springs, geophysical exploration of groundwater.

Module 6: Subsurface exploration methods: Soil profile, Fundamentals of Geophysical Prospecting,- Seismic refraction method and electrical resistivity method.

Module 7: Geohazards: Causes of earthquake and landslides, Remedial measures to mitigate damage to engineering structures.

Module 8: Dams and Tunnels: Types of dams**,** selection of dam sites, tunnels, geological investigation for a dam site, Seepage and leakage problems in dams- influencing factors and remedial measures. Geological consideration for tunneling, geothermal step, over break, stand up time, and logging of tunnels.

List of Practicals:

1. Identification of important minerals
2. Classification and identification of Igneous, Sedimentary, and metamorphic rocks
3. Structural geology- strike and dip, three and 3-point problems point problems.
4. Structural geology – Completion of outcrops maps, order of superposition.
5. Introduction to Geophysical methods for ground characterization-Electrical resistivity method, seismic refraction method

Reference Books/Material

Text books:

1. Text Book of Engineering Geology by N. Chenna Kesavulu, Mac Millan Ltd., New Delhi, 2018
2. Engineering Geology, D Venkat Reddy, Viskas Publishing House Pvt. Ltd., 2017

Reference books:

1. Engineering and General Geology – Parbin singh, Katson Publishers. 2013
2. Principles of Engineering Geology – K.V.G.K. Gokhale, BS Publications, Hyderabad, 2006.
3. Engineering Geology – F.G. Bell, Elsevier Publications, 2007
4. Principles of Engineering Geology and Geotechnics – D.P. Krynine, W.R. Judd, 2018

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105106/

Course Code	Course Name	L	T	P	Credits
CV204	Building and Construction Materials	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To introduce various types of building materials used in construction
2. Study of different components of a building such as doors, windows, lintels, floor, roof and stairs
3. Identify the construction materials required for the assigned work.
4. Provide procedural knowledge of the simple testing methods of cement, lime and concrete etc.
5. Study of materials and methods of formwork, damp proofing and plastering practices

Course Outcomes

On completion of the course the students will be able to:

CO1: Know the various building materials.

CO2: Understand the basic components of a building

CO3: Understand the general principles in stone and brick masonry

CO4: Acquire knowledge of testing procedures of basic building materials

CO5: Understand the plastering and damp proofing practices employed in building construction

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	L	L	L	L	L	L	L	L
CO2	H	H	M	H	L	L	L	L	L	L	L	L
CO3	H	M	M	M	L	L	L	L	L	L	L	L
CO4	H	M	M	H	L	L	L	L	L	L	L	L
CO5	H	M	M	M	L	L	L	L	L	L	L	L

Syllabus

Module 1: Building Materials: Bricks, Stone, Timber, Plywood, Steel: Classification, Properties and selection criteria, Cement, fine and coarse Aggregate, Admixture: Types, Properties and selection criteria and tests. Concrete: Preparation and properties. Mortar: Types, classification and strength, I.S. specifications, Sensitization on Carbon Footprints of building materials

Module 2: Masonry: Technical terms in masonry, classification and brief specifications of stone masonry, bonds in brick masonry, general principles to be observed in stone, mud and Brick Masonry Construction. Walls: Different types (load bearing, cavity-walls and partition walls), thickness considerations. AAC blocks

Module 3: Doors, Windows and Lintels: Different types based on materials (wooden, UPVC) and methods of construction, technical terms, size and locations.

Module 4: Floors and roofs: Ground and upper floors, various types, their suitability, construction details of concrete and terrazzo floors, Floor tiles. Roofs: Technical terms and different types of pitched and flat roofs. Various roof coverings for pitched and flat roofs

Module 5: Formwork and damp proofing and plastering: Different types of formwork, stripping times. Damp Proofing: Causes and effect of Dampness, parts of a building likely to be affected most, methods of damp proofing in different locations including roofs, Types and considerations during plastering and pointing.

Module 6: Stairs, Elevators, Escalators and Ramps: Types based on geometry and material, suitability, proportioning of stairs, lifts and escalators.

Reference Books/Material

Text books:

1. Building Materials, Duggal, S.K, New Age International (P) Limited Publishers., 2008, 3rd Edition
2. Civil Engineering Materials, Peter A. Claisse, Butterworth- Heinemann, 2016, 1st Edition

3. Building Construction, Punmia, B. C., Laxmi Publications, New Delhi,1999.
4. Concrete Technology, Shetty, M. S, S.Chand & Co., New Delhi, 1992.

Reference books:

1. Essentials of Civil Engineering Materials. Kathryn E. Schulte Grahame, Steven W. Cranford, Craig M. Shillaber, and Matthew J. Eckelman. Cognella Academic Publishing, San Diego, 2020, 1st Edition.
2. Building Materials in Civil Engineering, Haimei Zhang. Woodhead Publishing Limited and Science Press, 2011, 1st Edition.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_ar11/preview
2. https://nptel.ac.in/courses/105/102/105102088/
3. https://nptel.ac.in/courses/105/106/105106053/

Course Code	Course Name	L	T	P	Credits
CV205	Material Testing Laboratory	0	0	3	2

Pre-requisites: Mechanics of Solids

Course Objectives

1. Understand behaviour of materials under different types of loading.
2. Conduct investigations and apply proper tools to make measurements.
3. Know about the safety measurements while conducting the experiments.
4. Conduct the experiments with teamwork.

