Detailed Syllabus

B.Tech in Industrial Systems Engineering

Under SNU

(Applicable from the academic session 2025-2026)

DG Block (Newtown), Action Area I, 1/2, Newtown, New Town, Chakpachuria, West Bengal 700156

Program Outcomes (POs)

1. **Engineering Knowledge:**

Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to solve complex engineering problems.

2. **Problem Analysis:**

Identify, formulate, research literature, and analyze complex engineering problems using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/Development of Solutions:**

Design solutions for complex engineering problems and systems that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental aspects.

4. **Conduct Investigations of Complex Problems:**

Use research-based knowledge and research methods, including design of experiments, analysis, and interpretation of data, and synthesis of information to provide valid conclusions.

5. **Modern Tool Usage:**

Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations

6. **The Engineer and Society:**

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

7. **Environment and Sustainability:**

Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

8. **Ethics:**

Apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice.

9. **Individual and Teamwork:**

Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

10. **Communication:**

Communicate effectively on complex engineering activities with the engineering community and society, including comprehending and writing effective reports, making presentations, and giving and receiving clear instructions.

11. **Project Management and Finance:**

Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work, as a member or leader of a team, to manage projects in multidisciplinary environments.

12. **Lifelong Learning:**

Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO-1: System Design and Engineering Analysis:

Apply principles of basic sciences (e.g., mathematics, physics) and engineering sciences (e.g., mechanics, thermodynamics) to design, analyze, and optimize industrial systems for enhanced operational efficiency and reliability.

PSO-2: Data-Driven Decision Making:

Utilize mathematical modeling, statistical methods, and computational tools grounded in basic and engineering sciences to analyze complex systems, solve industrial problems, and make informed decisions.

PSO-3: Sustainable and Innovative Solutions:

Integrate knowledge of materials science, energy systems, and environmental science with advanced industrial engineering techniques to develop sustainable and innovative solutions for real-world industrial challenges.

1st Year 1st Semester

Sl. No.	Subject Code	Subject Name	L	T	P	Credits
		Theory				
1	BS-PH101	Physics	**3**	**0**	**0**	**3**
2	BS-M101	Mathematics I	**3**	**0**	**0**	**3**
3	ES-EM101	Engineering Mechanics	**4**	**0**	**0**	**4**
4	ES-EE101	Basic Electrical Engineering	**4**	**0**	**0**	**4**
5	HSS-EN101	English Composition and Oral Communication	**1**	**0**	**2**	**2**
Total Theory			**15**	**0**	**2**	**16**
		Practical				
1	ES-EE191	Basic Electrical Engineering Lab	**0**	**0**	**3**	**1.5**
2	ES-CS191	Computer Programming with General Applications	**1**	**0**	**3**	**2.5**
3	ES-ME191	Engineering Graphics	**0**	**0**	**3**	**1.5**
4	ES-ME192	Workshop Practice I	**0**	**0**	**3**	**1.5**
Total Practical			**1**	**0**	**12**	**7**
Total of 1st Semester			**16**	**0**	**14**	**23**

1st Year 2nd Semester

Sl. No.	Subject Code	Subject Name	L	T	P	Credits
		Theory				
1	BS-M202	Mathematics II	**3**	**1**	**0**	**4**
2	ES-FT201	Introduction to Fluid and Thermal Science	**4**	**0**	**0**	**4**
3	ES-BE201	Basic Electronics	**3**	**1**	**0**	**4**
4	BS-PS201	Probability and Statistics for Engineers	**4**	**0**	**0**	**4**
5	HSS-EN202	Communicative English	**1**	**0**	**2**	**2**
Total Theory			**15**	**2**	**2**	**18**
		Practical				
1	ES-BE291	Basic Electronics Lab	**0**	**0**	**3**	**1.5**
2	ES-ME291	Engineering Drawing	**0**	**0**	**3**	**1.5**
3	ES-ME292	Workshop Practice II	**1**	**0**	**3**	**2.5**
4	ES-NM291	Numerical Methods and Data Analysis Laboratory	**1**	**0**	**2**	**2**
Total Practical			**2**	**0**	**11**	**7.5**
Total of 2nd Semester			**17**	**2**	**13**	**25.5**

1st YEAR FIRST SEMESTER

Syllabus for Semester 1

Theory Subjects

Course Code	BS-PH101
Category	Basic Science Courses
Course Title	Physics
Semester	First
L-T-P	3-0-0
Credit	3
Pre-Requisites	High School Physics

Course Objectives:
To develop an understanding of quantum physics, photo-electricity, optics, and electromagnetism with applications in engineering, and to provide an introduction to key concepts of quantum mechanics.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Quantum Physics:** Black body radiation, photon concept, Compton effect, de Broglie hypothesis, wave-particle duality.	6
2	**Photo-Electricity:** Mechanisms, Einstein's hypothesis, Millikan validation, applications in sensors, photo-voltaic cells, imaging technology, etc.	8
3	**Optics:** Interference and diffraction, diffraction grating, polarization, circular and elliptical polarization, applications in LEDs and holography.	12
4	**Electromagnetism and Dielectrics:** Magnetic effects of current, electromagnetic induction, ferromagnetism, dielectric constants, and their applications.	10

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Understand quantum mechanics and its applications in engineering.
- **CO-2:** Analyze photoelectric effects and their role in modern technology.
- **CO-3:** Apply principles of optics in engineering systems like LEDs and holograms.
- **CO-4:** Evaluate the significance of electromagnetism in engineering applications.

Learning Resources:

1. Eisberg, R., & Resnick, R., Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, Wiley.
2. Jenkins, F. A., & White, H. E., Fundamentals of Optics, McGraw-Hill.

3. Griffiths, D. J., Introduction to Electrodynamics, Pearson.
4. Beiser, A., Concepts of Modern Physics, McGraw-Hill.
5. Tipler, P. A., & Llewellyn, R. A., Modern Physics, Freeman.

Course Code	BS-M101
Category	Basic Science Courses
Course Title	Mathematics I
Semester	First
L-T-P	3-0-0
Credit	3
Pre-Requisites	High School Mathematics

Course Objectives:
To provide knowledge of calculus, series, and multivariable calculus, and equip students with tools to address engineering problems involving multiple variables or constraints.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Sequence and Series:** Convergence tests, power series, Fourier series, and Parseval's theorem.	6
2	**Calculus:** Mean value theorems, Taylor and Maclaurin series, indeterminate forms, maxima, and minima.	6
3	**Multivariate Calculus (Derivatives)**: Introduction**, vectors and matrices, derivatives of multivariable function,** Gradient, curl, divergence, multivariable chain rule, Laplacian and Jacobian, maxima, minima using Lagrange multipliers.	6
4	**Multivariate Calculus (Integrals):** Introduction, double integrals (Cartesian), change of order of integration, change of variables (Cartesian to Polar), areas and volumes, center of mass and gravity (constant and variable densities); triple integrals (Cartesian), orthogonal curvilinear coordinates; applications to cubes, spheres, and rectangular parallelepipeds; scalar line integrals and scalar surface integrals.	8
4	**Matrices:** Eigenvalues, eigenvectors, diagonalization, system of equations using Gaussian elimination and iterative methods.	10

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Analyze convergence of series and apply Fourier techniques.
- **CO-2:** Utilize calculus for optimization in engineering problems.
- **CO-3:** Solve multivariable problems using partial derivatives and gradients.
- **CO-4:** Address linear algebra challenges in engineering applications.

Learning Resources:

1. Kreyszig, E., Advanced Engineering Mathematics, Wiley.
2. Greenberg, M., Advanced Engineering Mathematics, Pearson.
3. Grewal, B. S., Higher Engineering Mathematics, Khanna Publishers.
4. Veerarajan, T., Engineering Mathematics for First Year, Tata McGraw-Hill.

Course Code	ES-EM101
Category	Engineering Science Courses
Course Title	Engineering Mechanics
Semester	First
L-T-P	4-0-0
Credit	4
Pre-Requisites	High School Physics

Course Objectives:
To introduce the concepts of statics and dynamics and their applications in solving problems related to engineering mechanics.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
	Vector Algebra - Vector operations, orthogonal triad of unit vectors, position and identity vectors,	**3**
1	**Statics:** Free-body diagrams, equilibrium equations in 2D and 3D, system of forces, coplanar concurrent Forces, structural analysis of trusses and frames, beams, and machines.	11
	Friction: Static and dynamic friction, motion of bodies, wedge friction, law of friction force, applications in engineering	2

	Properties of surfaces and mass: First and Second Moments of areas- simple and composite figures, Mass moment inertia of circular plate, Cylinder, Cone, Sphere and Hook, Principle of virtual work; Distributed force and center of gravity.	4
2	**Kinematics:** Rectilinear and curvilinear motion, projectile motion, relative and constrained motion, work-energy principle, simple mechanisms- velocity analysis (graphical method).	10
3	**Dynamics:** Newton's laws of motion, inertia forces, central force motion, momentum and impulse, power and energy concepts.	12
4	**Mechanical Vibrations:** Single degree of freedom systems, natural frequency, resonance, and damped systems.	6

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Analyze equilibrium of forces in engineering structures.
- **CO-2:** Apply principles of kinematics to mechanical systems.
- **CO-3:** Solve problems involving dynamics and energy considerations.
- **CO-4:** Evaluate vibrational responses of mechanical systems.

Learning Resources:

1. Beer, F. P., & Johnston, E. R., Vector Mechanics for Engineers: Statics and Dynamics, McGraw-Hill.
2. Hibbeler, R. C., Engineering Mechanics: Statics and Dynamics, Pearson.
3. Shames, I. H., Engineering Mechanics: Statics and Dynamics, Pearson.

Course Code	ES-EE101
Category	Engineering Science Courses
Course Title	Basic Electrical Engineering
Semester	First
L-T-P	4-0-0
Credit	4
Pre-Requisites	High School Physics

Course Objectives:
To provide fundamental knowledge of electrical circuits, machines, and power systems and their applications in engineering.

Module-wise Syllabus

Module No.	**Description of Topic**	**Lecture Hours**

1	**DC Circuits:** Circuit elements, Kirchhoff's laws, circuit analysis, Thevenin and Norton theorems, RL and RC circuits.	8
2	**AC Circuits:** Sinusoidal waveforms, phasors, power calculations, single-phase and three-phase systems, resonance phenomena.	12
3	**Transformers:** Magnetic materials, equivalent circuits, efficiency, regulation, and three-phase transformer configurations.	6
4	**Electrical Machines:** Induction motors, DC motors, synchronous machines, torque-speed characteristics, applications.	10
5	**Power Converters and Installations:** DC-DC converters, inverters, switchgear, wiring, and battery backup.	6

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Analyze and design basic electrical circuits.
- **CO-2:** Evaluate the performance of electrical machines and systems.
- **CO-3:** Understand the working of transformers and power converters.
- **CO-4:** Apply electrical engineering principles to real-world problems.

Learning Resources:

1. Kothari, D. P., & Nagrath, I. J., Basic Electrical Engineering, Tata McGraw-Hill.
2. Hughes, E., Electrical and Electronic Technology, Pearson.
3. Toro, V. D., Electrical Engineering Fundamentals, Prentice Hall.

Course Code	HSS-EN101
Category	Humanities and Social Sciences
Course Title	English Composition and Oral Communication
Semester	First
L-T-P	1-0-2

Credit	2
Pre-Requisites	None

Course Objectives:
To improve communication skills, vocabulary, and professional writing skills, and to prepare students for effective participation in the workplace.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Vocabulary Building:** Word formation, synonyms and antonyms, prefixes and suffixes, acronyms.	2
2	**Writing Skills:** Sentence structures, paragraph cohesion, précis writing, essay writing, and business letters.	4
3	**Grammar and Usage:** Subject-verb agreement, articles, prepositions, redundancy, and common errors in writing.	3
4	**Professional Communication:** Comprehension, report writing, CV preparation, and email communication.	4

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Enhance vocabulary and grammar for effective communication.
- **CO-2:** Develop writing skills for technical and professional purposes.
- **CO-3:** Improve oral communication for workplace interactions.
- **CO-4:** Prepare effective resumes and cover letters.

Learning Resources:

1. Wren, P. C., & Martin, H., High School English Grammar and Composition, S. Chand.
2. Murphy, R., English Grammar in Use, Cambridge University Press.
3. Mohan, K., & Banerji, M., Developing Communication Skills, Macmillan.

Practical Subjects

Course Code	ES-EE191
Category	Engineering Science Laboratory
Course Title	Basic Electrical Engineering Lab
Semester	First

L-T-P	0-0-3
Credit	1.5
Pre-Requisites	High School Physics

Course Objectives:
To familiarize students with electrical instruments and validate theoretical concepts of electrical engineering.

Lab Modules

Module No.	Description of Experiment	Lab Hours
1	Introduction to electrical instruments: Multimeter, voltmeter, ammeter, and oscilloscope.	3
2	Steady-state response of R-L, R-C, and R-L-C circuits.	3
3	Load test and efficiency of transformers.	3
4	Speed-torque characteristics of induction and DC motors.	3
5	Power measurement in three-phase circuits using the two-wattmeter method.	3

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Operate basic electrical instruments for circuit analysis.
- **CO-2:** Analyze the performance of electrical machines and circuits.
- **CO-3:** Validate theoretical concepts through practical experiments.

Learning Resources:

1. Hughes, E., Electrical and Electronic Technology, Pearson.
2. Kothari, D. P., & Nagrath, I. J., Basic Electrical Engineering, Tata McGraw-Hill.
3. Toro, V. D., Electrical Engineering Fundamentals, Prentice Hall.

Course Code	ES-CS191
Category	Engineering Science Laboratory
Course Title	Computer Programming with General Applications
Semester	First

L-T-P	1-0-3
Credit	2.5
Pre-Requisites	None

Course Objectives:
To provide hands-on programming skills in C++ and Python, focusing on problem-solving and real-world applications in engineering and science.

Lab Modules

Module No.	Description of Experiment/Task	Lab Hours
1	**Introduction to Programming:** Setting up environments, basic syntax, variables, and data types in C++ and Python.	4
2	**Control Structures:** Implementation of conditional statements, loops, and iteration in C++ and Python.	6
3	**Functions and Modular Programming:** Writing and using functions, passing arguments, recursion basics.	6
4	**Data Structures:** Arrays, lists, and dictionaries in Python; arrays and STL vectors in C++.	8
5	**File Handling:** Reading, writing, and processing files in Python and C++.	4
6	**Introduction to Object-Oriented Programming:** Classes, objects, inheritance, and polymorphism in C++ and Python.	8
7	**Applications in Engineering:** Solving numerical problems, matrix manipulations, and data visualization.	8

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Develop and execute basic programs in C++ and Python.
- **CO-2:** Implement control structures and modular programming techniques.
- **CO-3:** Apply data structures to solve computational problems.
- **CO-4:** Utilize object-oriented programming concepts in real-world scenarios.
- **CO-5:** Solve engineering problems using programming skills and tools.

Learning Resources:

1. Balagurusamy, E., Object-Oriented Programming with C++, Tata McGraw-Hill.
2. Zed Shaw, Learn Python the Hard Way, Addison-Wesley.
3. Lutz, M., Learning Python, O'Reilly Media.
4. Stroustrup, B., The C++ Programming Language, Addison-Wesley.

5. Joshi, R., & Taneja, S., Python Programming: A Modular Approach, Oxford University Press.

Course Code	ES-ME191
Category	Engineering Science Laboratory
Course Title	Engineering Graphics
Semester	First
L-T-P	0-0-3
Credit	1.5
Pre-Requisites	None

Course Objectives:
To provide exposure to engineering design principles, technical drawing standards, and visualization techniques essential for engineering.

