SEMESTER 3

INDUSTRIAL ENGINEERING

SEMESTER S3

MATHEMATICS FOR ELECTRICAL SCIENCE AND PHYSICAL SCIENCE – 3

(Common to B & C Groups)

Course Code	**GYMAT301**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Basic knowledge in complex numbers.	**Course Type**	Theory

Course Objectives:

1. To introduce the concept and applications of Fourier transforms in various engineering fields.
2. To introduce the basic theory of functions of a complex variable, including residue integration and conformal transformation, and their applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fourier Integral, From Fourier series to Fourier Integral, Fourier Cosine and Sine integrals, Fourier Cosine and Sine Transform, Linearity, Transforms of Derivatives, Fourier Transform and its inverse, Linearity, Transforms of Derivative. **(Text 1: Relevant topics from sections 11.7, 11.8, 11.9)**	**9**
2	Complex Function, Limit, Continuity, Derivative, Analytic functions, Cauchy-Riemann Equations (without proof), Laplace's Equations, Harmonic functions, Finding harmonic conjugate, Conformal mapping, Mappings of $w= z^2$, $w=e^z$, $w= \frac{1}{z}$, $w= sinz$. **(Text 1: Relevant topics from sections 13.3, 13.4, 17.1, 17.2, 17.4)**	**9**
3	Complex Integration: Line integrals in the complex plane (Definition & Basic properties), First evaluation method, Second evaluation method, Cauchy's integral theorem (without proof) on simply connected domain, Independence of path, Cauchy integral theorem on multiply	**9**

	connected domain (without proof), Cauchy Integral formula (without proof). **(Text 1: Relevant topics from sections 14.1, 14.2, 14.3)**	
4	Taylor series and Maclaurin series, Laurent series (without proof), Singularities and Zeros – Isolated Singularity, Poles, Essential Singularities, Removable singularities, Zeros of Analytic functions – Poles and Zeros, Formulas for Residues, Residue theorem (without proof), Residue Integration- Integral of Rational Functions of $cos\theta$ and $sin\theta$. **(Text 1: Relevant topics from sections 15.4, 16.1, 16.2, 16.3, 16.4)**	**9**

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Determine the Fourier transforms of functions and apply them to solve problems arising in engineering.	**K3**
CO2	Understand the analyticity of complex functions and apply it in conformal mapping.	**K3**
CO3	Compute complex integrals using Cauchy's integral theorem and Cauchy's integral formula.	**K3**
CO4	Understand the series expansion of complex function about a singularity and apply residue theorem to compute real integrals.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10^{th} edition, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Complex Analysis	Dennis G. Zill, Patrick D. Shanahan	Jones & Bartlett	3rd edition, 2015
2	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39th edition, 2023
3	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44th edition, 2018
4	Fast Fourier Transform - Algorithms and Applications	K.R. Rao, Do Nyeon Kim, Jae Jeong Hwang	Springer	1st edition, 2011

SEMESTER S3

FLUID MECHANICS AND HYDRAULIC MACHINES

Course Code	**PCIET302**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs 30 Mins
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To familiarise fundamental concepts on mechanics of fluids to students.
2. To acquaint the students with basic flow properties and flow measuring devices.
3. To demonstrate the working principles of hydraulic machines.
4. To enable students to apply principles in fluid statics and dynamics, working principles of hydraulic machines to solve practical problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamental concepts:** Properties of fluid - density, specific weight, viscosity, surface tension, capillarity, vapour pressure, bulk modulus, compressibility, Newton's law of viscosity, Newtonian and non-Newtonian fluids, real and ideal fluids, incompressible and compressible fluids. **Fluid statics:** Atmospheric pressure, gauge pressure and absolute pressure. Pascal's Law, measurement of pressure - piezometer, manometers, pressure gauges, forces on planar and curved surfaces immersed in fluids, centre of pressure, buoyancy, equilibrium of floating bodies, metacentre and metacentric height.	**11**
2	**Fluid kinematics and Dynamics :** Overview on classification of flows, Continuity equation, Velocity and Acceleration of fluid flow, Euler's	**11**