Course Outcomes

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

CO1: Understand different types of stresses occur in different materials under different types of loads.

CO2: Collect and record data in an appropriate way.

CO3: Understand various precautions to be taken while conducting the experiments.

CO4: Learn team coordination.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	L	L	L	L	M	L	L	M	M	L
CO2	H	L	L	L	L	L	L	M	M	L	M	L
CO3	H	L	L	L	L	L	M	L	L	M	M	L
CO4	H	L	L	L	L	L	M	M	H	L	L	L

Syllabus

1. Stress-strain characteristics:
   (a) Mild Steel (b) Tor steel (c) Copper (d) Aluminium and (e) G.I. wire and sheet.
2. Compressive strength tests on building materials:
   (a) Wood (b) Brick (c) Rocks (d) Concrete.
3. Hardness tests of metals:
   (a) Steel (b) Brass (c) Aluminum (d) Copper.
4. Modulus of rigidity and Torsion test on:
   (a) Solid shafts (b) Hollow shaft.
5. Determination of deflection for different beams and application of Maxwell's reciprocal theorem:
   (a) Simply supported beam (b) Propped Cantilever beam (c) Continuous beam.
6. Ductility test for steel.
7. Shear test on steel.
8. Impact test on steel
9. Demonstration on Fire resistance tests

Reference Books/Material

1. Timoshenko and Gere, "Mechanics of Materials", CBS Publishers, New Delhi, 1996.
2. Indian Standard Codes, "IS: 1608 – 2005, IS: 516 – 1959, ISO 6506, IS: 5242 – 2006

Course Code	Course Name	L	T	P	Credits
CV206	Fluid Mechanics Laboratory	0	0	3	2

Pre-requisites: Mechanics of Fluids

Course Objectives

1: To understand flow measurement in a pipe flow.

2: To determine the energy loss in pipe flow

3: To measure the discharge in an open channel flow.

Course Outcomes

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

CO1: Calibrate various flow measuring devices in the pipe system.

CO2: Evaluate various losses in flow through a piping system.

CO3: Experimentally calculate the discharge in the open channel.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	L	L	L	L	L	H	H	M	M	L
CO2	H	L	L	L	L	L	L	H	H	M	M	L
CO3	H	L	L	L	L	L	L	H	H	M	M	L

Syllabus

1. Calibration of Venturimeter, Orifice meter
2. Calibration of Rectangular and Triangular notch:
3. Determination of Metacentric height
4. Determination of Reynold's number
5. Determination of Friction factor of pipes
6. Determination of the Impact of jet on vanes
7. Verification of Bernoulli's theorem
8. Determination of Losses in pipes

Reference Books/Material

Text books:

1. Flow in Open Channel, Subramanya, K., Tata McGraw Hill Publications, New Delhi, 2008.
2. Fluid Mechanics, F M White, McGraw Hill Education India Private Limited, 2017, 8th Edition.
3. Introduction to Fluid Mechanics, Robert W. Fox, Alan T. McDonald, John W. Mitchell, Wiley,2020.

Reference books:

1. Open Channel Hydraulics, Chow V.T., Blackburn Press, 2009.
2. Introduction to Fluid Mechanics, Robert W. Fox Ogukuo H. Orutcgardm Alan T. Mc Donald, Student Edition 7th Wiley India Edition, 2011.
3. Fluid Mechanics and Machinery, C. S. P. Ojha, P. N. Chandramouli, R. Berndtsson, Oxford University Press, 2010.
4. Fluid Mechanics Through Problems, R. J. Garde, New Age International, 2006.
5. An Introduction to Fluid Mechanics, Chung Fang, Springer International Publishing, 2018.

Online Resources:

1. https://nptel.ac.in/courses/112/105/112105218/
2. https://nptel.ac.in/courses/112/105/112105287/

Course Code	Course Name	L	T	P	Credits
CV207	Surveying Laboratory	0	0	3	2

Pre-requisites: Surveying

Course Objectives

1. Use the surveying equipment to carry out field surveys for location, design and construction of engineering projects.
2. Analyze and synthesize survey data from the field notes.
3. Work effectively as a member of a survey party in completing the assigned field work

Course Outcomes

On completion of the lab the students will be able to

CO1: Find out the bearings using compass survey

CO2: Locate the instrument station using a plane table survey.