Lab Modules

Module No.	Description of Experiment	Lab Hours
1	Introduction to engineering drawing tools, lettering, and dimensioning standards.	3
2	Geometrical construction of polygons, conic sections, curves, and spirals.	6
3	Orthographic projections of points, lines, surfaces and solid objects .	9
4	Isometric projections of solids	3
	Sectional views of objects including auxiliary plane sections	9
5	Plan, elevation and sectional drawings of simple engineering components.	6

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Utilize engineering drawing tools and techniques.
- **CO-2:** Create accurate orthographic and isometric projections.
- **CO-3:** Interpret and visualize engineering designs.

Learning Resources:

1. Bhatt, N. D., Engineering Drawing, Charotar Publishing House.
2. Jain, P., & Gautam, A. P., Engineering Graphics and Design, Khanna Publishing.
3. Shah, M. B., & Rana, B. C., Engineering Drawing and Computer Graphics, Pearson.

Course Code	ES-ME192
Category	Engineering Science Laboratory
Course Title	Workshop Practice I
Semester	First
L-T-P	0-0-3
Credit	1.5
Pre-Requisites	None

Course Objectives:
To impart practical knowledge of manufacturing techniques, tools, and processes through hands-on activities in various workshops.

Lab Modules

Module No.	Description of Experiment	Lab Hours
1	Fitting operations: Familiarization and creation of simple fittings using tools like files and chisels.	9
2	Carpentry: Preparation of joints such as cross joints and mortise joints.	9
3	Forging: Creation of simple forged components using hearth, hammer, tong and anvil.	9
4	Moulding and Casting: Preparation of sand moulds with cope and drag and casting simple non-ferrous components.	9

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Perform basic manufacturing operations with accuracy.
- **CO-2:** Understand the practical applications of manufacturing techniques.
- **CO-3:** Operate tools and machines in a workshop environment.

Learning Resources:

1. Hajra Choudhury, S. K., Elements of Workshop Technology, Media Promoters & Publishers.
2. Kalpakjian, S., Manufacturing Engineering and Technology, Pearson.
3. Rao, P. N., Manufacturing Technology, Tata McGraw-Hill.

1st YEAR SECOND SEMESTER

Syllabus for 1st Year Second Semester

Theory Subjects

Course Code	BS-M202
Category	Basic Science Courses
Course Title	Mathematics II
Semester	Second
L-T-P	3-1-0
Credit	4
Pre-Requisites	Mathematics I

Course Objectives:
To provide knowledge of multivariable calculus, ordinary and partial differential equations, and their applications in solving engineering problems.

Module No.	Description of Topic	Lecture Hours
1		12
2	**First-Order Ordinary Differential Equations:** Introduction, exact, linear, and Bernoulli's equations; equations solvable for p, y, and x; Clairaut's type equations.	9
3	**Higher-Order Ordinary Differential Equations:** Second-order linear differential equations with constant coefficients (D-operators), variable coefficients (method of variation of parameters); Cauchy-Euler equations; power series solutions, Laplace Transform,	12
4	**Introduction to Partial Differential Equations (PDEs):** Multidimensional field equations (e.g., temperature, velocity, concentration, electric charge); general forms of PDEs (parabolic, elliptical, hyperbolic); first-order linear and nonlinear equations; examples; homogeneous linear equations with constant and variable coefficients. Initial and boundary value problem	6
5	**Solution of PDE for simple casess:** Analytical solution for 1-D transient heat conduction equation for a semi-infinite solid using i) Laplace transform. and ii) Separation of variables, formulation, and solution of wave equations, numerical solution methodology by using finite difference discretization of a partial differential equation –example with 2-D steady state heat conduction equation	9

Course Outcomes (COs):
Upon completion of this course, students will be able to:
CO-1: Solve multivariable integrals and apply them to physical and engineering problems.
CO-2: Analyze and solve first-order and higher-order ordinary differential equations.
CO-3: Formulate and solve partial differential equations for multidimensional systems.
CO-4: Apply mathematical models to solve real-world engineering problems involving heat, wave, and field equations.

Learning Resources:

- Kreyszig, E., *Advanced Engineering Mathematics*, Wiley.
- Grewal, B. S., *Higher Engineering Mathematics*, Khanna Publishers.
- Strauss, W., *Partial Differential Equations: An Introduction*, Wiley.
- Boyce, W. E., & DiPrima, R. C., *Elementary Differential Equations and Boundary Value Problems*, Wiley.

Course Code	ES-FT201
Category	Engineering Science Courses
Course Title	Introduction to Fluid and Thermal Science
Semester	Second
L-T-P	4-0-0
Credit	4
Pre-Requisites	High School Physics

Course Objectives:,

To introduce the basic principles of fluid mechanics, thermodynamics and heat transfer with their applications in engineering systems.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction:** Importance, Properties of fluids, Newton's law of viscosity, Non-Newtonian fluids	2
	Fluid statics- Force on a submerged surface, buoyancy, and pressure measurements.	4
2	**Fluid Dynamics:** General concepts of streamline**,** Continuity Equation**,** Bernoulli's equation and applications including flow measuring devices, laminar and turbulent flow,	10

	Reynolds number, flow through pipes, and energy losses, basic concept of boundary layer.	
3	**Thermodynamic Systems and Properties:** Zeroth law, first law, and thermodynamic properties of pure substances, simple problems	6
4	**Second Law of Thermodynamics:** Entropy, Power engine and Heat pump, Carnot cycle, thermodynamic efficiency, concept of irreversibility	6
	Thermodynamic cycles: Air standard cycles, Steam Table/Mollier diagram, Vapor dome, Rankine cycle, Vapor compression cycle, basic calculations for power output and efficiency	9
5	**Applications:** Thermal devices – Steam and Gas turbines, Internal combustion engines; Refrigeration, and Air conditioning systems, , Heat and Work transfer in engineering systems	6
	Modes of Heat Transfer: Conduction – Fourier law of heat conduction, Convection - Newton's Law of cooling, Radiation- Stefan-Boltzmann law, radiation surface properties and Kirchhoff's law. Importance in engineering applications	3

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Analyze fluid properties and behavior in static and dynamic systems.
- **CO-2:** Apply thermodynamic principles to real-world systems.
- **CO-3:** Understand the interplay of energy, heat, and work in engineering processes.
- **CO-4:** Solve problems in fluid flow and heat transfer.

Learning Resources:

1. Cengel, Y. A., & Boles, M. A., *Thermodynamics: An Engineering Approach*, McGraw-Hill.
2. Fox, R. W., & McDonald, A. T., *Introduction to Fluid Mechanics*, Wiley.
3. White, F. M., *Fluid Mechanics*, McGraw-Hill.

Course Code	ES-BE201
Category	Engineering Science Courses
Course Title	Basic Electronics
Semester	Second
L-T-P	3-1-0
Credit	4
Pre-Requisites	None

Course Objectives:
To introduce students to the fundamentals of electronics, including analog and digital systems, operational amplifiers, and communication systems.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
2	**Diodes:** Semiconductor diode characteristics, rectifier circuits (half-wave, full-wave), Zener diodes, LED, and photodiodes.	6
3	**Transistors:** BJT configurations, biasing, small and large signal models, MOSFET basics, and applications.	6
4	**Operational Amplifiers and Oscillators:** Virtual ground, inverting/non-inverting amplifiers, integrators, waveform generators.	6
5	**Communication Systems:** Basics of wired and wireless systems, antennas, optical fiber communication.	6
6	**Digital Electronics:** Logic gates, multiplexers, demultiplexers, flip-flops, and sequential circuits.	10
7	**Applications of Electronic Systems:** Sensors and Instrumentation systems, regulated power supply, Security and system monitoring, data logging, and audio-video systems.	2

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Understand the functionality of electronic components.
- **CO-2:** Analyze analog systems and their applications.
- **CO-3:** Design digital logic circuits and apply them to practical problems.
- **CO-4:** Develop communication systems for engineering applications.

Learning Resources:

1. Boylestad, R., & Nashelsky, L., *Electronic Devices and Circuit Theory*, PHI, 8th Edition.
2. Floyd, T. L., *Electronic Devices*, Pearson Education, 8th Edition.
3. Sedra, A. S., & Smith, K. C., *Microelectronic Circuits*, Oxford University Press, 6th Edition.

Course Code	BS-PS201
Category	Basic Science Courses
Course Title	Probability and Statistics for Engineers
Semester	Second

L-T-P	4-0-0
Credit	4
Pre-Requisites	High School Mathematics

Course Objectives:
To provide students with an understanding of probability and statistics concepts and their applications in solving engineering problems.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Probability Theory:** , Frequency distribution , Measures of Central tendencies and dispersions, Basic terminology, types and rules, Probability under conditions of statistical independence and dependence, Bayes; Theorem and applications, Random variables, Use of expected value in decision making, Probability distributions, Choosing the correct probability distribution,	14
2	**Statistical Inference:** Random sampling and sampling distribution, point and interval estimation, Interval estimate using *t* distribution, hypothesis testing—one-sample test, chi-square and analysis of variance.	12
3	**Regression and Correlation:** Linear regression, multiple regression, correlation coefficients.	6
4	**Engineering Applications:** Time series and forecasting, Reliability analysis, Quality control and Data modeling.	8
5	**Stochastic Processes:** Markov chains – description with examples only, Queuing theory-Poisson processes, Exponential distribution,–description and simple problems	6

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Apply probability concepts to model random phenomena.
- **CO-2:** Use statistical inference methods to make decisions under uncertainty.
- **CO-3:** Analyze engineering data using regression and correlation techniques.
- **CO-4:** Model and solve engineering problems using stochastic processes.

Learning Resources:

1. Montgomery, D. C., & Runger, G. C., *Applied Statistics and Probability for Engineers*, Wiley.
2. Papoulis, A., *Probability, Random Variables, and Stochastic Processes*, McGraw-Hill.
3. Devore, J. L., *Probability and Statistics for Engineering and the Sciences*, Cengage Learning.

Course Code	HSS-EN202
Category	Humanities and Social Sciences
Course Title	Communicative English
Semester	Second
L-T-P	1-0-2
Credit	2
Pre-Requisites	HSS-EN101

Course Objectives:
To enhance students' communication skills in English with a focus on speaking, writing, and professional communication for engineering contexts.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Basics of Communication:** Types of communication, process, barriers, and overcoming them.	2
2	**Grammar and Vocabulary:** Sentence structure, subject-verb agreement, error correction, and vocabulary building.	4
3	**Writing Skills:** Letters, emails, technical reports, and summarizing.	4
4	**Speaking Skills:** Presentations, interviews, group discussions, and public speaking.	4
5	**Listening Skills:** Comprehension exercises, understanding accents, and critical listening.	2

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Demonstrate effective communication skills in professional and social settings.
- **CO-2:** Write technical documents and emails with clarity and accuracy.
- **CO-3:** Present ideas and participate in discussions confidently.
- **CO-4:** Improve listening skills to understand diverse perspectives.

Learning Resources:

1. Wren, P. C., & Martin, H., *High School English Grammar and Composition*, S. Chand.
2. Mohan, K., & Banerji, M., *Developing Communication Skills*, Mac

Course Code	ES-BE291
Category	Engineering Science Laboratory
Course Title	Basic Electronics Lab
Semester	Second
L-T-P	0-0-3
Credit	1.5
Pre-Requisites	High School Physics, Basic Electronics

Course Objectives:
To provide hands-on experience in electronic circuits, focusing on the functioning of basic electronic devices and their applications.

Lab Modules

Module No.	Description of Experiment/Task	Lab Hours
1	Introduction to electronic components and instruments: Multimeter, oscilloscope, function generator.	3
2	Diode characteristics and applications: Rectifier circuits (half-wave and full-wave).	3
3	Transistor characteristics and biasing configurations.	3
4	Logic gate implementation and verification using basic ICs.	3
5	Operational amplifier applications: Amplifiers, integrators, and differentiators.	3
6	Mini project: Design and implementation of a simple electronic circuit.	3

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Operate basic electronic instruments for circuit analysis and design.
- **CO-2:** Analyze the characteristics of diodes and transistors in various configurations.
- **CO-3:** Design and test digital circuits using logic gates and operational amplifiers.
- **CO-4:** Apply knowledge of electronics to build simple practical circuits.

Learning Resources:

1. Boylestad, R., & Nashelsky, L., *Electronic Devices and Circuit Theory*, PHI.
2. Sedra, A. S., & Smith, K. C., *Microelectronic Circuits*, Oxford University Press.

Course Code	ES-ME291
Category	Engineering Science Laboratory
Course Title	Engineering Drawing
Semester	Second
L-T-P	0-0-3
Credit	1.5
Pre-Requisites	None

Course Objectives:
To develop skills in creating manual and computer-aided technical drawings, understanding CAD interfaces, and mastering drafting techniques for engineering applications.

Module-wise Syllabus

Module No.	Description of Topic	Lab Hours
1	**Computer-Aided Drawing:** Manual mode and equipment used in the industry in earlier days, challenges with manual drafting (e.g., errors, revisions), advantages of CAD drafting, selection of appropriate CAD software, computer specifications, and conversion of manual drawings into CAD.	3
2	**CAD Interface:** Introduction to CAD hardware requirements, overview of various CAD software, familiarization with CAD window commands (New, Save, Open), template creation, setting up a new drawing (units, limits, grid, snap, sheet sizes), and plotting parameters (paper size, orientation, scale, preview).	4
3	**Exposure to CAD Commands:** Basic drawing entities (line, circle, arc, polygon, ellipse, rectangle, multiline), dimensioning, inserting text, applying constraints (horizontal, vertical, parallel, concentric, perpendicular, etc.), creating and modifying objects using scale, copy, mirror, array, fillet trim etc., Layer and block concept- uses and commands, Introduction to paper space and model space.	15
4	**Isometric Drawing:** Isometric view and isometric projection, converting orthographic views into isometric views.	6
5	**Manual Drawing:** Simple machine elements like cotter joint, knuckle joint, Rigid shaft coupling in section, Simple building floor plan with given dimensions, Welding, machining, surface roughness symbols,	12

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Understand the importance and advantages of computer-aided drafting over manual drafting.
- **CO-2:** Set up, configure, and efficiently use CAD software for engineering drawing.
- **CO-3:** Create accurate 2D and 3D engineering drawings using advanced CAD commands.
- **CO-4:** Develop and present orthographic, isometric, and sectional views in CAD applications.

Learning Resources:

1. Bhatt, N. D., *Engineering Drawing*, Charotar Publishing House.
2. Shah, M. B., & Rana, B. C., *Engineering Drawing and Computer Graphics*, Pearson Education.
3. AutoCAD Manuals and Online Tutorials.

Course Code	ES-ME292
Category	Workshop Practice
Course Title	Workshop Practice II
Semester	Second
L-T-P	1-0-3
Credit	2.5
Pre-Requisites	None

Course Objectives:
To impart practical skills in machining, welding, and electrical/electronics shop work through hands-on exercises.

Lab Modules

Module No.	Description of Experiment/Task	Lab Hours
1	Machining operations: Lathe, Shaping, Milling, and Grinding practices.	15
2	Welding techniques: Arc welding, gas welding, and TIG/MIG welding basics.	6
3	Electrical shop: Simple wiring, , simple testing and measuring instruments.	6
4	Electronics shop: Assembly and testing of simple circuits, PCB design basics.	6

	Advanced manufacturing processes: CNC turning and milling, Rapid Prototyping-demonstration only	3

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Operate machining tools to create simple components.
- **CO-2:** Perform welding tasks using different techniques.
- **CO-3:** Assemble and test basic electrical and electronic circuits.
- **CO-4:** Understand the fundamentals of manufacturing and electrical practices.

Learning Resources:

1. Hajra Choudhury, S. K., *Elements of Workshop Technology*, Media Promoters & Publishers.
2. Chapman, W. A. J., *Workshop Technology*, Edward Arnold.
3. Manuals and online resources for welding and machining techniques.