	equation, Bernoulli's equation. Reynolds experiment, Hagen-Poiseuille equation, Major and Minor losses in pipes, Darcy- Weisbach equation, Chezy's formula. Pipes in series and parallel, siphon effect, water hammer, transmission of power through pipes and related practical problems.	
3	**Flow rate measurements:** venturi and orifice meters, mouth pieces , notches and weirs (derivation of discharges only for basic geometries) , flow velocity measurements techniques. Time of emptying a tank , basic concepts on boundary layer theory, displacement, momentum and energy thickness. **Hydraulic Turbines :** Overview on Impact of jets on flat, curved symmetrical and unsymmetrical plates (stationary and moving), Impact of jet on hinged plate. impact of jet on moving series of flat and curved vanes, Hydroelectric power stations. Overview on Impulse, Reaction and Axial Flow Turbines, Working principles, constructional features, design parameters and practical problems on Pelton, Francis and Kaplan Turbines. Governing of Turbines, Draft tubes, Cavitation in Turbines	**11**
4	**Pumps :** Overview on rotary and positive displacement pumps, Working principles, applications, constructional features, design considerations, accessories, factors affecting performance characteristics and practical problems on Centrifugal pumps and Reciprocating pumps. Multi staging of pumps, Basic features and working of diaphragm pump, gear pump, peristaltic pump progressive cavity pump, drum pump, submersible pump, fire fighting pumps and Micro pumps.	**11**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain fluid properties, types of fluids, fluid statics, pressure measurements and forces, equilibrium of floating and submerged bodies.	**K2**
CO2	Apply concepts on fluid kinematics and dynamics and solve problems on flow through pipes, major and minor losses.	**K3**
CO3	Solve problems on discharge and velocity of flow, understand boundary layer theories, understand concepts and solve problems on impacts of jets and turbines.	**K3**
CO4	Demonstrate working of pumps, solve problems on centrifugal and reciprocating pumps and study basics on special types of pumps.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	3	-	-	1	-	-	-	-	-	2
CO2	3	-	3	-	1	3	-	-	-	-	-	2
CO3	3	-	3	-	1	3	1	-	-	-	-	3
CO4	3	-	3	-	1	3	1	-	-	-	-	3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	A Textbook of Fluid Mechanics and Hydraulic Machines	R.K. Bansal	Laxmi Publications (P) Ltd. NewDelhi	11 Edition, 2023
2	Fluid Mechanics and Hydraulic Machines	Rajput.R.K	S Chand Publishing	6th Edition, 2017
3	Hydraulics, fluid mechanics and Hydraulic machinery	P.N. Modi & S.M. Seth	Standard Book House	22nd Edition, 2019
4	Fluid Mechanics and Hydraulic Machines	Mahesh Kumar	Pearson Education	5th Edition, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fluid Mechanics Fundamentals and Applications	Yunus A.Cengel John M. Cimbala	McGraw Hill	4th Edition, 2019
2	Fluid Mechanics	Frank M. White, Henry Xue	McGraw Hill	8th Edition, 2015
3	Fluid Mechanics and Fluid Power Engineering	D.S. Kumar	Kataria & Sons	13th Edition, 2013
4	Instrumentation for Engineering Measurements (Chapter 12 – Fluid Flow Measurements)	James W. Dally, William E. Riley,	Wiley & Sons Inc. 2004	2nd Edition, 2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/112/105/112105171/
2	https://archive.nptel.ac.in/courses/112/105/112105183/
3	https://archive.nptel.ac.in/courses/103/103/103103147/ https://archive.nptel.ac.in/courses/105/103/105103192/ https://archive.nptel.ac.in/courses/112/103/112103249/
4	https://archive.nptel.ac.in/courses/112/103/112103249/