CO3: Find out the reduced levels using levelling

CO4: Determine the distances between two points using tacheometry

CO5: Calculate the area, height and distances using total station

Relationship of Course Outcomes to Program Outcomes H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	L	H	H	L	H	H	H	M	H
CO2	L	L	L	L	H	H	L	H	H	H	M	M
CO3	L	L	L	L	H	H	M	H	H	H	M	M
CO4	L	L	L	L	L	L	L	L	L	L	L	L
CO5	L	L	L	L	L	L	L	L	L	L	L	L

Syllabus

1. Setting out of a building
2. Levelling: Fly levelling and contouring
3. Theodolite surveying: Single and two plane observation of trigonometric levelling
4. Determination of Tacheometric Constants, Tangential Tacheometry
5. Total station-traversing, calculation of area, heights and distances.
6. Contour surveying – Determination of coordinates using total station and preparation of contour map using QGIS
7. Demonstration of Drone and DGPS survey

Reference Books/Material

Text books:

1. Surveying I & II, Punmia B C, Jain A K, Jain A K, Laxmi Publications, 2015
2. Higher Surveying, Chandra A. M., New Age International Publishers, 2015

Reference books:

1. Surveying Theory and Practice, James M A, Edward M, Tata Mc Graw Hill, 2012
2. Elementary Surveying, Charles D G, Wolf P R, Prentice Hall, 2012

Online Resources:

1. https://nptel.ac.in/courses/105/107/105107122/
2. https://nptel.ac.in/courses/105/104/105104101/
3. http://sl-iitr.vlabs.ac.in/sl-iitr/

IV Semester

Sl.No.	Course Code	Course Name	Type	L-T-P	Credits
1	IE250	Innovation & Entrepreneurship	OT	1-0-0	1
2	CV250	Computational Methods in Civil Engineering	DC	2-0-2	3
3	CV251	Structural Analysis	DC	3-0-0	3
4	CV252	Geotechnical Engineering	DC	3-0-0	3
5	CV253	Environmental Engineering	DC	3-0-0	3
6	CV254	Highway Engineering	DC	3-0-0	3
7	CV255	Concrete Technology Laboratory	DC	1-0-3	3
8	CV256	Building Design and Drafting Studio	DC	1-0-3	3
Total Credits					**22**

Course Code	Course Name	L	T	P	Credits
IE250	Innovation & Entrepreneurship	1	0	0	1

Pre-requisites: **Nil**

Course Objective

1. To introduce to a project-based learning approach from Ideation to Innovation and Entrepreneurship will be the key process considered here.
2. To learn the essential concepts of innovation and entrepreneurship through hands-on activities and the best and most relevant practical examples
3. To provide the tools necessary for starting independent innovation and businesses
4. To give students practical experience in market survey, commercialization, IPR and proactively work in projects in risky market environments

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. To comprehend the basic theories and concepts that underlie a survey study of Innovation, Entrepreneurship and Social Business/ Entrepreneurship

CO2. To understand how to generate good large company or startup business ideas / societal ideas, and refine these ideas, to substantially increase chances for success in the marketplace

CO3. The students will be exposed to the thoughts and strategies of some very effective real-life innovators and entrepreneurs through videos and small cases.

CO4. To understand about IPR, prototyping and financial management.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	H	L	H	M	H	H	L	H	H	H	H
CO2	L	H	L	H	H	H	H	L	H	H	H	H
CO3	L	H	L	H	H	H	H	L	M	H	H	H
CO4	L	H	L	H	H	H	H	H	L	L	H	H

Syllabus

Module 1: Introduction

Creative thinking, blocks to creativity, factors that influence creative design, engineering design and creative design, influence of society, market pull & technology push, attribute of a creative person Three levels of Design – Viceral, Behavioral and Reflective design.

Qualities and skills required for entrepreneurship, Functions of an entrepreneur, Importance of entrepreneur in economic development.

Module 2: Ideas for Entrepreneurship

Need or identification of a problem, market survey, data collection, review & analysis, problem definition, challenge statement, problem statement initial specifications, Brain storming, analogy technique or Synectic, check list, trigger words, morphological method, interaction matrix method, analysis of interconnected decision making.

Module 3: Theory of Inventive Problem Solving (TRIZ)

20 key TRIZ principles – multifunction, compensation, nested doll, blessing in disguise, segmentation, separation, symmetry change, opaque & porous, inflate and deflate, recycle & recover, phase transformation, energy, imaging, environment, composition, economical, surface response, static & dynamic, continuous & intermittent, dimensions.

Module 4: Product Design, IPR & Finance

Detail design, prototyping, product deployment, useful life assessment and recycling and sustainability; patent act, patent laws, Types of entrepreneurs- Based on type of business, based on use of technology, based on motivation, based on stages of development, based on motive, Based on capital ownership, Business Plan, Finance and Funding.

Reference Books/Material

1. C.B.Gupta & N.P.Srinivasan, ‘Entrepreneurial Development’, Sultan Chand & Sons, 2020, ISBN: 978-93-5161-132-5
2. Floyd Hurt, Rousing Creativity: Think New Now, Crisp Publ Inc. 1999, ISBN 1560525479.
3. Kalevi Rantanen & Ellen Domb, ‘Simplified TRIZ’ – II edn., Auerbach Publications, Taylor & Francis Group, 2010, ISBN: 978-142-0062-748
4. John Adair, ‘The Art of Creative Thinking’, Kogan Page Publication, 2011, ISBN 978-0-7494-5483-8

Course Code	Course Name	L	T	P	Credits
CV250	Computational Methods in Civil Engineering	2	0	2	3

Pre-requisites: **Nil**

Course Objectives

This course is designed to offer engineers and scientists a thorough understanding of numerical methods. It emphasizes essential concepts, including numerical solutions for algebraic, transcendental, and differential equations, and explores their practical applications.