Course Code	ES-NM291
Category	Engineering Science Laboratory
Course Title	Numerical Methods and Data Analysis Laboratory
Semester	Second
L-T-P	1-0-2
Credit	2
Pre-Requisites	Mathematics I, Computer programming

Course Objectives:
To provide computational skills in numerical methods and data analysis for solving engineering problems.

Lab Modules

Module No.	Description of Experiment/Task	Lab Hours
1	Introduction to MATLAB/Python for numerical computations	6
2	Data analysis and visualization using MATLAB/Python.	3
3	Solving systems of linear equations using numerical techniques.	6
4	Interpolation and curve fitting methods.	3
5	Numerical differentiation and integration techniques.	6

6	Root finding of non-linear equations by Bisection, Newton-Raphson and Regula Falsi methods	6
7	Solving ordinary differential equations using numerical methods – 1st order initial value problem by Euler explicit scheme, second-order one-dimensional boundary value problems by method of finite difference.	6

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Use computational tools for solving numerical problems.
- **CO-2:** Apply numerical methods to engineering problems.
- **CO-3:** Analyze and visualize data using modern software.
- **CO-4:** Develop programs for numerical and data-driven solutions.

Learning Resources:

1. Chapra, S. C., & Canale, R. P., *Numerical Methods for Engineers*, McGraw-Hill.

2nd Year 3rd Semester

Sl. No.	Subject Code	Subject Name	L	T	P	Credits
		Theory				
1	BS-TD301	Thermal and Fluid Devices and Systems	**3**	**1**	**0**	**4**
2	ES-MP301	Manufacturing Processes I	**3**	**0**	**0**	**3**
3	ES-MD301	Mechanics of Deformable Bodies	**3**	**1**	**0**	**4**
4	IS-IE302	Introduction to Industrial and Systems Engineering	**2**	**0**	**0**	**2**
5	IS-DS301	Operations Research	**4**	**0**	**0**	**4**
Total Theory			**15**	**2**	**0**	**17**
		Practical				
1	ME-LAB391	Mechanical Engineering Lab	**0**	**0**	**4**	**2**
2	ES-ME391	Engineering Drawing with Solid Modelling	**1**	**0**	**3**	**2.5**
Total Practical			**1**	**0**	**7**	**4.5**
Total of 3rd Semester			**16**	**2**	**7**	**21.5**

2nd Year 4th Semester

Sl. No.	Subject Code	Subject Name	L	T	P	Credits
		Theory				
1	IS-DS401	Data Science with Applications	**4**	**0**	**0**	**4**
2	ES-MP402	Manufacturing Processes II	**4**	**0**	**0**	**4**
3	ES-DME401	Design & Drafting of Machine Elements	**2**	**0**	**2**	**3**
4	IS-MSMH401	Material Handling Systems	**3**	**0**	**0**	**3**
5	IS-EI401	Elective I	**3**	**0**	**0**	**3**
Total Theory			**16**	**0**	**2**	**17**
		Practical				
1	AM-LAB491	Advanced Manufacturing Systems Laboratory	**0**	**0**	**4**	**2**
Total Practical			**0**	**0**	**4**	**2**
Total of 4th Semester			**16**	**0**	**6**	**19**

2nd YEAR THIRD SEMESTER

Theory Subjects

Course Code	BS-TD301
Category	Core Courses
Course Title	Thermal and Fluid Devices and Systems
Semester	Third
L-T-P	3-1-0
Credit	4
Pre-Requisites	Thermodynamics, Fluid Mechanics

Course Objectives:
To provide an understanding of thermodynamic cycles, fluid systems, and their components with applications in power generation, IC engines, refrigeration, and hydraulic systems.

Module No.	Description of Topic	Lecture Hours
1	**Rankine Cycle and Modified Rankine Cycle for power:** Work and efficiency calculations.	6
2	**Thermal Power Plant Systems:** Components, functions, and environmental impact mitigation strategies	4
3	**Gas Turbine Plant and IC Engines:** Types, air-standard cycles, and environment impact mitigation strategies.	6
4	**Refrigeration and Air Conditioning:** Thermodynamic cycles, applications, and system descriptions, COP	6
5	**Heat Exchangers s:** General description, functions, and industrial examples.	4
	Pumps, hydraulic turbine and fluid coupling—use and basic working principles	3
6	**Pumping Systems and Hydel Plant:** General system description and primary system-level calculations for pump specifications and turbine rating, Cavitation and Suction lift for pumping system.	6

Course Outcomes (COs):
CO-1: Understand thermodynamic cycles and their applications in power generation and refrigeration systems.
CO-2: Analyze the components and working principles of thermal and fluid devices.

CO-3: Perform primary calculations for pump and turbine systems.
CO-4: Evaluate the environmental impacts of thermal and fluid systems and suggest mitigation strategies.

Learning Resources:

- Cengel, Y. A., & Boles, M. A., *Thermodynamics: An Engineering Approach*, McGraw-Hill.
- Fox, R. W., & McDonald, A. T., *Introduction to Fluid Mechanics*, Wiley.
- Eastop, T. D., & McConkey, A., *Applied Thermodynamics for Engineering Technologists*, Pearson.

2. ES-MP301: Manufacturing Processes I (Forming, Machining, Casting)

Course Code	**ES-MP301**
Category	Core Courses
Course Title	Manufacturing Processes I
Semester	Third
L-T-P	3-0-0
Credit	3
Pre-Requisites	None

Course Objectives:
To introduce students to conventional manufacturing processes, including casting, forming, machining, and joining.

Module No.	**Description of Topic**	**Lecture Hours**
1	**Casting and Molding:** Foundry shop description and functions, metal casting processes, heat transfer and solidification, riser design, defects, and residual stresses.	10
2	**Bulk and Sheet Metal Forming:** Plastic deformation, hot/cold working, load estimation, forging, rolling, extrusion, drawing, and shearing.	6
3	**Machining:** Orthogonal cutting, tool geometry, tool life, tool material, chip formation, turning, drilling, milling, and finishing processes, surface roughness..	10
4	**Joining Processes:** Welding, brazing, soldering, solid/liquid state joining, adhesive bonding, and design considerations in welding.	4
	Introduction to Metallography and Heat Treatment – Metal crystal structure (FCC, BCC, HCP), solid solution and alloys, Microstructure description of steel, Fe-C phase equilibrium diagram, different heat treatment processes and uses	6

Course Outcomes (COs):
CO-1: Understand the fundamentals of casting, forming, machining, and joining processes.
CO-2: Analyze load estimation and material deformation in manufacturing.
CO-3: Evaluate machining operations and cutting tool performance.
CO-4: Apply knowledge of joining processes for industrial applications.

Learning Resources:

- Kalpakjian, S., & Schmid, S. R., *Manufacturing Engineering and Technology*, Pearson.
- Rao, P. N., *Manufacturing Technology*, Tata McGraw-Hill.
- Groover, M. P., *Fundamentals of Modern Manufacturing*, Wiley.

3. ES-MD301: Mechanics of Deformable Bodies

Course Code	**ES-MD301**
Category	Core Courses
Course Title	Mechanics of Deformable Bodies
Semester	Third
L-T-P	3-1-0
Credit	4
Pre-Requisites	Strength of Materials

Course Objectives:
To study the behavior of deformable bodies under various forces, covering stress, strain, and deformation analysis.

Module No.	**Description of Topic**	**Lecture Hours**
1	Stress and strain analysis: Normal and shearing stresses, deformation under axial loads, strain energy.	6
2	Biaxial Stress and Mohr's Circle: Principal stress, shear strain energy, stresses in thin-walled pressure vessels.	6

Module No.	Description of Topic	Lecture Hours
3	Beam Mechanics: Shear force and bending moment diagrams, bending stresses, and deflection of beams.	8
4	Torsion and Springs: Circular shafts, helical springs under axial pull, combined loading on shaft	4
5	Column Buckling: Euler's formula, empirical column formulas,.	8
6	Material Behavior: Stress-strain diagrams, ductile/brittle materials, hardness measurement	4

Course Outcomes (COs):
CO-1: Analyze stress and strain in deformable solids.
CO-2: Understand beam mechanics and torsion of circular shafts.
CO-3: Evaluate column stability under buckling loads.
CO-4: Apply material properties in mechanical component design.

Learning Resources:

- Gere, J. M., *Mechanics of Materials*, Cengage Learning.
- Beer, F. P., & Johnston, E. R., *Mechanics of Materials*, McGraw-Hill.
- Popov, E. P., *Engineering Mechanics of Solids*, Pearson.

4. IS-IE302: Introduction to Industrial and Systems Engineering

Course Code	IS-IE302
Category	Core Courses
Course Title	Introduction to Industrial and Systems Engineering
Semester	Third
L-T-P	2-0-0
Credit	2
Pre-Requisites	None

Course Objectives:
To introduce the principles and scope of industrial and systems engineering.

Module No.	Description of Topic	Lecture Hours
1	**Introduction:** Job roles, generic definitions, and major functions of industrial engineers. A general description of Systems Engineering	6
2	**Heritage and Evolution:** Industrial revolution, typewriter history, and progress to cyber operations. Some areas of industrial and systems engineering and related disciplines	6
3	**Systems and Operations:** Production function, overall equipment effectiveness, system lifecycle, and human-system interaction.	6
4	**Disciplines and Applications:** Analysis levels in production planning, ties to other engineering disciplines, and basics of systems engineering.	6

Course Outcomes (COs):
CO-1: Define roles and scope of industrial and systems engineering.
CO-2: Trace the evolution of industrial systems engineering.
CO-3: Apply basic concepts in production and operations planning.
CO-4: Understand human-system interaction and lifecycle considerations.

Learning Resources:

- Salvendy, G., *Handbook of Industrial Engineering*, Wiley.
- Badiru, A. B., *Handbook of Industrial and Systems Engineering*, CRC Press.
- Kusiak, A., *Computational Intelligence in Design and Manufacturing*, Wiley.

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5. IS-DS301: Operations Research

Course Code	IS-DS301
Category	Core Courses
Course Title	Operations Research
Semester	Third
L-T-P	4-0-0
Credit	4
Pre-Requisites	Mathematics II

Course Objectives:
To develop problem-solving skills in optimization, decision-making, and resource allocation using operations research techniques.

Module No.	Description of Topic	Lecture Hours
1.	**Introduction to OR:** Scope, methodology, models, and tools.	2
2.	**Linear Programming:** Formulation, graphical solutions, simplex method, and duality concepts.	9
3.	**Transportation Problems:** Formulation, solution methods include N-W corner rule, least cost method, Vogels approximate method	6
4.	**Assignment Problem**: Formulation, solution methods include Hungarian method, Branch and Bound algorithm	6
5.	**Monte Carlo Simulation:** Introduction, generation of random numbers, Model analysis, and simulation methodology, Problems,	4
6.	**Waiting Line Analysis**: The queuing system, elements of a queuing system., service mechanism and queue discipline, queueing models, examples and problems	6
7.	**Decision making under uncertainty:** Maximin, maximax, and minimax regret criteria, Bayesian decision theory, Prior and posterior probabilities, Value of information and value of perfect information	6
8.	**Inventory Models:** Basic purchase model, EOQ - infinite and finite out-of-stock cost conditions, price discount models, basic production model, EPQ.	3
9.	**Decision and Sequencing Models:** Decision trees, job sequencing, and scheduling models.	6

Course Outcomes (COs):

CO-1: Formulate and solve optimization problems using linear programming.
CO-2: Apply transportation and queuing models to industrial problems.
CO-3: Analyze inventory and replacement systems.
CO-4: Use simulation and decision-making techniques in real-world applications.

Learning Resources:

- Taha, H. A., *Operations Research: An Introduction*, Pearson.
- Hillier, F. S., & Lieberman, G. J., *Introduction to Operations Research*, McGraw-Hill.
- Winston, W. L., *Operations Research: Applications and Algorithms*, Cengage Learning.
- Agee, Marvin. A, Taylor. R & Torgersen, Paul. E, *Quantitative Analysis for Management Decisions,* Prentice Hall Inc., 1976.

Practical

1. ME-LAB391: Mechanical Engineering Lab (Fluid, Thermal, Material Testing, Dynamics)

Course Code	ME-LAB391
Category	Laboratory Courses
Course Title	Mechanical Engineering Lab
Semester	Third
L-T-P	0-0-4
Credit	2
Pre-Requisites	Fundamentals of Fluid Mechanics and Materials

Course Objectives:
To provide hands-on experience in fluid flow measurement, thermal analysis, material testing, and dynamics of machines.

Module No.	Description of Topic	Lab Hours
	Group I	
1.	Measurement of the coefficient of discharge using orifice and Venturi meters.	3
2.	Determination of friction factor for flow in pipe.	3
3.	Performance characteristics of Pelton Wheel/Francis turbine.	3
4.	Reynolds experiment	3
	Group II	
1.	Determination of calorific value, flash point, and fire point of a given fuel.	3
2.	Study of the working of a double pipe heat exchanger c	3
3.	Indicator diagram and performance analysis of a 4-stroke diesel engine.	3
4.	A simple refrigeration system- working demonstration and study of components	3
	Group III	
1.	Hardness testing using Brinell, Vickers, and Rockwell methods.	3
2.	Torsion test on mild steel rods.	3
3.	Impact testing of metallic specimens.	3
4.	Bending deflection test on beams.	3
5.	Vibration studies using sensors.	3

Module No.	Description of Topic	Lab Hours
	Group I	
6.	Microstructure analysis of a mild steel specimen.	3
	Group IV	
1.	An working model of air conditioning unit- working demonstration and study of components	3
2.	Study of a centrifugal pump fitted with a motor, identification of the impeller, casing, suction and delivery nozzles, bearings, gland and coupling, under disassembled condition and assembling back	3
3.	Performance characteristics of a centrifugal pump.	3
4.	Kinematic studies of mechanisms –gear train, worm and worm wheel, rack and pinions, four-bar, slider-crank, crank-rocker, cam and follower, screw and nut. Studies of basic m/c elements like different types of gears, bearings and couplings, clutches..	3
5.	Uniaxial tension test on mild steel test specimen.	3
6.	Study of small working systems of i) a belt conveyor system for bulk material, ii) roller conveyor and iii) bucket elevator system	3
7.	Study of a small single cylinder petrol/diesel engine: Identification of engine components including crank and connecting rod, crank, connecting rod under disassembled condition and assembling back.	6

N.B. Experiments in Group IV are compulsory, any two from III and any one from Gr. I and Group II

Course Outcomes (COs):
CO-1: Perform fluid flow and thermal property measurements.
CO-2: Evaluate material properties through tension, torsion, impact, and hardness tests.
CO-3: Analyze kinematic mechanisms and dynamic systems.
CO-4: Conduct microstructural and vibration studies.

Learning Resources:

- Lab manuals and experiment sheets.
- Holman, J. P., *Experimental Methods for Engineers*, McGraw-Hill.
- Dowling, N. E., *Mechanical Behavior of Materials*, Pearson.

2. ES-ME391: Engineering Drawing with Solid Modelling

Course Code	ES-ME391
Category	Laboratory Courses
Course Title	Engineering Drawing with Solid Modelling
Semester	Third
L-T-P	1-0-3
Credit	2.5
Pre-Requisites	Engineering Graphics

Course Objectives:
To develop proficiency in orthographic and isometric drawing and solid modeling using CAD tools.