SEMESTER S3

THERMAL ENGINEERING

Course Code	**PCIET303**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To familiarise the fundamental principles of thermodynamics and its applications.
2. To introduce principles and applications of steam engineering.
3. To acquaint the students with working principles of compressors and gas turbines.
4. To demonstrate the fundamental heat transfer principles and to describe the basic concepts of internal combustion engine operation, combustion processes, and alternative fuels.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamental of thermodynamics:** Introduction and significance, basic concepts of thermodynamics, laws of thermodynamics, first and second law applications, entropy, availability and unavailability, ideal and real gases, thermodynamic relations.	**10**
2	**Steam engineering:** Fundamentals of steam (properties of steam, T-s diagram, Mollier chart), steam power cycles (Rankine cycle, Modified Rankine cycle, relative efficiency, improvement in steam cycles: reheat cycle, regenerative cycle, binary vapour cycle), steam boilers (classification, Cochran boiler, Babcock and Wilcox boiler, boiler mountings and accessories).	**12**
3	**Compressors:** Reciprocating air compressors (work, efficiency, volumetric efficiency, clearance effects), Rotary compressors, Centrifugal & Axial compressors.	**10**

	Gas Turbines: Open & closed cycles, Ideal cycle, Efficiencies, Regeneration, Intercooling, Reheating. (Simple problems)	
4	**Heat transfer:** Different modes of heat transfer - Fourier law, Newton's law of cooling, Planck's law, Kirchhoff's law, Wien's displacement law and Stefan Boltzmann's law (simple problems). **IC engines:** Performance testing and Combustion in IC engines - Normal and abnormal combustion in SI and CI engines, Auto ignition, Pre ignition and detonation, Factors affecting detonation, Knocking in engine. **Alternate fuels in IC engines**: Biodiesel, hydrogen, natural gas, LPG - IC engine pollution and control (basic concepts only).	**12**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply fundamental laws of thermodynamic systems, processes, and solve related problems.	**K3**
CO2	Analyse steam power cycles and boiler systems by applying their knowledge of steam properties, cycle analysis, and boiler operation principles.	**K4**
CO3	Analyse the performance characteristics of compressors and gas turbines.	**K4**
CO4	Apply fundamental heat transfer principles, internal combustion engine performance and combustion phenomena in IC engines; understand the characteristics and implications of alternative fuels.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**3**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Thermal Engineering	Ballaney. P. L.	Khanna Publishers	25th 1st Reprint, 2017
2	Steam Table: With Mollier Diagram in S.I.Units	Khurmi. R. S. & Khurmi. N	S Chand Publishing	8th Edition, 2008
3	Engineering Thermodynamics	Nag. P. K	Tata McGraw-Hill Education	6th Edition, 2017
4	Thermal Engineering	Rajput. R. K	Laxmi publications	10th Edition, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Heat and Mass Transfer	Bergman. T. L., Incropera F. P., DeWitt D. P., Lavine, A. S.	John Wiley & Sons, Inc.	8th Edition, 2017
2	Gas Turbine Theory	Cohen H.,Saravanamuttoo H. I. H., Roger G. F. C., Straznicky P. & Nix, A. C	Pearson Education	7th Edition, 2019
3	Fundamentals of IC Engines	Ganesan, V	Tata McGraw Hill	2nd Edition, 2002
4	Thermodynamics	Holman J. P. & Bhattacharyya S	Tata McGraw-Hill	11th Edition, 2011
5	Fundamentals of Engineering Thermodynamics	Moran M. J., Shapiro H. N., Boettner D. D. & Bailey M. B.	John Wiley & Sons, Inc.	8th Edition, 2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/112105123
2	https://archive.nptel.ac.in/noc/courses/noc19/SEM2/noc19-me63/
3	https://archive.nptel.ac.in/courses/112/103/112103262/
4	http://nptel.ac.in/courses/112101097 https://archive.nptel.ac.in/courses/112/103/112103262/

SEMESTER S3

OPERATIONS MANAGEMENT

Course Code	**PBIET304**	**CIE Marks**	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	**ESE Marks**	40
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To equip students with a thorough understanding of operations management, enabling them to apply demand forecasting, inventory control, aggregate planning and modern production systems effectively.
2. To familiarise mathematical models and strategic methodologies for optimizing operational processes, enhance efficiency, and make informed decisions within organizational contexts.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Operation Management:** Role of Operations in an Organisation, Historical Evolution and perspectives, Operations strategies and productivity in organisations. **Demand Forecasting**: Forecasting methods: causal and time series models, moving average, exponential smoothing methods. Trend, cycle, and seasonality components, Winter's complete model. Analysis of forecast error, comparison of forecasting methods based on errors. **Facility Location and Layout**: Factors influencing location planning, Factor rating and center of gravity methods of location selection. Types facility of layouts, comparison of layouts. Systematic Layout Planning (SLP), software packages for SLP.	11