Course Outcomes

On completion of the lab the students will be able to

CO1: Gain expertise in numerical solving techniques for single-variable equations and systems of equations, and then apply these principles to address intricate engineering challenges out the bearings using compass survey

CO2:Understanding of the significance of curve fitting, interpolation, numerical differentiation and integration

CO3: Foster a deep comprehension of the importance of numerically solving ordinary and partial differential equations (ODEs) and explore their wide-ranging applications across diverse fields.

CO4: Develop a profound understanding of the significance of employing numerical methods through the utilization of diverse programming languages.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M	L	L	L	L	M	L	H
CO2	H	H	H	H	H	L	L	L	L	M	L	H
CO3	H	H	H	H	H	L	L	L	L	M	L	H
CO4	H	H	H	H	H	L	L	L	L	M	L	H

Syllabus

Module 1 Numerical solution of equations and systems

Equations in one variable: The Bisection method, Fixed point iteration method, Secant method, Regular-Falsi method, Newton's method and its extensions, Convergence of Newtons's method.

System of equations: Jacobi and Gauss-Seidel iterative methods, Sufficient conditions for convergence, Power method to find the dominant Eigen value and eigenvector.

Module 2 Interpolation, Numerical Differentiation and Integration

Interpolation and Curve fitting: The Lagrange polynomial, Divided differences, Method of least square approximations.

Numerical differentiation: Difference formula, Three and five point formula.

Numerical integration: Open and closed Newton-Cotes formulae, Gaussian quadrature formula.

Module 3 Numerical solution of Differential Equations

Ordinary Differential Equations: Euler's method, Euler's modified method, Taylor's method and Runge-Kutta method, Multistep methods. Elliptic partial differential equations: Fine difference method for two dimensional equations. Parabolic partial differential equations: Forward difference method, backward difference method and the Crank-Nicolson method for one dimensional equations. Hyperbolic partial differential equations: Central difference method for one dimensional equations

Lab Experiments: (2 hours per week)

1. Basic operations on Matlab/Python.
2. Program to solve one variable equation using Bisection and Fixed point method.
3. Program to solve one variable equation using Newton Raphson, Regula-Falsi and Secant method.
4. Program to solve system of equations using Gauss-Jacobi Method
5. Program to solve system of equations using Gauss-Seidal Method
6. Program to find dominant eigenvalue using the Power Method
7. Program to fit a curve using method of least square.
8. Program to interpolate using the Lagrange polynomial method.

9. Program to evaluate differentiation and integration.
10. Programs to solve ordinary differential equations using Euler's and Taylor's method.
11. Programs to solve ordinary differential equations using R-K method of order four.
12. Programs to solve ordinary differential equations using multistep methods.
13. Programs to solve elliptic equations using the finite difference method.
14. Programs to solve parabolic equations using the finite difference method.
15. Programs to solve hyperbolic equations using the finite difference method

Reference Books/Material

1. Numerical Methods for Scientific and Engineering Computation, Jain M K, Iyengar S R K, Jain R K, New Age Publishers, 6th Edition, 2012.
2. Advanced Engineering Mathematics, E.Kreyszig, 8th Edition, Wiley India Pvt. Ltd., 2010.
3. Numerical Analysis, Burden R L, Faires J D, 9th Edition, Brooks/Cole, 2012.
4. Numerical solution of Partial Differential Equations, Smith G D, Oxford University Press, 1985

Course Code	Course Name	L	T	P	Credits
CV251	Structural Analysis	3	0	0	3

Pre-requisites: Mechanics of Solids

Course Objectives

1. Apply the appropriate method for finding the deformation of beams under different loads.
2. Estimate deformations of structures with the help of Energy Principles.
3. To analyze 2D pin jointed and rigid jointed frames to find deformations.
4. To analyze arches, cable & suspension bridges by using energy and displacement methods.
5. Analysis of multi-storey frames for lateral loads and gravity loads.

Course Outcomes

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

CO1: Calculate deformations of beam under different loads.

CO2: Compute deformations of structures by using Elastic theorems.

CO3: Analyze pin jointed and rigid jointed frames.

CO4: Draw Influence line diagram for different types of determinate structures.

CO5: Computation of lateral loads and gravity loads on multi-storey frames.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	L	L	L	L	L	L	L	L
CO2	M	H	H	L	L	L	L	L	L	L	L	L
CO3	M	M	H	M	L	L	L	L	L	L	L	L
CO4	H	H	M	L	L	L	L	L	L	L	L	L
CO5	H	H	M	M	M	L	L	L	L	L	L	L

Syllabus

Module 1 Introduction: General introduction on concept of analysis of determinate structures. Concept of Force, Method of Analysis, Classification of Structures, Stress resultants, Degrees of freedom per node, Static and Kinematic Indeterminacy.