Module No.	Description of Topic	Lab Hours
1	Working in 3-D environment-: creating 3-D solid model of simple machine parts, Part Tools- Using features like Extrude, Hole, Revolve, Rib, Sweep, Sweep blend, Pattern etc.	8
3	Part editing tools and modifying tools: Trim, Extend, Erase and Mirror, Chamfer, Round, Copy, Move, Draft etc.	6
4	Intersect 2 solid components by inserting new body option, Boolean operations: Union, subtract, intersection	9
5	Assembly drawing: Preparation of assembly drawing by using assembly command, explode the assembly.	6
6	Orthographic projections: Generate orthographic projection of the assembly, Prepare Part list table (Bill of Materials)	6
	Printer selection, paper size, orientation, page set up	1

Course Outcomes (COs):
CO-1: Understand schematic symbols and apply them in engineering drawings.
CO-2: Create orthographic, sectional, and isometric projections.
CO-3: Develop assembly and detailed drawings for mechanical systems.
CO-4: Use CAD software to produce accurate engineering designs.

Learning Resources:

- Sam Tickoo, *SolidWorks for designers Release 2006*, Cadsim Technologies (soft cover)
- Sam Tickoo, *Auto desk Inventor for designers Release 10*, Cadsim Technologies (soft cover)

- Sam Tickoo, *Catia V5R17 for designers,* Cadsim Technologies (soft cover)
- Shah, M. B., & Rana, B. C., *Engineering Drawing and Computer Graphics*, Pearson.
- Manuals and tutorials for Pro-E, Catia/Solid*Works* or similar Solid modelling software.

2nd YEAR FOURTH SEMESTER

Theory Subjects

1. Data Science with Applications

Course Code	**IS-DS401**
Category	Core Course
Course Title	Data Science with Applications
Semester	Fourth
L-T-P	4-0-0
Credit	4
Pre-Requisites	None

Course Objectives:
To provide foundational knowledge of data science, introduce practical tools and techniques for data analysis, and demonstrate applications of data science in industrial and systems engineering.

Module-wise Syllabus:

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Data Science**: Overview of data science, role in industrial systems, introduction to Python/R for data science.	5
2	**Data Preparation**: Data cleaning, transformation, and visualization techniques; exploratory data analysis (EDA).	9
3	**Machine Learning Basics**: Introduction to supervised and unsupervised learning, key algorithms (e.g., linear regression, clustering and decision functions).	9
	Natural Language Processing	9
	Deep Learning	9
	Computer vision	4

Module No.	Description of Topic	Lecture Hours
4	**Applications in Industry**: Case studies on data science applications in manufacturing, logistics, and quality control.	3

Course Outcomes (COs):
CO-1: Understand the core concepts of data science and its importance in industrial systems.
CO-2: Apply data cleaning and visualization techniques using modern tools.
CO-3: Implement basic machine learning algorithms to solve industrial problems.
CO-4: Analyze real-world data and derive insights for decision-making.

Learning Resources:

- Hastie, T., Tibshirani, R., & Friedman, J., *The Elements of Statistical Learning*, Springer.
- McKinney, W., *Python for Data Analysis*, O'Reilly.
- James, G., et al., *An Introduction to Statistical Learning*, Springer.
- Murphy, K. P., *Machine Learning: A Probabilistic Perspective*, MIT Press.

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2. Manufacturing Processes II

Course Code	ES-MP402
Category	Core Course
Course Title	Manufacturing Processes II
Semester	Fourth
L-T-P	4-0-0
Credit	4
Pre-Requisites	None

Course Objectives:
To provide an understanding of advanced manufacturing techniques, including CNC, rapid prototyping, and laser material processing.

Module-wise Syllabus:

Module No.	Description of Topic	Lecture Hours
1	**Automation**: Fixed vs. flexible automation; Flexible Manufacturing Systems (FMS); CNC machining basics.	12

Module No.	Description of Topic	Lecture Hours
2	**CNC Machining**: CNC lathe and milling; part programming using ISO G and M codes; APT programming.	12
3	**Rapid Prototyping**: Overview, STL conversion, 3D printing methods (SLA, SLS, FDM, etc.).	12
4	**Laser Material Processing**: Laser cutting, welding, marking, and additive manufacturing applications.	12

Course Outcomes (COs):
CO-1: Understand different types of automation and their industrial applications.
CO-2: Develop part programs for CNC machines using ISO G and M codes.
CO-3: Explain rapid prototyping techniques and their industrial uses.
CO-4: Apply laser-based material processing techniques in manufacturing.

Learning Resources:

- Groover, M. P., *Automation, Production Systems, and Computer-Integrated Manufacturing*, Pearson.
- Gibson, I., Rosen, D. W., & Stucker, B., *Additive Manufacturing Technologies*, Springer.
- Kundra, T. K., *Numerical Control and Computer-Aided Manufacturing*, Tata McGraw-Hill.

3. Design & Drafting of Machine Elements

Course Code	ES-DME401
Category	Core Course
Course Title	Design & Drafting of Machine Elements
Semester	Fourth
L-T-P	2-0-2
Credit	3
Pre-Requisites	None

Course Objectives:
To introduce principles of design and analysis of machine elements and familiarize students with drafting techniques.

Module-wise Syllabus:

Module No.	Description of Topic	Lecture Hours
1	**Mechanical Elements and Drives:** Shaft, key and keyways, nut and bolt, Rack and pinion, bearings, gears and gear box, belt-pulley systems, chain-sprocket systems. couplings, clutch- description, working principles and uses	6
2	**Design Fundamentals**: Modes of failure, theories of failure, stress-strain diagram, allowable stress and safety factors, .standards and codes	3
3	**Design of Joints and Shafts**: solid and hollow shafts, key and keyway, Cotter and knuckle joints.	12
	Schematic symbols for standard components in mechanical, electrical, and electronic systems, welding, machining, surface roughness symbols	3
4	2-D drafting drawings of the M/c elements designed in module 3	6
	Solid Modelling of a gear train, knuckle joint and rigid coupling with given dimensions	6

Course Outcomes (COs):
CO-1: Analyze failure modes and select appropriate design criteria.
CO-2: Design basic machine components like joints, shafts, and bearings.
CO-3: Understand and apply mechanical drive principles.
CO-4: Create machine element drawings using CAD tools.

Learning Resources:

- Shigley, J. E., & Mischke, C. R., *Mechanical Engineering Design*, McGraw-Hill.
- Norton, R. L., *Machine Design: An Integrated Approach*, Pearson.
- Bhatt, N. D., *Machine Drawing*, Charotar Publishing.

4. Material Handling Systems

Course Code	IS-MSMH401
Category	Core Course
Course Title	Material Handling Systems
Semester	Fourth
L-T-P	3-0-0
Credit	3

Course Code	IS-MSMH401
Pre-Requisites	None

Course Objectives:
To provide knowledge of principles, equipment, and systems for effective material handling in industries.

Module-wise Syllabus:

Module No.	Description of Topic	Lecture Hours
1	**Introduction**: Objectives, functions, and principles of material handling.	6
2	**Material Handling Equipment**: conveyors and types, industrial trucks, cranes, tractor and trailer, hoisting systems	12
3	**Guidelines for Utilization**: Equipment selection, effective utilization principles.	9
4	**Applications**: Case studies in manufacturing, power plants, ports, cement and steel plants.	9

Course Outcomes (COs):
CO-1: Understand the objectives and principles of material handling systems.
CO-2: Identify and evaluate different material handling equipment.
CO-3: Select appropriate equipment for specific industrial applications.
CO-4: Analyze material handling case studies to suggest efficient solutions.

Learning Resources:

- A Spivakovsky and V Dyachkov, *Conveyors and related Equipment,* Peace Publishers, Moscow (available in Net for online reading)
- N. Rudenko **,** *Materials Handling Equipment,* Mir Publishers**,**
- Kulwiec, R. A., *Material Handling Handbook*, Wiley.
- Ray, S., *Introduction to Materials Handling*, New Age International.
- Sharma, S. C., *Material Handling and Logistics*, Khanna Publishers.

Elective I - Option 1: Material Science and Engineering

Course Code	IS-EI401A
Category	Elective I
Course Title	Material Science and Engineering

Course Code	IS-EI401A
Semester	Fourth
L-T-P	3-0-0
Credit	3
Pre-Requisites	None

Course Objectives:
To provide foundational knowledge of materials, their structures, properties, and applications in engineering.

Module-wise Syllabus:

Module No.	Description of Topic	Lecture Hours
	Material Types: Metals (Ferrous and Non-Ferrous), ceramics, polymers, composites, and advanced materials (nanomaterials, smart materials), importance and applications.	2
2	**Mechanical Properties of materials**: Stress-Strain behavior, Malleability and ductility, hardness, toughness, fatigue, and creep.	4
	Introduction to Material Science: Atomic structure, bonding, crystallography	9
	Solid Solutions and Alloys: Pure metals and alloys, crystal structure, microstructure of alloys	6
3	**Phase Diagrams**: Phase transformations, binary phase diagrams (unlimited and limited solubility), lever rule	9
	TTT diagram and Heat Treatment: Description of TTT diagram and importance, controlling mechanical properties of alloys through heat treatment, processes of heat treatment- Annealing, Tempering, Normalizing, Quenching; Position of the processes on Fe-C phase equilibrium diagram	6

Course Outcomes (COs):
CO-1: Understand the basic structure and properties of engineering materials.
CO-2: Analyze the mechanical behavior of different materials under varying conditions.
CO-3: Apply phase diagram concepts to predict material performance.
CO-4: Select appropriate materials for specific industrial applications.

Learning Resources:

- Callister, W. D., *Materials Science and Engineering: An Introduction*, Wiley.
- Van Vlack, L. H., *Elements of Materials Science and Engineering*, Pearson.
- Raghavan, V., *Materials Science and Engineering*, PHI Learning.

Elective I - Option 2: Renewable Energy

Course Code	IS-EI401B
Category	Elective
Course Title	Renewable Energy
Semester	Fourth
L-T-P	3-0-0
Credit	3
Pre-Requisites	None

Course Objectives:
To introduce renewable energy technologies and their applications, emphasizing sustainable energy systems.

Module-wise Syllabus:

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Renewable Energy**: Global energy scenario, Present and projected world power generation capacity mix**,** , need for renewable energy, Different types of renewable energy and their growth history.	3
2	**Solar Energy**: Solar radiation, photovoltaic systems, solar thermal systems.	12
3	**Wind Energy**: Wind characteristics, wind turbines, power generation, and grid integration.	12
4	**Other Renewable Sources**: Biomass, geothermal, tidal, and small hydroelectric systems.	9

Course Outcomes (COs):
CO-1: Understand the importance and potential of renewable energy sources.
CO-2: Analyze the working principles of solar and wind energy systems.
CO-3: Evaluate the feasibility of different renewable energy technologies for various applications.
CO-4: Propose sustainable energy solutions for industrial and societal needs.

Learning Resources:

- International Energy Agency (IEA*), World Energy Outlook 2020*
- Boyle, G., *Renewable Energy: Power for a Sustainable Future*, Oxford University Press.
- Duffie, J. A., & Beckman, W. A., *Solar Engineering of Thermal Processes*, Wiley.
- Sorensen, B., *Renewable Energy*, Academic Press.

Practical Subjects

Course Code	AM-LAB491
Category	Engineering Science Laboratory
Course Title	Advanced Manufacturing Systems Laboratory
Semester	Fourth
L-T-P	0-0-4
Credit	2
Pre-Requisites	Basic knowledge of manufacturing processes and tools.

Course Objectives

To provide practical exposure to advanced manufacturing systems, focusing on transport systems, automation, CAD/CAM, robotics, and CNC programming.

Lab Modules

Module No.	Description of Experiment/Task	Lab Hours
1	**Industrial Transport Systems**: Study and demonstration of different transport systems using small size working prototype- crane, bulk handling and unit handling equipment.	3
2	**Automated Guided Vehicle (AGV)**: Programming and control of a PLC-based AGV system with component assembly.	6
3	**Rapid Prototyping with CAD and 3D Printing**: Hands-on exercise- Using CAD solid model developed in previous year laboratory class to produce simple components using 3D printing.	6
4	**Six DOF Robot Programming**: Controlling and programming a six-degree-of-freedom robotic arm.	6
5	**Laser Processing System**: Demonstration of laser-based processes like drilling and bending of plates.	6
6	**CNC Turning and Milling**: Hands-on practice in CNC machining with part programming.	9

Course Outcomes (COs)

Upon completion of this course, students will be able to:
CO-1: Analyze and utilize various industrial transport systems.
CO-2: Assemble and program PLC-based AGV systems.
CO-3: Execute rapid prototyping projects using CAD and 3D printing.
CO-4: Program and control robotic systems with six degrees of freedom.
CO-5: Perform laser-based processing and CNC machining operations.

Learning Resources

- Groover, M. P., *Automation, Production Systems, and Computer-Integrated Manufacturing*, Pearson.
- Kalpakjian, S., & Schmid, S. R., *Manufacturing Engineering and Technology*, Pearson.
- Gibson, I., Rosen, D. W., & Stucker, B., *Additive Manufacturing Technologies*, Springer.
- Manuals and guides for CNC and robotic systems.

3rd Year 5th Semester

Sl. No.	Subject Code	Subject Name	L	T	P	Credits
		Theory				
1	IS-HFE501	Human Factors and Ergonomics in System Design	**2**	**0**	**0**	**2**
2	IS-OSCM501	Integrated Operations and Supply Chain Management	**4**	**0**	**0**	**4**
3	IS-SIM501	Simulation of Industrial Systems	**3**	**0**	**0**	**3**
4	IS-WPD501	Workplace Design	**2**	**0**	**0**	**2**
5	IS-QMS501	Quality Management Systems and Planning	**3**	**0**	**0**	**3**
6	IS-EII501	Elective II	**3**	**0**	**0**	**3**
Total Theory			**17**	**0**	**0**	**17**
		Practical				
1	IS-SIMLAB591	Engineering System Simulation Lab	**0**	**0**	**3**	**1.5**
2	IS-BASA591	Business Analytics Software and Applications	**0**	**0**	**3**	**1.5**
Total Practical			**0**	**0**	**6**	**3**
Total of 5th Semester			**17**	**0**	**6**	**20**

3rd Year 6th Semester

Sl. No.	Subject Code	Subject Name	L	T	P	Credits
		Theory				
1	IS-SE601	Systems Engineering	**4**	**0**	**0**	**4**
2	IS-LTS601	Logistics and Transportation Systems	**3**	**0**	**0**	**3**
3	IS-IAR601	Industrial Automation and Robotics	**2**	**0**	**0**	**2**
4	IS-EEF601	Engineering Economics and Financial Accounting	**3**	**0**	**0**	**3**
5	IS-EIII601	Elective III	**3**	**0**	**0**	**3**
Total Theory			**15**	**0**	**0**	**15**
		Practical				
		Industrial Internship/Practicum	**0**	**0**	**0**	**0**
Total Practical			**0**	**0**	**0**	**0**
Total of 6th Semester			**15**	**0**	**0**	**15**

3rd YEAR FIFTH SEMESTER

Theory Subjects

Course Code	IS-HFE501
Category	Industrial Systems Core
Course Title	Human Factors and Ergonomics in System Design
Semester	Fifth
L-T-P	2-0-0
Credits	2
Pre-Requisites	Basics of Engineering Systems and Workplace Design

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Course Objectives

- To understand the role of ergonomics in designing efficient and safe systems.
- To analyze the interaction between humans and their working environment.
- To integrate human factors principles into industrial and systems engineering.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Human Factors**: Definition, scope, and importance. Human-machine interaction and systems ergonomics.	4
2	**Workplace Design**: Anthropometry, workspace layout, and design principles.	4
3	**Cognitive Ergonomics**: Human perception, decision-making, workload, and fatigue.	6
4	**Occupational Safety and Health**: Workplace hazards, safety regulations, and risk management.	4
5	**Ergonomics Applications**: Case studies in industrial systems, tools, and methodologies.	6

Course Outcomes (COs)

- **CO-1**: Understand the fundamentals of human factors and ergonomics.