2	**Inventory Models:** Objectives, Types of Inventories, EOQ and EBQ models for uniform and variable demand with and without shortages. Quantity discount models, Probabilistic inventory models, Inventory systems under risk, service levels, safety stock. **Selective Inventory Control:** ABC Analysis, XYZ Analysis, VED Analysis.	**11**
3	**Aggregate Planning**: Definition, value of decision rules, Pure and Mixed strategies, Mathematical Models for Aggregate planning – Transportation Method, Linear programming Formulation, Linear Decision Rules. **Master production schedule:** Bill of Material (BOM), structuring BOM,, MRP -Lot sizing methods – Implementation issues, MRP – II, Introduction to ERP.	**11**
4	**Job Shop Production:** Activity planning, scheduling, shop loading, sequencing. Priority rules for dispatching jobs. **Modern Production Systems**: Introduction to Business Process Re-engineering, Lean Manufacturing, Kaizen, Toyota Production System, World Class Manufacturing Concepts. Kanban - Push vs Pull systems, Just-in-time systems.	**11**

Suggestion on Project Topics

- **Forecasting Model Implementation**
  – Students choose a product or service and apply different forecasting methods (e.g., causal models, time series models, moving average, exponential smoothing) to predict future demand.
- **Location Planning Analysis**
  – Students analyse factors influencing facility location decisions for a given company and apply factor rating and center of gravity methods to determine the optimal location.
- **Layout Design**
  – Students design different types of facility layouts (e.g., process layout, product layout) for a specific business scenario and compare their efficiencies.

- **EOQ/ EBQ Model Development**
  – Students develop advanced EOQ and EBQ models that account for real-world complexities such as variable demand, lead times, and shortages. They implement these models using programming languages like Python or MATLAB.
- **Optimization of Inventory Costs with Quantity Discounts**
  – Students create an optimization algorithm that determines the optimal order quantity considering quantity discounts and other cost factors. They use software like Excel Solver, Python, or MATLAB.
- **MPS Optimization for a Manufacturing Firm**
  – Students design an optimized Master Production Schedule (MPS) for a manufacturing firm using Linear Decision Rules and other relevant methodologies. They implement the optimization in software tools like Excel, Python, or MATLAB.
- **BOM Structuring and MRP System Development**
  – Students develop a comprehensive Bill of Material (BOM) for a complex product and implement a Material Requirements Planning (MRP) system using software tools like MS Project or specialized MRP software.
- **Case Study on Real-World ERP Implementation**
  – Students conduct a detailed case study on a real-world ERP implementation in a large enterprise, analysing the challenges, solutions, and outcomes.
- **Business Process Re-engineering (BPR) Case Study**
  – Students conduct a case study on Business Process Re-engineering (BPR) in a real or hypothetical company. They identify processes for re-engineering, propose improvements, and evaluate potential impacts.
- **Lean Manufacturing Implementation**
  – Students develop a Lean Manufacturing implementation plan for a manufacturing facility. They apply lean principles such as value stream mapping, 5S, and waste reduction techniques.

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 6 marks. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the role and evolution of operations management and apply its strategic impact on organizational productivity.	**K3**
CO2	Apply different inventory models and effectively manage inventory to optimize stock levels and reduce risks	**K3**
CO3	Proficient in developing aggregate plans and applying advanced planning systems for efficient operations.	**K3**
CO4	Effectively plan and schedule job shop production activities and apply modern production system principles to enhance operational efficiency.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	1	-	2	2	-	2
CO2	3	3	2	2	2	-	-	-	2	2	2	2
CO3	3	3	3	2	2	-	-	-	2	2	2	2
CO4	3	3	3	2	2	-	-	-	3	2	2	2