Module 2 Deflection of beams: Moment curvature relation of beam, differential equation of beam. Slope and deflection for determinate structures by using integration, moment area and conjugate beam method.

Module 3 Elastic theorems and Energy Principles: Strain energy and complementary energy - review of strain energy due to axial load - bending, shear and torsion - principle of superposition - principle of virtual work - Castigliano‘s theorem for deflection - theorem of complementary energy - Betti’s theorem - Maxwell‘s law of reciprocal deflections - application of method of virtual work (unit load method) and strain energy method for determination of deflections of statically determinate beams, pin-jointed trusses and rigid frames - temperature effects.

Module 5 Rolling Loads and Influence Lines: Rolling loads, influence lines for beams and trusses, Absolute maximum bending moment.

Module 6 Analysis of Arches: Analysis of Arches, Linear Arch, Eddy's theorem, three hinged parabolic arch, moving loads & influence lines.

Module 7 Analysis of Cables and Suspension bridges: Analysis of Cables under point loads and UDL, Analysis of Suspension bridges.

Module 8 Approximate Methods of Analysis: Introduction, Analysis of multi-storey frames for lateral loads, Analysis of multi-storey frames for gravity loads.

Reference Books/Material

Text books:

1. Theory of Structures (Vol. 1), G. Pandit, S. Gupta, Rajesh Gupta, Tata McGraw Hill Pub., 2017.
2. Theory and Problems in Structural Analysis, L.S. Negi, Tata McGraw Hill Pub., 1997.
3. Mechanics of Structures Vol 1 & Vol.2, Junarkar. S. B and Shah H.J, Charotar Publishers, 2008, 32nd Edition**.**
4. Structural Analysis, Menon, D, Narosa publishers, New Delhi, 2008.
5. Theory of Structures, Ramamurtham S. and Narayan R, Dhanpat Rai Publications.

Reference books:

1. Intermediate Structural Analysis, Chu-Kia Wang, Tata McGraw Hill Publishers, 2017.
2. Structural Analysis, R C Hibbeler, Pearson, 2017.
3. Analysis Of Structures (Analysis, Design And Details of Structures) – Vol.1, V. N. Vazirani, M. M. Ratwani, S. K. Duggal, Khanna Publishers, 1999
4. Basic Structural Analysis, C S Reddy, Tata McGraw Hill Publishers, 2017
5. Theory of Structures, Timoshenko, S.P. and Young, D.H., McGraw Hill, New York, 1988

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105166/

Course Code	Course Name	L	T	P	Credits
CV252	Geotechnical Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand the use of a three phase system in soil mechanics and estimation of soil properties using the three phase system.
2. To study the role of water in soil behaviour and estimation of soil stresses, permeability, soil compaction and quantity of seepage including flow net.
3. To appreciate the importance of soil stress distribution and stress influence under various types of loads.
4. Understand the effect of drainage conditions on appropriate soil strength parameters along with the importance of site investigation.

Course Outcomes

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

CO1: Understand the importance of geotechnical engineering in civil engineering and perform proper soil classification and three phase systems to solve the problems.

CO2: Solve any practice problems related to soil stress estimation, permeability, seepage including flow net diagram.

CO3: Perform proper stress estimation under any system of foundation loads.

CO4: Estimate appropriate soil strength parameters with respect to the drainage conditions.

CO5: Solve any practical problems related to the field compaction method.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	L	H	L	L	L	L	L	L	L	L
CO2	H	H	M	H	L	L	L	L	L	L	L	L
CO3	H	H	L	M	L	L	L	L	L	L	L	L
CO4	H	M	L	H	L	L	L	L	L	L	L	L
CO5	M	L	M	H	M	L	L	L	L	L	L	L

Syllabus

Module 1 Soil properties and classification: Formation of soils and types, Soil as three phase system. Grain size distribution, Soil consistency, sensitivity and thixotropy. Classification of soil.

Module 2 Soil compaction: Principles, water content – dry unit weight relationships, optimum moisture content, maximum dry unit weight, factors affecting compaction. Effects of compaction on density, shear strength and permeability. Field compaction methods.

Module 3 Permeability: Soil-water systems – capillarity, flow, Darcy's law, permeability and tests for its determination, Permeability of stratified soils, estimation of permeability in the field, piping, quicksand condition, seepage, flow nets.

Module 4 Consolidation and Settlement Analysis: Equation of one-dimensional consolidation. Coefficient of compression, compression index, pre-compression pressure, over-consolidation, Coefficient of consolidation, Settlement analysis. Basics of three-dimensional consolidation, Sand drains.

Module 5 Shear strength of soil: Coulomb's law, Mohr's stress circle, strength envelope and failure conditions, Direct and triaxial shear tests and unconfined compression tests, Effect of pore pressure.

Module 6 Stresses in Soils: Boussinesq's Equation: Vertical Stress distribution on horizontal and vertical planes, Newmark's influence chart, Contact pressure distribution.

Reference Books/Material

Text books:

1. Basic and Applied Soil Mechanics, Ranjan G, Rao A S R, New Age Int. Publishers, 2019.
2. Geotechnical Engineering, Murthy V N S, CBS Publishers, 2018
3. Introduction to Geotechnical Engineering, Das B M, Sivakugan N, Cengage Learning, 2015.