- **CO-2**: Design efficient workplaces by applying ergonomic principles.
- **CO-3**: Analyze cognitive factors affecting human performance.
- **CO-4**: Ensure safety and health in the workplace through risk assessment.
- **CO-5**: Apply ergonomic techniques to optimize industrial systems.

Learning Resources

1. Sanders, M. S., & McCormick, E. J. *Human Factors in Engineering and Design*, McGraw-Hill.
2. Bridger, R. S. *Introduction to Human Factors and Ergonomics*, CRC Press.
3. Dul, J., & Neumann, W. P. *Ergonomics: How to Design for Ease and Efficiency*, Wiley.

Course Code	**IS-OSCM501**
Category	Industrial Systems Core
Course Title	Integrated Operations Management and Supply Chain Management
Semester	Fifth
L-T-P	4-0-0
Credits	4
Pre-Requisites	Basics of Operations Research

Course Objectives

- To provide a thorough understanding of operations and supply chain management.
- To equip students with tools and techniques for analyzing and optimizing supply chain operations.

Module-wise Syllabus

Module No.	**Description of Topic**	**Lecture Hours**
1	**Introduction to Supply Chain**: Definition, Supply chain – objectives – importance – decision phases, competitive and supply chain strategies, achieving strategic fit, supply chain drivers,	2
2	**Designing the Supply Chain Network**- Designing the distribution network – role of distribution – factors influencing distribution, design options – e-business and its impact, Distribution networks in practice – factors affecting the network design decisions – modeling for supply chain.	4

Module No.	Description of Topic	Lecture Hours
3	**Supply Chain Strategies**: Lean and agile supply chains, demand forecasting-approaches-role of IT	4
4	**Planning and Managing Inventories**- Safety inventory and its appropriate level – impact of supply uncertainty, aggregation and replenishment policies, JIT	6
5	**Transportation Networks and Sourcing**-: Role of transportation – modes and their performance, – transportation infrastructure and policies - design options and their trade-offs – Tailored transportation. Sourcing – In-house or Outsource – 3rd and 4th PLs – supplier scoring and assessment, Transportation and network models and optimization.	9
6	**Coordination in a Supply Chain**- Lack of supply chain coordination and the Bullwhip effect – obstacle to coordination	2
7	**Operations Management**: Overview of production systems- Inputs, Process and outputs; Classification of operations; Responsibilities of Operations Manager; New Product Development, Selection and Design of Product / Services; capacity planning.	8
8	**Operations Strategies**: Lean manufacturing, Six Sigma, and process improvement.	3
9	**Production Planning & Control:** Production planning techniques for various process choices, Techniques of production control, Aggregate planning techniques,	3
10	**Quality management**: Introduction; Meaning; Quality characteristics of goods and services; Tools and techniques for quality improvement: check sheet, histogram, scatter diagram, cause and effect diagram, Pareto chart	4
11	**Productivity Improvement Techniques**: Work study; Method study; Work measurement: time study: stop watch time study; Work sampling. Maintenance: maintenance policies for facilities and equipment; Time of failure; Preventive versus breakdown maintenance;, total productive maintenance (TPM)	6

Course Outcomes (COs)

- **CO-1**: Understand the concepts of operations and supply chain management.
- **CO-2**: Analyze production and inventory systems using various techniques.
- **CO-3**: Evaluate supply chain strategies to enhance efficiency.
- **CO-4**: Apply network design principles for transportation and logistics optimization.
- **CO-5**: Solve real-world supply chain issues through case study analysis.

Learning Resources

1. Chopra, S., & Meindl, P. *Supply Chain Management: Strategy, Planning, and Operation*, Pearson.
2. Slack, N., Chambers, S., & Johnston, R. *Operations Management*, Pearson.

3. Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. *Designing and Managing the Supply Chain*, McGraw-Hill.

Course Code	IS-SMA501
Category	Industrial Systems Core
Course Title	Simulation of Industrial Systems
Semester	Fifth
L-T-P	3-0-0
Credits	3
Pre-Requisites	Basics of Modeling and Operations Research

Course Objectives

- To introduce students to simulation and modeling tools for analyzing engineering systems.
- To develop skills in building and interpreting simulation models for optimization.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Simulation**: Role, importance, and basic concepts.	6
2	**System Dynamics Modeling**: Feedback loops, causal diagrams, and dynamic behavior., computer model, S-shaped growth dynamics model, Modeling delays and oscillations , non-linearity and Table functions, verification and validation,	9
3	**Discrete Event Simulation (DES)**: Tools, techniques, and applications.	9
4	**Input and Output Analysis**: Random number generation, statistical testing, interpretation.	6
5	**Simulation Case Studies**: Applications in manufacturing, logistics, and operations.	6

Course Outcomes (COs)

- **CO-1**: Understand the fundamentals of simulation and modeling techniques.
- **CO-2**: Develop system dynamics and DES models.
- **CO-3**: Analyze simulation input-output data for system optimization.
- **CO-4**: Apply simulation tools to industrial case studies.

- **CO-5**: Interpret and validate simulation results effectively.

Learning Resources

1. Law, A. M. *Simulation Modeling and Analysis*, McGraw-Hill.
2. Sterman, J. D. *Business Dynamics*, McGraw-Hill.
3. Banks, J. *Discrete-Event System Simulation*, Pearson.

Course Code	IS-WPD501
Category	Industrial Systems Core
Course Title	Workplace Design
Semester	Fifth
L-T-P	2-0-0
Credits	2
Pre-Requisites	Basics of Ergonomics and Systems Design

Course Objectives

- To provide knowledge on designing workplaces for improved productivity and safety.
- To apply principles of ergonomics and systems analysis to optimize workplace environments.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Workplace Design**: Importance, objectives, and principles of effective design.	4
2	**Anthropometric Considerations**: Human measurements, workspace design standards.	4
3	**Workstation Layout**: Manual work design, seating, tools, and visual display arrangements.	6
4	**Work Environment Factors**: Lighting, noise, vibration, temperature, and safety.	4
5	**Workplace Optimization**: Lean principles, simulation tools, and case studies.	6

Course Outcomes (COs)

- **CO-1**: Understand the fundamentals of workplace design and its importance.
- **CO-2**: Apply anthropometric data to design workspaces.
- **CO-3**: Optimize workstation layout for better ergonomics and efficiency.
- **CO-4**: Evaluate environmental factors affecting workplace productivity.
- **CO-5**: Implement workplace optimization techniques using case studies.

Learning Resources

1. Bridger, R. S. *Introduction to Human Factors and Ergonomics*, CRC Press.
2. Dul, J., & Neumann, W. P. *Ergonomics: How to Design for Ease and Efficiency*, Wiley.
3. Konz, S., & Johnson, S. *Work Design: Industrial Ergonomics*, Holcomb Hathaway.

Course Code	**IS-QMS501**
Category	Industrial Systems Core
Course Title	Quality Management Systems and Planning
Semester	Fifth
L-T-P	3-0-0
Credits	3
Pre-Requisites	Basics of Industrial Systems and Operations Management

Course Objectives

- To understand the principles of quality management systems and their role in industrial processes.
- To equip students with tools for quality planning, control, and improvement.

Module-wise Syllabus

Module No.	**Description of Topic**	**Lecture Hours**
1	**Introduction to Quality Management**: Concepts of quality, Total Quality Management (TQM), and standards.	6
2	**Quality Tools**: Seven QC tools, Pareto analysis, cause-effect diagrams.	8
3	**Statistical Process Control (SPC)**: Control charts, process capability analysis.	8

Module No.	Description of Topic	Lecture Hours
4	**Quality Standards and Audits**: ISO 9001, Six Sigma methodologies, auditing techniques.	8
5	**Quality Improvement Techniques**: Kaizen, PDCA, and continuous improvement case studies.	6

Course Outcomes (COs)

- **CO-1**: Understand the fundamentals of quality management systems.
- **CO-2**: Utilize quality tools for identifying and solving process problems.
- **CO-3**: Apply statistical process control techniques to ensure quality.
- **CO-4**: Analyze quality standards and perform audits.
- **CO-5**: Develop quality improvement strategies for industrial systems.

Learning Resources

1. Juran, J. M. *Juran's Quality Handbook*, McGraw-Hill.
2. Evans, J. R., & Lindsay, W. M. *Managing for Quality and Performance Excellence*, Cengage.
3. Montgomery, D. C. *Introduction to Statistical Quality Control*, Wiley.
4. Feigenbaum, A. V. *Total Quality Control*, McGraw-Hill.
5.

ELECTIVE SUBJECTS

Course Code	IS-EII501A
Category	Elective
Course Title	Sustainable Engineering
Semester	Fifth
L-T-P	3-0-0
Credits	3
Pre-Requisites	Basics of Environmental Studies

Course Objectives

- To introduce concepts of sustainability in engineering practices.
- To analyze the environmental, economic, and social impacts of engineering solutions.
- To equip students with tools and techniques for sustainable system design.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Sustainability**: Concepts of sustainable development, triple bottom line approach.	6
2	**Sustainable Engineering Principles**: Life Cycle Assessment (LCA), eco-efficiency, circular economy.	9
3	**Energy and Resource Management**: Renewable energy, energy-efficient technologies, and resource conservation.	9
4	**Green Manufacturing**: Design for environment (DFE), waste minimization, and green supply chain management.	6
5	**Sustainable Case Studies**: Examples of sustainable practices in industries.	6

Course Outcomes (COs)

- **CO-1**: Understand the principles of sustainable development in engineering.
- **CO-2**: Apply LCA and eco-efficiency techniques in system design.
- **CO-3**: Analyze resource and energy management techniques.
- **CO-4**: Implement green manufacturing concepts in industrial processes.
- **CO-5**: Evaluate real-world case studies to adopt sustainable engineering practices.

Learning Resources

1. Anastas, P. T., & Zimmerman, J. B. *Design through the 12 Principles of Green Engineering*, Wiley.
2. Graedel, T. E., & Allenby, B. R. *Industrial Ecology and Sustainable Engineering*, Pearson.
3. Peet, J. *Energy and the Ecological Economics of Sustainability*, Island Press.

Course Code	IS-EII501B
Category	Elective
Course Title	Supply Chain Economics
Semester	Fifth
L-T-P	3-0-0
Credits	3
Pre-Requisites	Basics of Operations and Supply Chain Management

Course Objectives

- To develop an understanding of economic concepts in supply chain management.
- To optimize supply chain systems through economic analysis and decision-making tools.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Supply Chain Economics**: Cost structures, demand-supply analysis, and value creation.	6
2	**Economic Order Quantity (EOQ)**: Inventory costs, trade-offs, and EOQ models.	8
3	**Transportation Economics**: Cost optimization, network planning, and logistics.	8
4	**Global Supply Chain Economics**: Currency fluctuation, taxation, and trade-offs in global networks.	6
5	**Supply Chain Case Studies**: Economic analysis of real-world supply chains.	6

Course Outcomes (COs)

- **CO-1**: Understand the fundamentals of supply chain economics.
- **CO-2**: Optimize inventory systems using economic analysis tools.
- **CO-3**: Analyze transportation economics for cost-effective logistics.
- **CO-4**: Apply economic principles in global supply chain management.
- **CO-5**: Evaluate supply chain systems through case studies.

Learning Resources

1. Chopra, S., & Meindl, P. *Supply Chain Management: Strategy, Planning, and Operation*, Pearson.
2. Shapiro, J. F. *Modeling the Supply Chain*, Duxbury Press.
3. Taylor, D. A. *Introduction to Logistics and Supply Chain Management*, Pearson Education.

Practical Subjects

Course Code	IS-SIMLAB591
Category	Lab
Course Title	Engineering System Simulation Lab
Semester	Fifth
L-T-P	0-0-3

Course Code	IS-SIMLAB591
Credits	1.5
Pre-Requisites	Basics of Simulation and Modeling

Lab Modules

Module No.	Description of Experiment/Practical	Lab Hours
1	**Introduction to Simulation Tools**: Overview of simulation software.	6
2	**Discrete Event Simulation**: Modeling simple industrial processes.	8
3	**System Dynamics Modeling**: Developing feedback loop models.	8
4	**Input-Output Analysis**: Statistical analysis using simulation results.	6
5	**Case Study Projects**: Simulation-based industrial case studies.	6

Course Outcomes (COs)

- **CO-1**: Understand the use of simulation tools for industrial systems.
- **CO-2**: Design and implement discrete event simulation models.
- **CO-3**: Analyze and interpret simulation results for process improvement.
- **CO-4**: Develop models using system dynamics techniques.
- **CO-5**: Solve real-world industrial problems using simulation software.

Learning Resources: Simulation software like AnyLogic, Plant Simulation, Enterprise Dynamics etc.

Course Code	IS-BASA591
Category	Lab
Course Title	Business Analytics Software and Applications
Semester	Fifth
L-T-P	0-0-3
Credits	1.5
Pre-Requisites	Basics of Statistics and Programming

Lab Modules

Module No.	Description of Experiment/Practical	Lab Hours
1	**Introduction to Business Analytics Tools**: Overview of tools like Excel, R, and Python.	6
2	**Data Analysis Techniques**: Data cleaning, visualization, and descriptive statistics.	8
3	**Regression and Forecasting**: Linear regression models and prediction analysis.	8
4	**Optimization and Simulation**: Business case study using optimization techniques.	8
5	**Case Studies**: Solving real-world business problems using analytics tools.	6

Course Outcomes (COs)

- **CO-1**: Gain hands-on experience with business analytics tools.
- **CO-2**: Analyze and visualize data effectively.
- **CO-3**: Apply regression models for predictive analysis.
- **CO-4**: Use optimization techniques for solving business problems.
- **CO-5**: Implement business analytics solutions for real-world case studies.

Learning Resources: Commercial software like **ZOHO Analytics,** SAS Business Analytics (SAS BA), Tablaue Big Data Analytics

3rd YEAR SIXTH SEMESTER

Theory Subjects

Course Code	IS-SE601
Category	Industrial Systems Core
Course Title	Systems Engineering
Semester	Sixth
L-T-P	4-0-0
Credits	4
Pre-Requisites	Basics of Operations Research, Probability and Statistics and Manufacturing Systems

Course Objectives

- To provide an understanding of production and operations management concepts.
- To equip students with tools to optimize production systems and operational processes.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1.	**System Engineering Overview:** A bit of history, the "V"-Model, SE Standards and Handbooks Interdisciplinary field of engineering and engineering management, managing complex systems over the life cycle, engineered system with a useful function, challenges of current practice	4
2.	**Systems Engineering: As Human Activity:** Role of Human in Systems Engineering- User, Designer, Manufacturer,	4
3.	**Humans as users**- Stakeholder Analysis - Identifying Stakeholders – stakeholder need analysis-Concept of Operations (CONOPS) - Stakeholder Value Network (SVN) Analysis	4
4.	**Humans as Manufacturers of Systems** – case studies	4
5.	**Humans as Designers**: Challenges facing organisatons in designing large systems, challenges facing systems engineers Introduction to Automotive Powertrain System	4
6.	**System Architecture and Concept Generation**	4
7.	**Trade Space Exploration and Concept Selection**	4
8.	**Design solution Definition**	4
9.	**Multidisciplinary Optimization** - Mathematical Modeling of a System,ν Design Oriented Analysis ν Approximation Concepts ν System Sensitivity Analysis ν Classical Optimization Procedures ν Human Interface	4
10.	**Requirements driven system design**: Axiomatic designs- Axiom 1(independence axiom),-axiom 2(Information (information axiom, design structure matrix (DSM) for technical systems- example and case studies	4
11.	**Robust Design**: concepts and methods	4
12.	**Critical parameter design and management: Developing capability indices**	4
13.	**Innovations in Systems Engineering**:: Individuals creativity in systems design – users' needs –structured innovation in system design, Innovations in large systems, innovations in the context of technical systems (architectural innovation, the route of innovation management)	4
14.	**Verification and Validation:** Verification - During development - checking if requirements are met - typically in the laboratory - Component/subsystem centric, Validation - - During or after integration -typically in real or simulated mission environment -Check if stakeholder intent is met	4

Module No.	Description of Topic	Lecture Hours
15.	**Life Cycle Management:** Definition of Lifecycle Management, Lifecycle Properties, i.e. the "Illities", A Case Study (Reconfiguration of Communications Satellite Constellations-Typ.)	4

Course Outcomes (COs)

- **CO-1**: Understand the fundamentals of production and operations management.
- **CO-2**: Apply production planning techniques for capacity and scheduling.
- **CO-3**: Optimize inventory management systems using modern tools.
- **CO-4**: Implement operations strategies like lean manufacturing and Six Sigma.
- **CO-5**: Analyze and improve productivity and quality in industrial systems.