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Operations Management: Processes and Supply Chains	Lee J. Krajewski, Manoj Malhotra	Pearson Education	14th Edition, 2024
2	Operations Management	William J. Stevenson	McGraw-Hill Education	14th Edition, 2020
3	Production and Operations Management	R. Paneerselvam	PHI Learning	3rd Edition, 2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Operations and Supply Chain Management	Cecil B. Bozarth, Robert B. Handfield	Pearson	5th Edition, 2019
2	Operations Management: Sustainability and Supply Chain Management	Jay Heizer, Barry Render, Chuck Munson	Pearson	14th Edition, 2022
3	Operations Management: Processes and Value Chains	Lee J. Krajewski, Larry P. Ritzman, Manoj K. Malhotra	Pearson	10th Edition, 2012
4	Production and Operations Management	S. N. Chary	McGraw-Hill	6th Edition, 2019
5	Operations Management: Theory and Practice	B. Mahadevan	Pearson India	3rd Edition, 2015

Video Links (NPTEL, SWAYAM…)	
Sl No	**Link ID**
1	https://archive.nptel.ac.in/courses/112/107/112107238/

PBL Course Elements

L: Lecture (3 Hrs.)	**R: Project (1 Hr.), 2 Faculty Members**		
	Tutorial	**Practical**	**Presentation**
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	**Evaluation for**	**Allotted Marks**
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		**30**

1. **Project Planning and Proposal (5 Marks)**
    - Clarity and feasibility of the project plan
    - Research and background understanding
    - Defined objectives and methodology

2. **Contribution in Progress Presentation and Question Answer Sessions (4 Marks)**
    - Individual contribution to the presentation
    - Effectiveness in answering questions and handling feedback

3. **Involvement in the Project Work and Team Work (3 Marks)**
    - Active participation and individual contribution
    - Teamwork and collaboration

4. **Execution and Implementation (10 Marks)**
    - Adherence to the project timeline and milestones
    - Application of theoretical knowledge and problem-solving
    - Final Result

5. **Final Presentation (5 Marks)**
    - Quality and clarity of the overall presentation
    - Individual contribution to the presentation
    - Effectiveness in answering questions

6. **Project Quality, Innovation, and Creativity (3 Marks)**
    - Overall quality and technical excellence of the project
    - Innovation and originality in the project
    - Creativity in solutions and approaches

SEMESTER S3

INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Course Code	**GNEST305**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Demonstrate a solid understanding of advanced linear algebra concepts, machine learning algorithms and statistical analysis techniques relevant to engineering applications, principles and algorithms.
2. Apply theoretical concepts to solve practical engineering problems, analyze data to extract meaningful insights, and implement appropriate mathematical and computational techniques for AI and data science applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to AI and Machine Learning**: Basics of Machine Learning - types of Machine Learning systems-challenges in ML- Supervised learning model example- regression models- Classification model example- Logistic regression-unsupervised model example- K-means clustering. Artificial Neural Network- Perceptron- Universal Approximation Theorem (statement only)- Multi-Layer Perceptron- Deep Neural Network- demonstration of regression and classification problems using MLP.(Text-2)	**11**

2	**Mathematical Foundations of AI and Data science**: Role of linear algebra in Data representation and analysis – Matrix decomposition- Singular Value Decomposition (SVD)- Spectral decomposition- Dimensionality reduction technique-Principal Component Analysis (PCA). (Text-1)	**11**
3	**Applied Probability and Statistics for AI and Data Science**: Basics of probability-random variables and statistical measures - rules in probability- Bayes theorem and its applications- statistical estimation-Maximum Likelihood Estimator (MLE) - statistical summaries- Correlation analysis- linear correlation (direct problems only)- regression analysis- linear regression (using least square method) (Text book 4)	**11**
4	**Basics of Data Science**: Benefits of data science-use of statistics and Machine Learning in Data Science- data science process - applications of Machine Learning in Data Science- modelling process- demonstration of ML applications in data science- Big Data and Data Science. (For visualization the software tools like Tableau, PowerBI, R or Python can be used. For Machine Learning implementation, Python, MATLAB or R can be used.)(Text book-5)	**11**