Reference books:

1. Essentials of Soil Mechanics and Foundations – Basic Geotechnics, McCarthy D F, Pearson Education Ltd., 2014
2. Soil Mechanics and Foundations, Budhu M, Wiley Publishers, 2016
3. Geotechnical Engineering Lab Manual, Kitch W A, Angelo State Universty, 2011.
4. Soil Mechanics in Engineering Practice, Terzaghi K, Peck R B, Mesri G, John Wiley, New York, 1996.
5. Relevant IS codes

Online Resources:

1. https://nptel.ac.in/courses/105/101/105101201/
2. https://nptel.ac.in/courses/105/105/105105168/
3. https://nptel.ac.in/courses/105/101/105101160/

Course Code	Course Name	L	T	P	Credits
CV253	Environmental Engineering	3	0	0	3

Pre-requisites: **Nil**

Course Objectives

1. To explain the classifications of water sources, including surface water and groundwater.
2. To describe the biological indicators used to assess water quality, such as fecal coliforms and biological oxygen demand (BOD).
3. To estimate water demand for various purposes, including domestic, industrial, and agricultural uses.
4. To design the layout and sizing of essential components within a water treatment plant, such as sedimentation tanks and filtration units.
5. To understand the sources and defects of air, noise pollution and suggest control measures

Course Outcomes

After completion of the course the students will be able to:

CO1: Understand the classification of various water sources, causes of contamination and later effect on human health

CO2: Identify the physico-chemical and biological characteristics of water

CO3: Calculate the water demand, population forecasting

CO4. Design various components of typical water distribution networks

CO5: Assess sources, defects and associated control measures of air, noise pollution

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	L	L	L	L	L	L	L	L
CO2	H	M	M	M	L	L	L	L	L	L	L	L
CO3	H	M	L	M	L	L	L	L	L	L	L	L
CO4	H	M	M	M	L	L	L	L	L	L	L	L
CO5	H	L	M	M	L	L	L	L	L	L	L	L

Syllabus

Module 1 Introduction: Necessity and importance of water supply schemes, Water demand, Classification of water demands, Estimation of quantity of water required by a town, factors affecting demand, design period and population forecasting. Sources of water supply: Surface sources and underground sources, Intake works, site selection, type of intake works.

Module 2 Quality of Water: Common impurities, physical, chemical and biological characteristics of water, water quality standards for municipal and domestic supplies.

Module 3 Unit processes in water treatment: Sedimentation: Theory of sedimentation, sedimentation tanks, types, design parameters, sedimentation with coagulation, coagulants and coagulant aids, Jar test. Theory of filtration, slow sand and rapid sand filters, Construction and operation. Methods of disinfection, Chlorination, Softening, Methods of Softening, Iron Removal, Fluoridation.

Module 4: Water distribution networks: Distribution of water: Pipe lay-outs, pumps, storage and balancing reservoirs, water loss in distribution system, house connection, valves, plumbing fixtures- pipe network analysis- introduction to EPANET.

Module 5: Air and Noise Pollution: Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.
Noise Pollution: Types of noise, Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Reference Books/Material

Text books:

1. Environmental Engineering, Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, McGraw Hill Education, 2017
2. Environmental Engineering (Vol. I): Water supply Engineering, P.N. Modi, Standard Book House, 2018, 5th Edition
3. Environmental Engineering (Vol.II): Sewage Disposal and Air Pollution Engineering, S.K. Garg, Khanna Publishers, 1999, 40th Edition

Reference books:

1. Environmental Engineering (Vol. I): Water supply Engineering, Garg S K, Khanna Publishers, 2017, 34th Edition
2. MWH's Water Treatment: Principles and Design, Crittenden J C, Trussell R R, Hand D W, Howe K J, Tchobanoglous G, John Wiley & Sons, Inc.,2012, 3rd Edition
3. Water and Wastewater Engineering: Design Principles and Practice, Davis M L, McGraw Hill Education, 2017,1st Edition
4. Water Supply and Sewerage, Mcghee T, McGraw-Hill Education, 1991, 6th edition
5. Introduction to Environmental Engineering and Science, Masters G M, Ela W P, Prentice Hall of India, 1994, 3rd Edition
6. C P H E E O Manual on Water Supply and Treatment Environmental Science and Engineering

Online resources:

1. http://cpheeo.gov.in/cms/manual-on-water-supply-and-treatment.php
2. http://cpheeo.gov.in/cms/manual-on-operation--and-maintenance-of-water-supply system-2005.php
3. http://cpheeo.gov.in/cms/manual-on-storm-water-drainage-systems---2019.php
4. https://nptel.ac.in/courses/105/105/105105201/
5. https://nptel.ac.in/courses/105/106/105106119/
6. https://nptel.ac.in/courses/105/104/105104102/

Course Code	Course Name	L	T	P	Credits
CV254	Highway Engineering	3	0	0	3

Pre-requisites: **Nil**

Course Objectives

1. Fix the horizontal and vertical alignments of roads and design the elements.
2. Suggest and design circulation improvement measures.
3. Identify and test the properties of pavement materials.
4. Design flexible and rigid pavements.
5. Identify probable causes of distress of pavements and suggest remedial measures.