Learning Resources

1. Kossiakoff, A., Sweet, W. N., Seymour, S J and Biemer, S M *Systems Engineering Principles and Practice (2nd ed) ,* Wiley
2. Chase, R. B., Jacobs, F. R., & Aquilano, N. J. *Operations Management for Competitive Advantage*, McGraw-Hill.
3. Heizer, J., & Render, B. *Operations Management: Sustainability and Supply Chain Management*, Pearson.
4. Krajewski, L. J., Ritzman, L. P., & Malhotra, M. K. *Operations Management: Processes and Supply Chains*, Pearson.
5. Prof. Olivier L. de Weck, *Fundamentals of Systems Engineering,* MIT document

Course Code	IS-LTS601
Category	Industrial Systems Core
Course Title	Logistics and Transportation Systems
Semester	Sixth
L-T-P	3-0-0
Credits	3
Pre-Requisites	Basics of Supply Chain Management

Course Objectives

- To introduce the concepts of logistics and transportation systems in supply chain management.
- To analyze the optimization of transportation networks and logistics costs.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Logistics**: Definition, importance, and logistics cost components.	6
2	**Transportation Systems**: Modes of transportation, selection criteria, and route planning.	8
3	**Logistics Optimization**: Network design, distribution systems, and transportation cost models.	10
4	**Technology in Logistics**: Role of IT, RFID, GPS, and IoT in logistics management.	6
5	**Logistics Case Studies**: Analysis of real-world transportation and logistics systems.	6

Course Outcomes (COs)

- **CO-1**: Understand the fundamentals of logistics and transportation systems.
- **CO-2**: Analyze and optimize transportation systems for industrial processes.
- **CO-3**: Evaluate logistics costs and network design strategies.
- **CO-4**: Integrate modern technologies like RFID, IoT, and GPS in logistics systems.
- **CO-5**: Solve real-world logistics problems using case study analysis.

Learning Resources

1. Ballou, R. H. *Business Logistics/Supply Chain Management*, Pearson.
2. Coyle, J. J., Langley, C. J., & Gibson, B. J. *Supply Chain Management: A Logistics Perspective*, Cengage Learning.
3. Chopra, S., & Meindl, P. *Supply Chain Management: Strategy, Planning, and Operation*, Pearson.

Course Code	IS-IAR601
Category	Industrial Systems Core
Course Title	Industrial Automation and Robotics
Semester	Sixth
L-T-P	2-0-0
Credits	2
Pre-Requisites	Basics of Manufacturing Processes

Course Objectives

- To introduce concepts of automation and robotics in industrial systems.
- To understand robotic systems, sensors, and their applications in manufacturing.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Automation**: Need for automation, types, and components of automation systems.	3
2	**Basics of Robotics**: Definitions, classification, robotic system--basic motions and degrees of freedom..	6
3	**Sensors and Actuators**: Types, applications, and integration into automation.	6
4	**Control Systems**: Programmable Logic Controllers (PLC), feedback control systems.	6
5	**Applications of Robotics**: Industrial applications such as assembly, welding, and material handling.	3

Course Outcomes (COs)

- **CO-1**: Understand the role and need for automation in industrial systems.
- **CO-2**: Explain the fundamentals of robotic systems and their classifications.
- **CO-3**: Analyze the role of sensors and actuators in automated systems.
- **CO-4**: Implement PLC and control systems for automation.
- **CO-5**: Evaluate industrial applications of robotics and automation techniques.

Learning Resources

1. Groover, M. P. *Automation, Production Systems, and Computer-Integrated Manufacturing*, Pearson.
2. Mikell, P. G. *Industrial Robotics: Technology, Programming, and Applications*, McGraw-Hill.
3. Craig, J. J. *Introduction to Robotics: Mechanics and Control*, Pearson.

Course Code	IS-EEF601
Category	Industrial Systems Core
Course Title	Engineering Economics and Financial Accounting
Semester	Sixth
L-T-P	3-0-0

Course Code	IS-EEF601
Credits	3
Pre-Requisites	None

Course Objectives

- To provide an understanding of the fundamental concepts of engineering economics.
- To develop the ability to analyze the financial aspects of engineering projects.
- To equip students with the knowledge of financial accounting principles for industrial applications.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Engineering Economics**: Definition, macro and micro economics, scope, importance, supply-demand curves, demand theory and pricing, economy of scale, applications of economics in engineering.	6
2	**Production and Cost analysis**: Fixed and variable costs, marginal cost, sunk cost, opportunity cost, break-even analysis.	9
3	**Time Value of Money**: Interest rates, present and future value, discounted cash flow (DCF), compounding, annuity.	8
4	**Project Evaluation and Decision-Making**: Investment analysis techniques, Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period.	4
5	**Financial Accounting**: Basics of accounting, financial statements, balance sheet, income statement, and cash flow statement.	9

Course Outcomes (COs)

- **CO-1**: Understand the basic principles of engineering economics and financial accounting.
- **CO-2**: Analyze costs in engineering projects using different cost concepts.
- **CO-3**: Apply time value of money concepts for project evaluation and decision-making.
- **CO-4**: Evaluate engineering projects using financial tools like NPV, IRR, and Payback Period.
- **CO-5**: Prepare and interpret financial statements such as balance sheets and income statements.

Learning Resources

1. Riggs, J. L., & Bedworth, D. C. *Engineering Economics*, McGraw-Hill.

2. Chopra, P. K. *Engineering Economics and Financial Accounting*, Prentice Hall India.
3. Pandey, I. M. *Financial Management*, Vikas Publishing.
4. Maheshwari, S. N. *Financial Accounting*, Vikas Publishing.

Elective Subjects

Course Code	**IS-EIII601A**
Category	Elective
Course Title	Lean Manufacturing
Semester	Sixth
L-T-P	3-0-0
Credits	3
Pre-Requisites	Basics of Operations and Production Management

Course Objectives

- To introduce the concepts of lean manufacturing and waste elimination techniques.
- To apply lean principles for improving productivity and efficiency in industrial systems.

Module-wise Syllabus

Module No.	**Description of Topic**	**Lecture Hours**
1	**Introduction to Lean Manufacturing**: Principles, benefits, and origin of lean systems.	6
2	**Lean Tools and Techniques**: Value Stream Mapping (VSM), 5S, Kaizen, and Poka-Yoke.	9
3	**Waste Elimination**: Types of waste, lean practices to minimize waste.	9
4	**Lean Implementation**: Lean metrics, continuous improvement cycles, and culture building.	6
5	**Case Studies**: Real-world applications of lean manufacturing in various industries.	6

Course Outcomes (COs)

- **CO-1**: Understand the fundamentals and principles of lean manufacturing.
- **CO-2**: Apply lean tools and techniques to improve industrial processes.

- **CO-3**: Identify and eliminate waste in manufacturing systems.
- **CO-4**: Implement lean strategies for continuous improvement.
- **CO-5**: Analyze case studies to understand real-world applications of lean principles.

Learning Resources

1. Womack, J. P., Jones, D. T., & Roos, D. *The Machine That Changed the World*, Free Press.
2. Liker, J. K. *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*, McGraw-Hill.
3. Rother, M., & Shook, J. *Learning to See: Value Stream Mapping*, Lean Enterprise Institute.

Course Code	**IS-EIII601B**
Category	Elective
Course Title	Data Analytics
Semester	Sixth
L-T-P	3-0-0
Credits	3
Pre-Requisites	Basics of Statistics and Programming

Course Objectives

- To introduce data analytics concepts and tools for solving industrial problems.
- To apply statistical and computational techniques for data-driven decision-making.

Module-wise Syllabus

Module No.	**Description of Topic**	**Lecture Hours**
1	**Introduction to Data Analytics**: Importance, types (descriptive, predictive, prescriptive).	6
2	**Data Preprocessing**: Data cleaning, transformation, and visualization techniques.	10
3	**Review of Statistical Analysis**: Hypothesis testing, regression analysis, and correlation.	6
4	**Predictive Analytics**: Machine learning models, classification, and forecasting.	8

Module No.	Description of Topic	Lecture Hours
5	**Applications and Case Studies**: Data analytics applications in manufacturing, logistics, and operations.	6

Course Outcomes (COs)

- **CO-1**: Understand the fundamentals of data analytics and its industrial relevance.
- **CO-2**: Preprocess and analyze data for industrial decision-making.
- **CO-3**: Apply statistical techniques for data analysis.
- **CO-4**: Develop predictive models using machine learning techniques.
- **CO-5**: Solve real-world problems using data analytics tools and case studies.

Learning Resources

1. Provost, F., & Fawcett, T. *Data Science for Business*, O'Reilly Media.
2. Montgomery, D. C., Peck, E. A., & Vining, G. G. *Introduction to Linear Regression Analysis*, Wiley.
3. Mitchell, T. M. *Machine Learning*, McGraw-Hill.

Course Code	**IS-EIII601C**
Category	Elective
Course Title	Business Environment and Law
Semester	Seventh
L-T-P	3-0-0
Credit	3
Pre-Requisites	None

Course Objectives:

1. To introduce students to the business environment and its components.
2. To highlight key issues related to economic systems, ethics, and management structures.
3. To apprise students of statutory laws and acts related to business operations.

Module No.	Description of Topic	Lecture Hours
1	**Dynamics of Business Environment:** Industrial Policy of 1991, liberalization, privatization, globalization, ethics, and environmental issues.	3
2	**Infrastructural Environment:** Energy, transport, communication, social and political environments, productivity, global trends, and Indian industry.	3
3	**Fiscal and Trade Policy:** Monetary and fiscal policies, EXIM policy, WTO's role in global trade, dumping and anti-dumping measures.	6
4	**Laws in Business:** Contracts, partnership, sale of goods, insurance, negotiable instruments, and agency laws.	7

Module No.	Description of Topic	Lecture Hours
5	**Companies Act 1956:** Kinds of companies, formation, directors, meetings, management, accounts, and winding up.	7
6	**Labor and Industrial Laws:** Factories Act, Industrial Disputes Act, Minimum Wages Act, and Workmen Compensation Act.	7
7	**Information Technology Act 2000 and GST Act 2017:** Scope, application, e-governance, digital signature, and cyber regulations.	3

Course Outcomes (COs):
CO-1: Understand the importance of the business environment and its dynamics.
CO-2: Acquire knowledge of business policies and environmental factors.
CO-3: Analyze the impact of social, political, and technological factors on businesses.
CO-4: Understand and apply laws governing business activities.

Learning Resources:

1. Aswathappa, K., *Essentials of Business Management*, Himalaya Publishers.
2. Keith-Davis & William Frederick, *Business and Society*, McGraw-Hill, Tokyo.
3. Rudder Dutt & Sundaram, *Indian Economy*, Vikas, New Delhi.
4. Kapoor, N.D., *Elements of Mercantile Law*, Sultan Chand & Sons.
5. Maheswari & Maheswari, *Mercantile Law*, National Publishing House.

Practical Subjects

Course Code	Practical/Internship
Category	Internship/Practical
Course Title	Industrial Internship/Practicum
Semester	Sixth
L-T-P	0-0-0
Credits	0
Pre-Requisites	Completion of 5th Semester Industrial Core Courses

Course Objectives

- To provide hands-on industrial exposure to students.
- To apply theoretical knowledge to solve real-world industrial problems.

Activities and Guidelines

Phase No.	Description of Activity	Hours
1	**Industry Selection**: Identifying and securing internships in relevant industries.	N/A

Phase No.	Description of Activity	Hours
2	**Project Scope Definition**: Problem identification and literature review.	N/A
3	**Implementation and Data Collection**: Execution of tasks assigned by industry mentors.	N/A
4	**Analysis and Reporting**: Analyzing results, preparing a report, and presentation.	N/A

Course Outcomes (COs)

- **CO-1**: Gain practical exposure to industrial processes and systems.
- **CO-2**: Solve real-world industrial problems using theoretical knowledge.
- **CO-3**: Collaborate with professionals in industrial settings.
- **CO-4**: Prepare technical reports documenting industrial experiences.
- **CO-5**: Demonstrate project outcomes through presentations.

Evaluation Criteria

- **Industry Mentor Feedback** – 30%
- **Project Report Quality** – 30%
- **Presentation and Viva** – 40%

4th Year 7th Semester

Sl. No.	Subject Code	Subject Name	L	T	P	Credits
		Theory				
1	IS-ERP701	Enterprise Resource Planning (ERP)	**3**	**0**	**0**	**3**
2	IS-POM701	Principles of Organization and Management	**3**	**0**	**0**	**3**
3	IS-PM701	Project Management	**3**	**0**	**0**	**3**
4	IS-HRM701	Human Resource Management for Engineers	**2**	**0**	**0**	**2**
5	IS-EIV701	Elective IV	**3**	**0**	**0**	**3**
Total Theory			**14**	**0**	**0**	**14**
		Practical				
1	IS-PM791	ERP and Project Management Laboratory	**0**	**0**	**4**	**2**
2	IS-CAP701	Capstone Project I	**0**	**0**	**6**	**3**
Total Practical			**0**	**0**	**10**	**5**
Total of 7th Semester			**14**	**0**	**10**	**19**

4th Year 8th Semester

Sl. No.	Subject Code	Subject Name	L	T	P	Credits
		Theory				
1	IS-ES801	Environment and Sustainability	**2**	**0**	**0**	**2**
2	IS-MRE801	Maintenance and Reliability Engineering	**2**	**0**	**0**	**2**
3	IS-PEL801	Professional Ethics and Leadership	**2**	**0**	**0**	**2**
4	IS-EV801	Elective V	**3**	**0**	**0**	**3**
5	IS-OE801	Open Elective	**3**	**0**	**0**	**3**
Total Theory			**12**	**0**	**0**	**12**
		Practical				
1	IS-CAP801	Capstone Project II	**0**	**0**	**6**	**3**
Total Practical			**0**	**0**	**6**	**3**
Total of 8th Semester			**12**	**0**	**6**	**15**

4th YEAR SEVENTH SEMESTER

THEORY

Course Code	**IS-ERP701**
Category	Industrial Systems Core
Course Title	Enterprise Resource Planning (ERP)
Semester	Seventh
L-T-P	3-0-0
Credit	3
Pre-Requisites	Basics of Operations and Supply Chain Management
Course Objectives	To introduce the concepts of ERP systems, their implementation, and integration with modern technologies. It aims to equip students with knowledge of core ERP modules and their role in business process optimization.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to ERP**: Definition, Evolution of ERP, Integrated Data Management, Benefits and Challenges.	6
2	**ERP Modules**: Overview of core modules: Finance, HR, Supply Chain Management, Production, CRM, etc.	8
3	**ERP Implementation**: Life Cycle Phases – Planning, Selection, Installation, Training, and Maintenance.	8
4	**ERP Technologies**: Role of databases, Cloud-based ERP, ERP and Internet of Things (IoT), AI integration.	8

Module No.	Description of Topic	Lecture Hours
5	**ERP Case Studies**: Success and failure stories of ERP implementation in industries.	6

Course Outcomes (COs)

After completing the course, students will be able to:

- **CO-1**: Understand the fundamentals of ERP systems and their role in business process integration.
- **CO-2**: Explore the functionality of key ERP modules and their application across industries.
- **CO-3**: Analyze ERP implementation strategies and challenges.
- **CO-4**: Evaluate emerging technologies and trends in ERP systems.
- **CO-5**: Apply ERP knowledge through real-world case study analysis.