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the concept of machine learning algorithms including neural networks and supervised/unsupervised learning techniques for engineering applications.	**K3**
CO2	Apply advanced mathematical concepts such as matrix operations, singular values, and principal component analysis to analyze and solve engineering problems**.**	**K3**
CO3	Analyze and interpret data using statistical methods including descriptive statistics, correlation, and regression analysis to derive meaningful insights and make informed decisions.	**K3**
CO4	Integrate statistical approaches and machine learning techniques to ensure practically feasible solutions in engineering contexts.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Linear Algebra	Gilbert Strang	Wellesley-Cambridge Press	6th edition, 2023
2	Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow	Aurélien Géron	O'Reilly Media, Inc.	2nd edition,2022
3	Mathematics for machine learning	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press	1st edition. 2020
4	Fundamentals of mathematical statistics	Gupta, S. C., and V. K. Kapoor	Sultan Chand & Sons	9th edition, 2020
5	Introducing data science: big data, machine learning, and more, using Python tools	Cielen, Davy, and Arno Meysman	Simon and Schuster	1st edition, 2016

Reference Books				
1	Data science: concepts and practice	Kotu, Vijay, and Bala Deshpande	Morgan Kaufmann	2nd edition, 2018
2	Probability and Statistics for Data Science	Carlos Fernandez-Granda	Center for Data Science in NYU	1st edition, 2017
3	Foundations of Data Science	Avrim Blum, John Hopcroft, and Ravi Kannan	Cambridge University Press	1st edition, 2020
4	Statistics For Data Science	James D. Miller	Packt Publishing	1st edition, 2019
5	Probability and Statistics - The Science of Uncertainty	Michael J. Evans and Jeffrey S. Rosenthal	University of Toronto	1st edition, 2009
6	An Introduction to the Science of Statistics: From Theory to Implementation	Joseph C. Watkins	chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.math.arizo	Preliminary Edition.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106198/
2	https://archive.nptel.ac.in/courses/106/106/106106198/ https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/resources/lecture-29-singular-value-decomposition/
3	https://ocw.mit.edu/courses/18-650-statistics-for-applications-fall-2016/resources/lecture-19-video/
4	https://archive.nptel.ac.in/courses/106/106/106106198/

SEMESTER S3/S4

ECONOMICS FOR ENGINEERS

(Common to All Branches)

Course Code	**UCHUT346**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Understanding of finance and costing for engineering operation, budgetary planning and control
2. Provide fundamental concept of micro and macroeconomics related to engineering industry
3. Deliver the basic concepts of Value Engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Economics Concepts - Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility – Law of Demand - Law of supply – Elasticity - measurement of elasticity and its applications – Equilibrium- Changes in demand and supply and its effects Production function - Law of variable proportion – Economies of Scale – Internal and External Economies – Cobb-Douglas Production Function	**6**
2	Cost concepts – Social cost, private cost – Explicit and implicit cost – Sunk cost - Opportunity cost - short run cost curves - Revenue concepts Firms and their objectives – Types of firms – Markets - Perfect Competition – Monopoly - Monopolistic Competition - Oligopoly (features and equilibrium of a firm)	**6**

3	Monetary System – Money – Functions - Central Banking –Inflation - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation Taxation – Direct and Indirect taxes (merits and demerits) - GST National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators- SENSEX and NIFTY	**6**
4	Value Analysis and value Engineering - Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning	**6**

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Case study/Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	**15**	**12.5**	**12.5**	**50**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks **(6x3 =18marks)**	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. **(4x8 = 32 marks)**	**50**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	**K2**
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	**K3**
CO3	Outline the macroeconomic principles of monetary and fiscal systems, national income and stock market.	**K2**
CO4	Make use of the possibilities of value analysis and engineering, and solve simple business problems using break even analysis, cost benefit analysis and capital budgeting techniques.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	-	-	1	-
CO2	-	-	-	-	-	1	1	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	-	2	-
CO4	-	-	-	-	1	1	-	-	-	-	2	-

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Managerial Economics	Geetika, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	Mc Graw Hill	7th Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001