Course Outcomes

On completion of the course, the students will be able to

CO1: Carry out surveys involved in planning the highway alignment.

CO2: Design cross section elements, sight distances, horizontal and vertical alignment

CO3: Able to able the modern methods in road construction and its recent innovations

CO4: Design flexible and rigid pavements.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	L	L	L	L	L	L	L	L
CO2	H	H	H	M	L	L	L	L	L	L	L	L
CO3	H	M	M	M	L	L	L	L	L	L	L	L
CO4	H	H	H	M	L	L	L	L	L	L	L	L
CO5	H	H	M	H	L	L	L	L	L	L	L	L

Syllabus

Module 1: Highway Classification, Alignment and Geometrical Design: Highway development in India - Classification of roads - Typical cross sections of roads - Requirements and factors controlling the alignment of roads - Engineering surveys for highway location - Pavement surface characteristics - Camber and width requirements - Sight distances - Stopping and overtaking sight distances, overtaking zone requirements - Design of horizontal alignment - speed, radius, superelevation, methods of providing supe

Module 2: Highway Cross Section Elements: Carriageway, Shoulders, Formation, Road Margins, Width of roadway, Right of way; Kerbs, Foot paths, Medians service ducts - Design specifications; Pavement Surface characteristics; Skid resistance, Factors affecting skid resistance, Measurement of skid resistance; Road roughness, Measurement of road roughness; Camber, Objectives of camber, Design standards. Typical cross section of road –cuttings, Embankment, Hilly areas, 6 lane expressway, Divided highway.

Module 3: Geometric Design of Road: Factors influencing geometric design elements, Types of sight distances and Significance, Analysis of sight distances, Horizontal Alignment: Requirements, Super elevation, Methods of attainment of super elevation, Extra widening of curves, Transition curves, Types, Length of transition curve. Vertical Alignment: Types of gradients, Grade compensation on curves, Vertical curves Intersections: Types, At-grade Intersections, Channelization, Objectives; Traffic islands.

Module 4: Pavement Design and Pavement Failures: Design of Flexible Pavements: Methods, IRC guidelines, CBR method of design, Group index method. Design of Rigid Pavements: Factors affecting design, Stresses in rigid pavements, IRC method of design, Joints in Rigid pavements, Design of joints.

Failures in pavements: Brief study of failures in flexible and Rigid pavements and Maintenance, strengthening of existing pavements, Overlays, Worked out problems.

Module 5: Design, Construction and Maintenance: Types of pavements and its components, Factors influencing the design of pavements, Wheel load applications, pavement design traffic, Subgrade strength and Characteristics. Construction of Roads: Bituminous concrete, Cement concrete, Cement stabilized roads, Brief study of types and Uses of failures in flexible and Rigid pavements and Maintenance, Strengthening of existing pavements, Modern methods of road construction and recent innovations

Module 6: Traffic engineering: Introduction - Road user, vehicle, and traffic characteristics - Speed, volume, travel time and delay, parking, accident studies - Simple worked-out problems - Principles of design of at-grade intersections - Simple layouts - Objectives, classification, and uses of traffic signs and markings - Design of isolated signals.

Reference Books/Material

Text books:

1. Traffic Engineering and Transport Planning, Kadiyali, L.R., Khanna Publishers, 2018, Ninth Edition.
2. Highway Engineering, Khanna, S.K., Justo C.E.G., and Veeraragavan A., Nem Chand and Bros., Roorkee, India, 2017, Tenth Edition.
3. Highway Materials and Pavement Testing, Khanna, S.K., Justo, C.E.G. and A. Veeraragavan, Nem Chand and Bros, Roorkee, India, 2013, Fifth Edition

Reference books:

1. Principles of Transportation Engineering, Chakroborty, P. and Animesh Das., Prentice Hall of India Pvt. Ltd, New Delhi, India, 2017, Second Edition.
2. Transportation Engineering: An Introduction, Jotin Khisty C., and B. Kent Lall., Prentice Hall of India Pvt. Ltd, New Delhi, India, 2002, Third Edition.

3. Bituminous Road Construction in India, Kandhal P.S., PHI Learning Pvt. Ltd., New Delhi, India, 2016.
4. Principles of Pavement Design, Yoder E.J. and M.W. Witczak., Second Edition, John Wiley and Sons, New York, USA, 2012.
5. Relevant IRC codes

Online Resources:

1. https://nptel.ac.in/courses/105/101/105101087/

Course Code	Course Name	L	T	P	Credits
CV255	Concrete Technology Laboratory	1	0	3	3

Pre-requisites: Building and Construction Materials

Course Objectives

1. Integrate the hands-on experience on material testing with their theoretical understanding of mechanical behavior of materials
2. Prepare reports and present the results based on the test data complying with the codes regulations
3. Refer codes and other reference materials for standard property data
4. Interpret the results and recommend the suitability of a material for a given load case.