Learning Resources

1. **Leon, A.** *Enterprise Resource Planning: Demystified*, Tata McGraw-Hill.
2. **Monk, E., & Wagner, B.** *Concepts in Enterprise Resource Planning*, Cengage Learning.
3. **Alexis Leon**, *ERP Systems: Enterprise Resource Planning*, Pearson Education.
4. **Davenport, T. H.**, *Mission Critical: Realizing the Promise of Enterprise Systems*, Harvard Business Review Press.
5. **O'Leary, D. E.**, *Enterprise Resource Planning Systems: Systems, Life Cycle, Electronic Commerce, and Risk*, Cambridge Press.

Course Code	IS-POM701
Category	Industrial Systems Core
Course Title	Principles of Organization and Management
Semester	Seventh

Course Code	IS-POM701
Category	Industrial Systems Core
L-T-P	3-0-0
Credit	3
Pre-Requisites	Basic Knowledge of Management Concepts
Course Objectives	To familiarize students with management principles, organizational structure, and management practices in engineering industries.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Management**: Functions of Management – Planning, Organizing, Leading, Controlling.	6
2	**Organizational Structures**: Types of organizations – Line, Functional, Matrix; Span of control.	8
3	**Leadership and Motivation**: Theories of leadership; Motivation theories – Maslow, Herzberg, McGregor.	8
4	**Decision-Making**: Types of decisions, Decision-making models, Tools for decision-making in organizations.	6
5	**Change Management**: Managing organizational change, Resistance to change, Strategies for effective change.	6

Course Outcomes (COs)

After completing the course, students will be able to:

- **CO-1**: Understand fundamental principles of management and organization.
- **CO-2**: Analyze organizational structures and their impact on efficiency.
- **CO-3**: Explore leadership styles and motivation techniques for effective team management.
- **CO-4**: Apply decision-making tools in organizational contexts.
- **CO-5**: Evaluate strategies for managing organizational change.

Learning Resources

1. **Koontz, H., & Weihrich, H.** *Essentials of Management*, Tata McGraw-Hill.
2. **Stoner, J. A. F., Freeman, R. E., & Gilbert, D. R.** *Management*, Pearson Education.
3. **Robbins, S. P., & Coulter, M.** *Management*, Prentice Hall.
4. **Drucker, P. F.** *The Practice of Management*, Harper Business.
5. **Daft, R. L.** *Organization Theory and Design*, Cengage Learnin

Course Code	**IS-PM701**
Category	Industrial Systems Core
Course Title	Project Management
Semester	Seventh
L-T-P	3-0-0
Credit	3
Pre-Requisites	Basic Understanding of Operations and Systems Management
Course Objectives	To provide knowledge on the principles of project management, including project planning, execution, and control techniques.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Project Management**: Definition, Characteristics of Projects, Project Life Cycle.	4
2	**Project Planning**: Project scheduling techniques – Gantt charts, Critical Path Method (CPM), project scheduling using PERT- time estimation-critical path estimation	10
3	**Resource Management**: Crashing, Resource leveling, Cost and Time estimation, Budgeting techniques.	10
4	**Project Execution and Control**: Monitoring progress, Earned Value Management (EVM), Risk management.	6

Module No.	Description of Topic	Lecture Hours
5	**Project Closure**: Post-project review, Documentation, Success and failure analysis of projects.	6

Course Outcomes (COs)

After completing the course, students will be able to:

- **CO-1**: Understand the principles and life cycle of project management.
- **CO-2**: Apply scheduling techniques for project planning.
- **CO-3**: Manage project resources effectively and estimate costs.
- **CO-4**: Monitor and control project progress using advanced tools.
- **CO-5**: Conduct project closure activities and analyze performance.

Learning Resources

1. **Kerzner, H.** *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*, Wiley.
2. **Lock, D.** *Project Management*, Routledge.
3. **PMBOK Guide** *A Guide to the Project Management Body of Knowledge*, PMI.
4. **Gido, J., & Clements, J. P.** *Successful Project Management*, Cengage Learning.
5. **Shtub, A., Bard, J. F., & Globerson, S.** *Project Management: Processes, Methodologies, and Economics*, Pearson.

Course Code	IS-HRM701
Category	Industrial Systems Core
Course Title	Human Resource Management for Engineers
Semester	Seventh
L-T-P	2-0-0
Credit	2
Pre-Requisites	Basic Management Concepts
Course Objectives	To develop an understanding of HRM principles and their application to engineering organizations.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to HRM**: HRM functions, Role of HRM in modern organizations, HRM vs. Personnel Management.	4
2	**Recruitment and Selection**: Job analysis, Recruitment methods, Selection processes, Interviews.	6
3	**Training and Development**: Need for training, Training methods, Skill development programs.	6
4	**Performance Management**: Appraisals, Performance metrics, Feedback systems.	4
5	**Compensation and Retention**: Compensation plans, Employee retention strategies, HR policies.	4

Course Outcomes (COs)

After completing the course, students will be able to:

- **CO-1**: Understand the role and functions of HRM in engineering organizations.
- **CO-2**: Apply recruitment and selection techniques to build a skilled workforce.
- **CO-3**: Design effective training and development programs for engineers.
- **CO-4**: Implement performance management and feedback systems.
- **CO-5**: Develop strategies for employee compensation and retention.

Learning Resources

1. **Dessler, G.** *Human Resource Management*, Pearson Education.
2. **Armstrong, M.** *A Handbook of Human Resource Management Practice*, Kogan Page.
3. **Aswathappa, K.** *Human Resource Management: Text and Cases*, Tata McGraw-Hill.
4. **Mathis, R. L., & Jackson, J. H.** *Human Resource Management*, Cengage Learning.
5. **Ivancevich, J. M.** *Human Resource Management*, McGraw-Hill.

Course Code	IS-EIV701A
Category	Elective – Industrial Systems
Course Title	Facility Design
Semester	Seventh
L-T-P	3-0-0
Credit	3
Pre-Requisites	Basics of Operations Research and Systems Engineering
Course Objectives	To familiarize students with the principles of facility design, layout optimization, and resource allocation in industrial systems.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Facility Design**: Importance, Principles of facility layout, Types of layouts – product, process, and hybrid.	6
2	**Location Planning**: Factors influencing location, Location models – Center of Gravity, Break-even analysis.	10
3	**Layout Planning**: Systematic Layout Planning (SLP), Algorithms for layout design – CRAFT, ALDEP, CORELAP.	8
4	**Material Flow and Handling**: Principles of material handling, Selection of material handling equipment, Integration with layout design.	4
5	**Facility Design Case Studies**: Practical applications and industry case studies on facility layout and optimization.	8

Course Outcomes (COs)

After completing the course, students will be able to:

- **CO-1**: Understand the importance and principles of facility design in industrial systems.
- **CO-2**: Apply location planning techniques to optimize facility placement.
- **CO-3**: Design efficient layouts using systematic planning methods and algorithms.
- **CO-4**: Integrate material flow and handling principles into facility layouts.
- **CO-5**: Analyze real-world case studies to optimize facility designs in industries.

Learning Resources

1. **Tompkins, J. A., White, J. A., Bozer, Y. A., & Tanchoco, J. M. A.** *Facilities Planning*, Wiley.
2. **Francis, R. L., McGinnis, L. F., & White, J. A.** *Facility Layout and Location: An Analytical Approach*, Pearson.
3. **Muther, R.** *Systematic Layout Planning (SLP)*, Management & Industrial Research Publications.
4. **Heragu, S. S.** *Facilities Design*, CRC Press.
5. **Apple, J. M.** *Plant Layout and Material Handling*, Krieger Publishing.

Course Code	**IS-EIV701B**
Category	Elective – Industrial Systems
Course Title	Advanced Simulation Techniques
Semester	Seventh
L-T-P	3-0-0
Credit	3
Pre-Requisites	Basics of Simulation and Modeling

Course Objectives:
To develop expertise in advanced simulation methodologies, focusing on their application in analyzing and improving industrial systems and processes.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	Introduction to Advanced Simulation: Role of simulation in decision-making, types of models.	6
2	Discrete Event Simulation (DES): Concepts, applications in manufacturing and supply chains.	9
3	System Dynamics: Feedback loops, causal diagrams, applications in policy-making.	9
4	Agent-Based Modeling (ABM): Principles, tools, and applications in social and industrial systems.	6
5	Case Studies and Applications: Industrial system analysis, resource optimization using simulation tools.	6

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Understand advanced simulation methodologies and their industrial relevance.
- **CO-2:** Design and analyze discrete event simulation models.
- **CO-3:** Apply system dynamics to solve complex industrial and societal problems.
- **CO-4:** Use agent-based modeling for analyzing decentralized systems.
- **CO-5:** Evaluate real-world scenarios through advanced simulation tools.

Learning Resources:

1. Banks, J., Carson, J. S., Nelson, B. L., & Nicol, D. M., Discrete-Event System Simulation, Pearson.
2. Sterman, J. D., Business Dynamics: Systems Thinking and Modeling for a Complex World, McGraw-Hill.
3. Macal, C. M., & North, M. J., Agent-Based Modeling and Simulation: An Introduction, Elsevier.
4. Law, A. M., Simulation Modeling and Analysis, McGraw-Hill.
5. Fishwick, P. A., Handbook of Dynamic System Modeling, CRC Press.

Course Code	IS-EIV701C
Category	Elective – Industrial Systems

Course Code	IS-EIV701C
Course Title	Managerial Economics
Semester	Seventh
L-T-P	3-0-0
Credit	3
Pre-Requisites	None

Course Objectives:

1. To acquaint students with basic tools and concepts of microeconomic analysis.
2. To enable the students to correlate engineering and business activities with the subject of economics.
3. To equip students to identify firm-level economic problems.
4. To develop cost-centric approaches to systems and operational activities in a plant.
5. To prepare students for careers in diverse areas of business and industry, including industrial and systems engineering and finance sectors.

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Managerial Economics:** Basic concepts and scope.	1
2	**Theory of Demand:** Determinants, law of demand, and demand curves.	4
3	**Theory of Consumer Behavior:** Utility analysis, indifference curve analysis, and budget constraints.	5
4	**Elasticity and Demand Forecasting:** Price, income, and cross elasticity; methods of demand forecasting.	6
5	**Production Analysis:** Production functions, law of variable proportions, returns to scale.	6
6	**Cost Analysis:** Types of costs, cost-output relationships, and economies of scale.	6
7	**Theory of Markets:** Perfect competition, monopoly, monopolistic competition, and oligopoly.	6
8	**Product Pricing:** Pricing methods and strategies.	2

Course Outcomes (COs):

CO-1: Apply microeconomic principles for managerial decision-making.
CO-2: Understand the financial environment and its interrelation with plant economics.
CO-3: Interact effectively with finance professionals on cost and financial matters.
CO-4: Optimize scarce resources to achieve managerial goals.

Learning Resources:

1. Koutsoyiannis A., *Modern Microeconomics*, Palgrave Macmillan, London.
2. Thomas Christopher & Maurice S. Charles, *Managerial Economics*, McGraw-Hill Higher Education.
3. Paul G. Keat et al., *Managerial Economics*, Pearson.
4. Dwivedi D.N., *Managerial Economics*, Vikas Publishing House.

PRACTICAL

Course Code	IS-PM791
Category	Lab
Course Title	ERP and Project Management Laboratory
Semester	Seventh
L-T-P	0-0-4
Credit	2
Pre-Requisites	Knowledge of ERP Systems

Course Objectives:
To provide hands-on training in enterprise resource planning (ERP) software and project management tools like Microsoft Project.

Lab Modules

Module No.	Description of Experiment/Practical	Lab Hours
1	Introduction to ERP Tools: Navigation, creating user profiles.	4
2	Core Modules in ERP: Financial, inventory, and production modules.	16
3	Project software basics: Task creation, scheduling, and resource allocation.	4

4	Advanced Features in Project software : Earned value analysis, tracking.	12
5	Case Study: Implementing ERP in a simulated industrial environment.	12

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Navigate and operate ERP software efficiently.
- **CO-2:** Use core ERP modules for industrial system management.
- **CO-3:** Plan and schedule projects using project management software.
- **CO-4:** Analyze project performance through advanced tools.
- **CO-5:** Apply ERP solutions to solve practical industrial challenges.

Learning Resources:

1. Monk, E., & Wagner, B., Concepts in Enterprise Resource Planning, Cengage Learning.
2. Hamilton, S., Maximizing Your ERP System, McGraw-Hill.
3. Chatfield, C., & Johnson, T., Microsoft Project 2019 Step by Step, Microsoft Press.
4. ERP Software Manuals and Online Documentation.
5. ERP softwares – QuickBooks/ Odoo/,ERPNext/, NetSuite ERP etc**. ,**
6. Project Management software: GANTTPRO/ Zoho Projects/TeamGantt/ MS project etc.

Course Code	IS-CAP701
Category	Capstone Project
Course Title	Capstone Project I (Team-based Industry Project)
Semester	Seventh
L-T-P	0-0-6
Credit	3
Pre-Requisites	Completion of Core Industrial Engineering Courses

Course Objectives:
To provide a platform for applying theoretical knowledge to solve real-world industrial problems through team-based projects.

Project Guidelines

Phase No.	Description of Activity	Hours
1	Problem Identification: Selection of an industrial problem.	10
2	Literature Review: Study of existing solutions and frameworks.	12
3	Methodology Design: Planning and resource allocation.	20
4	Execution: Developing solutions and analyzing outcomes.	30
5	Report Preparation: Documentation and presentation.	12

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Identify and formulate industrial problems effectively.
- **CO-2:** Conduct in-depth research and propose innovative solutions.
- **CO-3:** Design and execute projects collaboratively.
- **CO-4:** Analyze project outcomes and suggest future improvements.
- **CO-5:** Present findings professionally through comprehensive reports.

Evaluation Criteria:

1. Problem Identification and Objective Definition – 20%.
2. Research and Methodology – 30%.
3. Execution and Results – 30%.
4. Presentation and Documentation – 20%.

4th YEAR EIGHTH SEMESTER

THEORY

Course Code	IS-ES801
Category	Core
Course Title	Environment and Sustainability
Semester	Eighth
L-T-P	2-0-0
Credit	2
Pre-Requisites	None

Course Objectives:
To introduce the fundamentals of environmental science and sustainable practices and equip students with the ability to analyze the impact of industrial systems on the environment and develop sustainable solutions.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	Introduction to Environment: Natural resources, ecosystems, and biodiversity. Environmental degradation.	4
2	Industrial Pollution and Control: Types of pollution, control measures, case studies in industrial systems.	4
3	Sustainability Concepts: Sustainable development goals (SDGs), life cycle assessment (LCA), and green technologies.	6
4	Environmental Policies and Laws: Overview of environmental laws in India and international conventions.	5
5	Sustainability in Industrial Systems: Implementation of energy-efficient and low-carbon technologies in industries.	5

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Understand the principles of environmental science and ecosystem dynamics.
- **CO-2:** Analyze industrial pollution and propose control measures.
- **CO-3:** Apply sustainability concepts and tools to evaluate industrial practices.
- **CO-4:** Interpret and comply with environmental policies and regulations.
- **CO-5:** Develop sustainable solutions for industrial processes and systems.

Learning Resources:

1. Cunningham, W. P., & Cunningham, M. A., Principles of Environmental Science, Tata McGraw-Hill.
2. Rajagopalan, R., Environmental Studies: From Crisis to Cure, Oxford University Press.
3. Baker, S., Sustainable Development, Routledge.
4. Rogers, P. P., Jalal, K. F., & Boyd, J. A., An Introduction to Sustainable Development, Earthscan.
5. Pichtel, J., Waste Management Practices, CRC Press.

Course Code	IS-MRE801
Category	Core
Course Title	Maintenance and Reliability Engineering
Semester	Eighth
L-T-P	2-0-0
Credit	2
Pre-Requisites	Basics of Mechanical and Industrial Systems

Course Objectives:
To provide students with the knowledge and tools necessary to design, evaluate, and improve maintenance and reliability strategies for industrial systems.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1.	Introduction to Maintenance Engineering: Role and importance, organization of a typical engineering/maintenance department	2
2.	Different types of maintenance strategies and practices: Flow chart , Planned maintenance- preventive-corrective, Reactive maintenance-breakdown-emergency	2
3.	Preventive maintenance: routine-scheduled – predictive, condition monitoring techniques, tools, and applications.	2
4.	Maintenance Planning: Scheduling, resource allocation, cost estimation.	4
5. :	Contract maintenance: Circumstances for awarding maintenance contract, advantages and disadvantages, types of contract for maintenance, tendering practice-different steps	2
6.	Reliability Engineering Basics: Reliability concepts, failure modes, and effects analysis (FMEA).	4
7.	Equipment Replacement Policy: Equipment that deteriorate gradually-average annual cost method and, NPV method, equipment that fail suddenly-group replacement-expected life-optimum period for group replacement, combination policy and cost comparison.	4
8.	Case Studies: Analysis of industrial case studies focusing on maintenance and reliability improvements.	4

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Understand the principles and strategies of maintenance engineering.
- **CO-2:** Apply reliability engineering tools to analyze failure data.
- **CO-3:** Utilize predictive maintenance tools to improve system performance.
- **CO-4:** Develop effective maintenance plans considering cost and resource constraints.
- **CO-5:** Analyze real-world case studies to derive best practices in maintenance and reliability.

Learning Resources:

1. Dhillon, B. S., Engineering Maintenance: A Modern Approach, CRC Press.
2. Smith, R., & Hawkins, B., Lean Maintenance: Reduce Costs, Improve Quality, and Increase Market Share, Elsevier.
3. Mobley, R. K., Maintenance Engineering Handbook, McGraw-Hill.

4. Moubray, J., Reliability-Centered Maintenance, Industrial Press.
5. Higgins, L. R., Maintenance Engineering Handbook, Tata McGraw-Hill.

Course Code	IS-PEL801
Category	Core
Course Title	Professional Ethics and Leadership
Semester	Eighth
L-T-P	2-0-0
Credit	2
Pre-Requisites	None

Course Objectives:
To cultivate ethical awareness and leadership skills among engineering professionals, emphasizing their responsibilities towards society and the industry.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	Introduction to Professional Ethics: Principles, values, and moral philosophies in engineering.	4
2	Leadership Theories: Leadership styles, traits, and contemporary approaches.	4
3	Corporate Social Responsibility (CSR): Ethics in corporate decision-making, sustainability.	5
4	Case Studies in Ethics and Leadership: Analysis of ethical dilemmas and leadership successes.	4
5	Developing Leadership Skills: Communication, team building, and conflict resolution.	5

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Understand the principles of professional ethics and their importance in engineering.
- **CO-2:** Analyze leadership styles and apply them effectively in organizational contexts.
- **CO-3:** Evaluate the role of CSR in modern organizations.
- **CO-4:** Solve ethical dilemmas using structured decision-making approaches.
- **CO-5:** Demonstrate leadership skills through effective communication and teamwork.

Learning Resources:

1. Martin, M. W., & Schinzinger, R., Ethics in Engineering, McGraw-Hill.
2. Northouse, P. G., Leadership: Theory and Practice, Sage Publications.
3. Velasquez, M. G., Business Ethics: Concepts and Cases, Pearson Education.
4. Goetsch, D. L., Occupational Safety and Health for Technologists, Engineers, and Managers, Pearson.
5. Kouzes, J. M., & Posner, B. Z., The Leadership Challenge, Wiley.

Course Code	**IS-EV801A**
Category	Elective – Industrial Systems
Course Title	AI in Industrial Systems
Semester	Eighth
L-T-P	3-0-0
Credit	3
Pre-Requisites	Basics of Artificial Intelligence

Course Objectives:
To introduce the concepts of artificial intelligence (AI) and its application in optimizing industrial systems, focusing on automation, efficiency, and decision-making.

Module-wise Syllabus

Module No.	Description of Topic	Lecture Hours
1	Introduction to AI: Basics, evolution, and relevance in industrial systems.	6
2	Machine Learning in Industries: Supervised and unsupervised learning applications.	10
3	AI Tools for Optimization: Heuristic algorithms, genetic programming.	8
4	Industrial Automation with AI: Robotics, predictive maintenance, and control systems.	6
5	Case Studies: Successful applications of AI in manufacturing and supply chains.	6

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Understand AI concepts and their industrial relevance.
- **CO-2:** Apply machine learning techniques to solve industrial problems.
- **CO-3:** Use AI tools for optimizing industrial processes.
- **CO-4:** Develop AI-based automation solutions for industrial systems.
- **CO-5:** Evaluate real-world case studies of AI applications in industries.

Learning Resources:

1. Russell, S., & Norvig, P., Artificial Intelligence: A Modern Approach, Pearson Education.
2. Goodfellow, I., Bengio, Y., & Courville, A., Deep Learning, MIT Press.
3. Bishop, C. M., Pattern Recognition and Machine Learning, Springer.
4. Hastie, T., Tibshirani, R., & Friedman, J., The Elements of Statistical Learning, Springer.
5. Mohri, M., Rostamizadeh, A., & Talwalkar, A., Foundations of Machine Learning, MIT Press.

Course Code	IS-EV801B
Category	Elective – Industrial Systems
Course Title	Network Optimization
Semester	Eighth
L-T-P	3-0-0
Credit	3

Course Code	IS-EV801B
Pre-Requisites	Operations Research, Graph Theory

Course Objectives:
To introduce network optimization techniques and their applications in industrial systems and operations planning.

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Network Optimization:** Basic definitions, network models, and optimization problems.	6
2	**Shortest Path Problem:** Dijkstra's algorithm, Bellman-Ford algorithm, and applications in routing.	6
3	**Minimum Spanning Tree:** Prim's and Kruskal's algorithms, applications in network design.	6
4	**Maximum Flow Problems:** Ford-Fulkerson algorithm, Edmonds-Karp algorithm, and applications.	6
5	**Network Design and Reliability:** Facility location, network connectivity, and redundancy optimization.	6
6	**Applications of Network Optimization:** Transportation, logistics, telecommunications, and project scheduling (PERT/CPM).	6

Course Outcomes (COs):
Upon completion of this course, students will be able to:
CO-1: Understand and model real-world problems as network optimization problems.
CO-2: Solve shortest path and spanning tree problems using standard algorithms.
CO-3: Apply maximum flow techniques to optimize network operations.
CO-4: Design reliable and cost-effective networks for industrial applications.
CO-5: Utilize network optimization in transportation, logistics, and project scheduling.

Learning Resources:

- Ahuja, R. K., Magnanti, T. L., & Orlin, J. B., *Network Flows: Theory, Algorithms, and Applications*, Pearson.
- Bertsekas, D. P., *Network Optimization: Continuous and Discrete Models*, Athena Scientific.
- Hillier, F. S., & Lieberman, G. J., *Introduction to Operations Research*, McGraw-Hill.

Course Code	IS-EV801C
Category	Elective Industrial Systems
Course Title	Energy Management and Audit
Semester	Seventh

Course Code	IS-EV801C
L-T-P	3-0-0
Credit	3
Pre-Requisites	None

Course Objectives:

1. To understand the energy scenario and the importance of energy audits.
2. To learn methods for analyzing energy consumption patterns and identifying energy-saving opportunities.
3. To equip students with knowledge of energy management systems, tools, and reporting techniques.
4. To provide insights into thermal and electrical energy management practices.

Module No.	Description of Topic	Lecture Hours
1	**General Aspects:** Energy scenario in India, need for energy audits and management, mass and energy balances, energy performance contracts, fuel substitution, and energy policies.	7
2	**Energy Audit Concepts:** Types of energy audits, benchmarking, energy performance, maximizing system efficiencies, energy audit instruments, and techniques.	8
3	**Energy Management Systems:** Designing energy management programs, monitoring and targeting, energy audit reporting, case studies, and energy-saving potential.	8
4	**Thermal Energy Management:** Energy conservation in boilers, steam turbines, industrial heating, cogeneration, waste heat recovery, thermal insulation, and HVAC systems.	8
5	**Electrical Energy Management:** Minimizing supply-demand gaps, modernizing power plants, reactive power management, HVDC, FACTS, energy-efficient motors, and demand-side conservation.	8

Course Outcomes (COs):
Upon completion of this course, students will be able to:
CO-1: Understand energy audit techniques, procedures, and instruments.
CO-2: Identify and analyze energy-saving opportunities in thermal and electrical systems.
CO-3: Design energy management systems and prepare energy audit reports.

Learning Resources:

1. Murphy, W. R., *Energy Management*, Elsevier India Private Limited.
2. De, B. K., *Energy Management, Audit & Conservation*, Vrinda Publication.
3. Turner, W. C., Doty, S., & Turner, W. C., *Energy Management Handbook*, Fairmont Press.

4. Witte, L. C., Schmidt, P. S., & Brown, D. R., *Industrial Energy Management and Utilization*, Hemisphere Publishing.
5. Gyftopoulos, E. P., *Industrial Energy Conservation Manuals*, MIT Press.

Web Resources:

- Bureau of Energy Efficiency: https://beeindia.gov.in/content/energy-auditors
- SWAYAM/NPTEL: https://nptel.ac.in/courses/112105221

Open Electives

Course Code	**IS-OE801A**
Category	Open Elective- Industrial Systems
Course Title	IoT and Industry 5.0 Applications
Semester	Eighth
L-T-P	3-0-0
Credit	3
Pre-Requisites	Basics of Networking and Automation

Course Objectives:
To provide students with a deep understanding of Internet of Things (IoT) concepts and their role in Industry 5.0, emphasizing intelligent systems, human-machine collaboration, and sustainable industrial operations.

Module No.	**Description of Topic**	**Lecture Hours**
1	**Introduction to IoT:** IoT architecture, sensors and actuators, communication protocols, and IoT platforms.	6
2	**IoT Data Management and Analytics:** Data collection, cloud integration, edge computing, and IoT analytics.	6
3	**IoT Security and Privacy:** Challenges in IoT security, cryptographic solutions, and privacy-preserving mechanisms.	6
4	**Introduction to Industry 5.0:** Evolution from Industry 4.0, human-centric automation, collaborative robots (cobots), and AI in manufacturing.	6
5	**Integration of IoT with Industry 5.0:** Real-time data processing, predictive maintenance, smart factories, and digital twins.	6

Module No.	Description of Topic	Lecture Hours
6	**Sustainability and IoT in Industry 5.0:** Energy-efficient systems, circular economy, and IoT-driven green manufacturing.	6

Course Outcomes (COs):
Upon completion of this course, students will be able to:
CO-1: Understand the fundamental concepts of IoT architecture and its components.
CO-2: Analyze data management techniques and the role of analytics in IoT systems.
CO-3: Evaluate IoT security challenges and implement privacy-preserving mechanisms.
CO-4: Explain the principles and applications of Industry 5.0 in intelligent manufacturing systems.
CO-5: Integrate IoT and Industry 5.0 technologies for sustainable industrial operations.

Learning Resources:

- Bahga, A., & Madisetti, V., *Internet of Things: A Hands-on Approach*, Universities Press.
- Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M., *Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions*, Elsevier.
- Xu, X., & Li, L., *Industry 5.0: A Human-Centric Solution*, Springer.
- Raj, P., & Raman, A., *The Internet of Things: Enabling Technologies, Platforms, and Use Cases*, CRC Press.

Course Code	IS-OE801B
Category	Open Elective- Industrial Systems
Course Title	Procurement and Quality Management
Semester	Seventh
L-T-P	3-0-0
Credit	3
Pre-Requisites	Basics of Operations Management

Course Objectives:

1. To understand the principles and processes of procurement in industrial and business contexts.
2. To analyze supplier selection, procurement planning, and contract management strategies.
3. To impart knowledge of quality management principles and tools for ensuring product and process quality.
4. To develop skills in quality improvement, standards compliance, and audits.

Module No.	Description of Topic	Lecture Hours
1	**Introduction to Procurement Management:** Importance, objectives, and process of procurement; roles in supply chain management.	4
2	**Supplier Management:** Vendor selection, evaluation, and relationship management; procurement planning and sourcing strategies.	6
3	**Contract Management:** Types of contracts, key terms, negotiation techniques, and legal considerations in procurement.	6
4	**Introduction to Quality Management:** Definitions of quality, historical evolution, and significance in manufacturing and services.	4
5	**Quality Tools and Techniques:** Seven basic tools of quality, statistical process control (SPC), and process capability analysis.	6
6	**Quality Standards and Certifications:** ISO 9001, Six Sigma, Total Quality Management (TQM), and Lean methodologies.	6
7	**Audits and Continuous Improvement:** Internal and external audits, Kaizen, and quality improvement programs.	4
8	**Case Studies and Applications:** Real-world examples of procurement and quality management in industrial settings.	4

Course Outcomes (COs):

CO-1: Understand procurement processes and their significance in supply chain management.
CO-2: Develop strategies for supplier selection, evaluation, and contract management.
CO-3: Apply quality management tools to improve product and process quality.
CO-4: Implement quality standards and practices to meet industrial requirements.
CO-5: Design and execute quality audits and continuous improvement programs.

Learning Resources:

1. Baily, P., Farmer, D., Jessop, D., & Jones, D., *Procurement Principles and Management*, Pearson.
2. Feigenbaum, A. V., *Total Quality Control*, McGraw-Hill.
3. Juran, J. M., & Godfrey, A. B., *Juran's Quality Handbook*, McGraw-Hill.
4. Evans, J. R., & Lindsay, W. M., *Managing for Quality and Performance Excellence*, Cengage Learning.
5. Burt, D. N., Dobler, D. W., & Starling, S. L., *World Class Supply Management: The Key to Supply Chain Management*, McGraw-Hill.

Practical Subjects

Course Code	**IS-CAP801**
Category	Capstone Project
Course Title	Capstone Project II (Continuation from Semester 7)
Semester	Eighth
L-T-P	0-0-6
Credit	3
Pre-Requisites	Successful completion of Capstone Project I

Course Objectives:
To extend the project work initiated in Semester 7, with a focus on detailed implementation, testing, and analysis.

Project Guidelines

Phase No.	Description of Activity	Hours
1	Detailed Design and Development: Refining solutions from Capstone Project I.	20
2	Testing and Validation: Conducting experiments and analyzing outcomes.	20
3	Final Report and Presentation: Preparing comprehensive documentation and presenting findings.	20

Course Outcomes (COs):
Upon completion of this course, students will be able to:

- **CO-1:** Apply advanced engineering knowledge to implement and test solutions.
- **CO-2:** Validate and analyze project outcomes comprehensively.
- **CO-3:** Prepare detailed technical documentation for projects.
- **CO-4:** Demonstrate professional communication through final presentations.
- **CO-5:** Deliver industry-relevant solutions to complex problems.

Evaluation Criteria:

1. Design and Development – 30%.
2. Testing and Validation – 30%.
3. Final Report – 20%.
4. Presentation – 20%.