SEMESTER S3/S4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	**UCHUT347**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of ethics** - Personal vs. professional ethics, Civic Virtue, Respect for others, **Profession and Professionalism,** Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, **Technology and digital revolution**-Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, **High technologies: connecting people and places**-accessibility and social impacts, **Managing conflict**, Collective bargaining, **Confidentiality**, Role of confidentiality in moral integrity, **Codes of Ethics**. **Basic concepts in Gender Studies** - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, **Gender disparity and discrimination in education**, employment and everyday life, History of women in Science & Technology, Gendered	6

	technologies & innovations**, Ethical values and practices in connection with gender** - equity, diversity & gender justice, **Gender policy and women/transgender empowerment initiatives.**	
2	**Introduction to Environmental Ethics:** Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). **Sustainable Engineering Principles:** Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. **Ecosystems and Biodiversity:** Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. **Landscape and Urban Ecology:** Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	**6**
3	**Hydrology and Water Management:** Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. **Zero Waste Concepts and Practices:** Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. **Circular Economy and Degrowth:** Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. **Mobility and Sustainable Transportation:** Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.	**6**
4	**Renewable Energy and Sustainable Technologies:** Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. **Climate Change and Engineering Solutions:** Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. **Environmental Policies and Regulations:** Overview of key environmental policies and	**6**

	regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. **Case Studies and Future Directions:** Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.	

Course Assessment Method
(CIE: 50 marks , ESE: 50)

Continuous Internal Evaluation Marks (CIE):

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
- Activities are to be distributed between 2 class hours and 3 Self-study hours.
- The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

Sl. No.	Item	Particulars	Group/Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12
3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings.	G	5
		Total Marks		**50**

*Can be taken from the given sample activities/projects

Evaluation Criteria:

- **Depth of Analysis**: Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts**: Ability to apply course concepts to real-world problems and local contexts.
- **Creativity**: Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills**: Clarity, coherence, and professionalism in the final presentation.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop the ability to apply the principles of engineering ethics in their professional life.	**K3**
CO2	Develop the ability to exercise gender-sensitive practices in their professional lives	**K4**
CO3	Develop the ability to explore contemporary environmental issues and sustainable practices.	**K5**
CO4	Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience.	**K4**
CO5	Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3	2	3	3	2		2
CO2		1				3	2	3	3	2		2
CO3						3	3	2	3	2		2
CO4		1				3	3	2	3	2		2
CO5						3	3	2	3	2		2

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Ethics in Engineering Practice and Research	Caroline Whitbeck	Cambridge University Press & Assessment	2nd edition & August 2011
2	Virtue Ethics and Professional Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainability Science	Bert J. M. de Vries	Cambridge University Press & Assessment	2nd edition & December 2023
4	Sustainable Engineering Principles and Practice	Bhavik R. Bakshi,	Cambridge University Press & Assessmen	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi	4" edition, 2014

Suggested Activities/Projects:

Module-II

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts
- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college campus etc) and propose conservation strategies to protect it.
- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and suggest sustainable management and restoration practices.
- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).
- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

Module-IV

- Evaluate the potential for installing solar panels on the college campus including cost-benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy-saving gadgets?
- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

SEMESTER S3

FLUID MECHANICS AND HYDRAULIC MACHINES LAB

Course Code	**PCIEL307**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Lab

Course Objectives:

1. To familiarize practical fluid discharge measurements.

2. To practice performance evaluations of pumps and turbines.

Expt. No.	Experiments
1	Determination of coefficient of discharge and calibration of Notches.
2	Determination of coefficient of discharge and calibration of Orifice meter.
3	Determination of coefficient of discharge and calibration of Venturi meter.
4	Determination of hydraulic coefficients of orifices.
5	Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus.
6	Experiments on hydraulic ram.
7	Reynolds experiment.
8	Determination of metacentric height and radius of gyration of floating bodies.
9	Performance test on positive displacement pumps.
10	Performance test on centrifugal pumps, determination of operating point and efficiency.
11	Performance test on Impulse turbines.
12	Performance test on reaction turbines (Francis and Kaplan Turbines).

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Determine CD of notches/orifice/venturi meter	**K3**
CO2	Calibrate notches, orifice meter and Venturi meter	**K3**
CO3	Evaluate the losses in pipes	**K3**
CO4	Find the metacentric height and differentiate flows	**K3**
CO5	Evaluate performance of pumps and turbines	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	-	2	3	2	-	2
CO2	2	1	-	-	-	-	-	2	3	2	-	2
CO3	2	1	-	-	-	-	-	2	3	2	-	2
CO4	2	1	-	-	-	-	-	2	3	2	-	2
CO5	2	1	-	-	-	-	-	2	3	2	-	2