Course Outcomes

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

CO1: Identify quality control tests on concrete making materials

CO2: Understand the behaviour of fresh and hardened concrete

CO3: Design concrete mixes as per IS and ACI codes

CO4: Understand the non-destructive testing equipment

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	L	L	L	L	M	L	L	M	M	L
CO2	L	L	L	L	L	L	L	M	M	L	M	L
CO3	L	L	L	L	L	L	M	L	L	M	M	L
CO4	M	L	L	L	L	L	M	M	H	L	L	L

Syllabus

1. Determination of:
    a. fineness and specific gravity of cement.
    b. consistency of standard cement paste.
    c. initial and Final Setting times of Cement.
    d. compressive strength of cement.
    e. fineness modulus of coarse and fine aggregates.
    f. percentage of voids, Bulk density, Specific Gravity of coarse and fine aggregates.
    g. workability: slump cone test, compaction factor test, vee-bee consistometer test.
    h. hardened properties of concrete – compressive strength, split tensile strength and flexural strength.
    i. stress - strain characteristics of concrete and tests for tensile strength of concrete.
2. Concrete mix design
3. Experiments to demonstrate the use of non-destructive test equipment

Reference Books/Material

Text books:

1. Properties of Concrete, AM Nevelli, Prentice Hall Publishers, 2012, 5 th Edition.
2. Concrete Technology: Theory And Practice, M. S. Shetty and A. K. Jain, S Chand Co., Publishers, 2018.

Reference books:

1. Concrete: Structure, Properties and Materials, P. K. Mehta and Paulo K. Monteiro, Prentice-hall international series in civil engineering and engineering mechanics, 1993.
2. Concrete Technology, J.J. Brooks and A. M. Neville, Pearson, 2019, 2nd Edition.
3. Concrete Technology, A.R. Santhakumar, Oxford Higher education, 2018
4. Concrete Technology: Theory and Practice, M.L. Gambhir, Tata Mc Graw Hill Publishers, 2017, 5th Edition
5. Relevant IS and ACI codes

Online resources:

1. https://nptel.ac.in/courses/105/102/105102012/

Course Code	Course Name	L	T	P	Credits
CV256	Building Design and Drafting Studio	1	0	3	3

Pre-requisites: Engineering Drawing

Course Objectives

1. To study the concept of drawing plan, elevation, sectional elevation and building byelaws.
2. To study the basic use of AutoCAD software.
3. Detailed drawing of door, window, and staircase.
4. Planning and drawing of residential, industrial and public buildings with various requirements.

Course Outcomes

CO1: Plan and design of Residential buildings - domestic units, flat, cottages and bungalows with flat and pitched roof.

CO2: Plan and design of Public buildings – utility shelters, dispensaries, banks, schools, offices, libraries, hostels, restaurants, commercial complexes, factories etc.

CO3: Prepare site plans and service plans as per building rules.

CO4: Prepare detailed drawings of septic tanks and soak-pit.

CO5: Prepare detailed drawings for plumbing, water supply and drainage for buildings.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	L	M	M	H	M	H	H	M	L
CO2	L	L	L	L	M	M	H	M	H	H	M	L
CO3	L	L	L	L	M	M	H	M	H	H	H	L
CO4	L	L	L	L	M	M	H	M	H	H	H	L
CO5	L	L	L	L	M	M	H	M	H	H	H	L

Syllabus

Module 1 Introduction to building drawing: Plan, section, elevation and sectional elevation, requirements of residential buildings, industrial structures, office and commercial units. Building bye-laws: Permissible sizes of plots, margins, area of rooms, plinth height, height of floors and other details, relevant provisions in the National Building Code

Module 2 Detailed Drawings of:

a. Panelled doors, glazed windows, and ventilators
b. Steel and Aluminium windows
c. Steel roof trusses
d. Reinforced concrete staircase

Module 3 Planning, designing from given requirements of areas & specifications and preparation of sketch design and working drawings for:

a. Residential building- flat and pitched roof, economic domestic units, cottages, bungalows and building flats
b. Public building – small public utility shelters, dispensaries, banks, schools, offices, libraries, hostels, restaurants, commercial complexes, factories etc.
c. Preparation of site plans and service plans as per Building Rules
d. Septic Tank and Soak Pit – detailed drawings.
e. Plumbing, water supply and drainage for buildings

Reference Books/Material

Text books:

1. Building Drawing and Detailing, Balagopal T S Prabhu, Spades Publishers, 2007

2. Building Construction, Punmia B. C., Jain A.J., and Jain A.J., Laxmi Publication, 2016, Eleventh Edition.
3. The Text book for Building Construction, Arora S. P., and Bindra S. P., Dhanpat Rai Publications, 2010

Reference books:

1. Building Construction, Varghese P.C., PHI Learning Pvt. Ltd., 2017, 2nd Edition.
2. National Building Code of India, Bureau of Indian Standards, 2016.
3. Local Building Bye-laws
4. AutoCAD manual (https://knowledge.autodesk.com/)

Online resources:

1. https://nptel.ac.in/courses/105/106/105106197/
2. https://nptel.ac.in/courses/105/102/105102175/