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fluid Mechanics and Hydraulic Machines	R.K. Bansal	Laxmi Publications (P) Ltd. NewDelhi	11 Edition, 2023
2	Hydraulics, FM and HM	P.N. Modi & S.M. Seth	Standard Book House	22nd Edition 2019
3	Fluid Mechanics and Hydraulic Machines	Rajput.R.K	S. Chand Publishing	6th Edition 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fluid Mechanics Fundamentals and Applications	Yunus A.Cengel John M. Cimbala	McGraw Hill	4th Edition, 2019
2	Fluid Mechanics	Frank M. White, Henry Xue	McGraw Hill	8th Edition, 2015
3	Fluid Mechanics and Fluid Power Engineering	D.S. Kumar	Kataria & Sons	13th Edition, 2013
4	Instrumentation for Engineering Measurements (Chapter 12 – Fluid Flow Measurements)	James W. Dally, William E. Riley,	Wiley & Sons Inc. 2004	2nd Edition, 2010

Continuous Assessment (25 Marks)

1. **Preparation and Pre-Lab Work (7 Marks)**

    - Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
    - Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. **Conduct of Experiments (7 Marks)**

    - Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
    - Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
    - Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**

    - Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
    - Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**

    - Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

    - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
    - Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
    - Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
    - Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

    - Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S3

THERMAL ENGINEERING LAB

Course Code	**PCIEL308**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Lab

Course Objectives:

1. To familiarize the performance characteristics of internal combustion engines and compressors based on experimentation.
2. To practice analysis of exhaust and flue gases, determination of thermal properties of materials and fluids, and determination of heat transfer parameters.

Expt. No.	Experiments
1	Performance test on petrol engines / MPFI engine.
2	Performance test on Diesel engines / Turbocharged engine.
3	Retardation test on IC engines.
4	Morse test on petrol engine.
5	Heat Balance test on petrol/diesel engines.
6	Determination of volumetric efficiency and air-fuel ratio of IC engines.
7	Performance test on reciprocating compressor.
8	Performance test on rotary compressor/blower.
9	Analysis of automobile exhaust gas and flue gas using exhaust gas analyser.
10	Cooling curve of IC engines.
11	Determination of flash and fire points of petroleum products -flash and fire point apparatus.
12	Determination of viscosity of lubricating oil- viscometer.
13	Determination of thermal conductivity of solids (composite wall/metal rod).
14	Determination of heat transfer coefficients in free convection.
15	Determination of emissivity of a specimen.

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyse the performance of internal combustion engines and compressors	**K4**
CO2	Apply thermophysical properties of fluids and materials	**K3**
CO3	Analyse combustion emissions and engine cooling characteristics	**K4**
CO4	Examine heat transfer phenomena relevant to IC engine	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	2	-	-	-	2	2	-	2
CO2	3	3	-	2	2	-	-	-	2	2	-	2
CO3	3	3	-	2	2	-	2	-	2	2	-	2
CO4	3	3	2	2	2	-	2	-	2	2	-	2

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Thermal Engineering	Ballaney. P. L.	Khanna Publishers	25th 1st Reprint, 2017
2	Steam Table: With Mollier Diagram in S.I.Units	Khurmi. R. S. & Khurmi. N	S Chand Publishing	8th Edition, 2008
3	Engineering Thermodynamics	Nag. P. K	Tata McGraw-Hill Education	6th Edition, 2017
4	Thermal Engineering	Rajput. R. K	Laxmi publication	10th Edition, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	IC Engine fundamentals	J.B.Heywood	McGraw-Hill	2nd Edition, 2019
2	Internal Combustion Engines	V. Ganesan	Tata McGraw-Hill	4th Edition, 2012
3	An Introduction to Combustion: Concepts and Applications	Stephen R Turns	McGraw-Hill	4th Edition, 2021
4	Thermal Engineering	Ballaney, P. L.	Khanna Publishers	1st Reprint, 2017
5	Heat and mass transfer	Rajput, R. K	S.Chand & Co	4th Edition, 2015
6	Thermal Engineering	Rajput, R. K.	Laxmi publications	10th Edition,2018

Continuous Assessment (25 Marks)

1. **Preparation and Pre-Lab Work (7 Marks)**

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. **Conduct of Experiments (7 Marks)**

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted