VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Semester-I

Scheme of Teaching and Examinations and Syllabus
M.Tech., Program in

Thermal Power Engineering
(UNIVERSITY)

(Effective from the Academic year 2022-23)

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022-23
M.Tech., in Thermal Power Engineering (UTP)
Choice Based Credit System (CBCS) and Outcome-BasedEducation (OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical/Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	BSC	22UTP11	Applied Mathematics	03	00	00	03	50	50	100	3
2	IPCC	22UTP12	Theory and Design of Modern IC Engine	03	02	00	03	50	50	100	4
3	PCC	22UTP13	Advanced Fluid Mechanics	03	00	02	03	50	50	100	4
4	PCC	22UTP14	Advanced Thermodynamics and Combustion	02	00	02	03	50	50	100	3
5	PCC	22UTP15	Finite Element Method in Heat Transfer	02	00	02	03	50	50	100	3
6	MCC	22RMI16	Research Methodology and IPR	03	00	00	03	50	50	100	3
7	PCCL	22UTPL17	FEM & Simulation Lab	01	02	00	03	50	50	100	2
8	AUD/AEC	22AUD18/ 22AEC18	NPTEL/MOOC/Coursera/MIT	Classes and evaluation procedures are as per the policy of the online course providers.							PP
			TOTAL	**17**	**04**	**06**	**21**	**350**	**350**	**700**	**22**

Note: BSC-Basic Science Courses, PCC: Professional core. IPCC-Integrated Professional Core Courses, MCC- Mandatory Credit Course,
AUD/AEC –Audit Course / Ability Enhancement Course (A pass in AUD/AEC is mandatory for the award of the degree), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities** (Hours are for Interaction between faculty and students)

Integrated Professional Core Course (IPCC): **Integrated Professional Core Course (IPCC)**: Refers to Professional Theory Core Course Integrated with practical of the same course. The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses): Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs.

Ability Enhancement Courses:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialisation as well allied fields that leads to employable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.
- The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.

3. Involve in case studies and field visits/ fieldwork.
4. Accustomed to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Applied Mathematics			
Course Code	**22UTP11**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3 Hr

Course Learning objectives:

- The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of Thermal engineering subjects.
- The topics introduced will serve as basic tools for specialized studies in the fields of Thermal engineering and technology.
- An understanding of Fourier Series and Laplace Transform to solve real world problems.
- An understanding of Linear Algebra through matrices and understanding of statistical analysis using ANOVA.

Module-1	
Error definition, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering. Vector and Tensor Analysis in Cartesian system, effect of rotation of coordinate systems.	
Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.
Module-2	
Roots of Equations: Graphical method, Bisection method, Newton- Raphson method, Secant Method. Simple fixed-point iteration. Roots of polynomial-Polynomials in Engineering and Science, Muller‘s method, Bairstow‘s Method Graeffe‘s Roots Squaring Method	
Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.
Module-3	
Linear systems of algebraic equations: Gauss elimination, LU decomposition, Triangularization method, Cholesky Method, Partition method. Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder‘s method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method.	
Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.
Module-4	
Solving ODE’s using: Picard’s method, Runge-Kutta fourth order and Stiffness of ODE using shooting method. Solving PDE‘s by numerical method: one dimensional wave equation and heat equation.	
Teaching-Learning	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Process	

Module-5

Probability distributions: Binomial, Poisson. Normal. Sampling Theory: Testing of hypothesis for large and small samples, Goodness of fit. F-test, Analysis of Variance: One – way with/without interactions, problems related to ANOVA, Design of experiments.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks.**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs.

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks.**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. C. Ray Wylie and Louis C Barrett, ―Advanced Engineering Mathematics‖. 6th edition, McGraw-Hill, 1995.
2. K Shankar Rao, ―Introduction to Partial Differentia Equations‖ Prentice - Hall of India Pvt. Lt., 1995 Edition.
3. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
4. Steven C Chapra and Raymond P Canale: Numerical Methods for Engineers, 7th Ed., McGraw-Hill Edition, 2015.

Reference Books

1. William W.H., Douglas C.M., David M.G. and Connie M.B., ―Probability and Statistics in

Engineering, 4th Edition, Willey Student edition, 2008.
2. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2017
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engineering computation, New Age International, 2003.
4. Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010.

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/111/107/111107119/
https://archive.nptel.ac.in/courses/111104145/
https://onlinecourses.nptel.ac.in/noc21_ma64/preview
https://archive.nptel.ac.in/courses/111/102/111102133/
https://archive.nptel.ac.in/courses/111/105/111105091/
https://archive.nptel.ac.in/courses/111/104/111104024/

Skill Development Activities Suggested

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Acquire the idea of significant figures, types of errors during numerical computation.	
CO2	Develop the mathematical models of thermal system using ODE's and PDE's.	
CO3	Learn the deterministic approach for statistical problems by using probability distributions.	
CO4	Classify and analyze mathematical tools applied to thermal engineering study cases.	

Mapping of COS and POs

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**1**	**1**	**2**	**1**	**1**
CO2	**3**	**2**	**1**	**2**	**2**	**1**	**1**
CO3	**3**	**2**	**1**	**2**	**2**	**1**	**1**
CO4	**3**	**2**	**1**	**2**	**2**	**1**	**1**

Semester - I

Theory and Design of Modern IC Engine			
Course Code	**22UTP12**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	3 Hr

Course objectives:

1. To provide the sufficient knowledge of concept, applications, importance of IC engines.
2. To understand the mechanism of combustion in SI and CI engine and its effect on engine performance.
3. To familiarize the students about the IC engines systems, processes, alternative fuels etc.
4. Knowledge ofdifferent Injection Systems and Engine emissions and their control.

MODULE-1

Introduction to IC Engines: Basic engine components and nomenclature, Applications of IC Engines**,** Engine characteristics, geometrical properties of reciprocating engines, specific emissions and emission index, relationships between performance parameters, Engine design and performance data. Energy flow through IC engines, Various Auxiliary systems. Environment friendly engines. Fuel –Air and Actual Engines: Modelling of Fuel-Air cycle Effect of operating variables on the performance of Fuel –air Cycles, Detailed analysis of difference between Fuel-Air and Real Cycle, Combustion charts and Gas Tables.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

MODULE-2

Combustion in SI engine: Introductions, Ignition limits, Stages of Combustion in SI Engine, Effect of Engine Variables on Ignition lag, Effect of Engine variable on flame propagation, Detonation on knocking, Abnormal combustion knock-surface ignition, Cyclic variations in combustion, partial burning, and misfire, SI Engine combustion chamber designs, Combustion chamber design principles.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

MODULE-3

Combustion in CI engine: Introduction, Combustion in the CI engine, Types of diesel Combustion Systems, Air-Fuel ration in CI Engines, Ignition Delay, Variables affecting delay period, Analysis of cylinder pressure Data, Fuel Spray Behaviour, The CI engine Combustion Chamber.

Alternate fuels for IC engines: Vegetable oils, alcohol, LPG, CNG, Hydrogen fuels, Biogas, Dual fuels, other possible fuels.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

MODULE-4

Carburetion: Introduction, Factors affecting carburetion, mixture requirements at different load and speed, principles of carburetion, essential parts, and functions of a carburettor, compensating devices, Modern Carburetors, Altitude compensation devices, Injection in SI engine. **Injection Systems:** Introduction to Mechanical Injection System, Functional Requirements and classification, Fuel feed

pump and Fuel Injector, **Electronic injection systems:** Types, Merits and Demerits, Multi point fuel injection system (MPFI), Electronic control system, Injection timings, Common –Rail Fuel Injection System.	
Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.
MODULE 5	
Engine emissions and their control: Air pollution due to IC engines, emission characteristics, Euro norms, engine emissions, Hydrocarbon emissions, CO emission, NOx- Photo chemical smog, Particulates, other emissions, Smoke, emission control methods – thermal converters, catalytic converters, particulate traps, Ammonia injection systems, exhaust gas recirculation, ELCD, Crank case blow by control. IC engine Noise characteristics, types, standards and control methods, Air quality emission standards **Measurement:** Noise, Emission, Pressure, crank angle torque, valve timings, temperature, and flow measurements.	
Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

PRACTICAL COMPONENT OF IPCC (May cover all / major modules)

Sl.NO	Experiments
1.	Performance analysis of single cylinder, four stroke, Petrol engine connected to eddy current dynamometer for loading.
2.	Performance analysis of single cylinder, four stroke, Diesel engine connected to eddy current dynamometer for loading.
3.	Performance analysis of four cylinder, four stroke, Turbocharged Diesel engine connected to Eddy current dynamometer for engine loading
4.	Performance analysis of a four cylinder, four stroke, Petrol (MPFI) engine connected to eddy current dynamometer for loading
5.	Performance analysis of a single cylinder, four stroke, VCR (Variable Compression Ratio) Diesel engine connected to eddy current dynamometer for loading.
6.	Performance analysis of a single cylinder, four stroke, VCR (Variable Compression Ratio) Diesel engine connected to eddy current dynamometer for loading for different biodiesel.
7.	Performance analysis of a single cylinder, four stroke, VCR (Variable Compression Ratio) Diesel engine connected to eddy current dynamometer for loading for Dual Fuel Mode.
8.	Performance analysis of a single cylinder, four stroke, CRDI VCR (Variable Compression Ratio) engine connected to eddy current dynamometer.
9.	Set-up for Extraction of Vegetable Oil and its Transesterification
10.	Exhaust Gas analyser for diesel and Biodiesel fuel

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the

academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of IPCC

1. Two Tests each of **20 Marks.**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks.**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated, and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students must answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of

04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student must secure an aggregate of 50% of maximum marks of the course (CIE+SEE).

Suggested Learning Resources:

Books

1. John B Heywood, ―IC Engines fundamentals‖, McGraw- Hill Publications,2011.
2. V. Ganesan, ―Internal Combustion Engines‖, Tata McGraw-Hill Publications, 4th Edition.
3. Internal Combustion Engines, Mathur R.P. & Sharma M.L., Dhanpat Rai Publication, 2014.
4. Richard stone, "Introduction to IC Engines" Palgrave Publication 3rd edition.
5. The Internal Combustion Engines in Theory and practice, Taylor C.F., MIT Press, 1985.

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/112/103/112103262/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To explore the knowledge of performance parameters and its characteristics, variables effect the performance of engine and methods of improving engine performance of internal combustion engine.	
CO2	Analyze combustion and apply remedial measures to avoid abnormal combustion in SI and CI Engine.	
CO3	Specify and interpret data of alternative fuels and its emission which effect the environment.	
CO4	Analyze different electronic fuel injection system, supercharging and its effect on performance of SI and CI engine.	
CO5	Apply various emission control system and modification to take corrective actions to reduce pollution.	

Mapping of COS and POs

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**1**	**-**	**-**	**1**	**1**
CO2	**3**	**2**	**1**	**2**	**-**	**1**	**1**
CO3	**3**	**2**	**1**	**2**	**-**	**1**	**1**
CO4	**3**	**2**	**1**	**2**	**-**	**1**	**1**
CO5	**3**	**2**	**1**	**-**	**-**	**1**	**1**

Semester - I

Advanced Fluid Mechanics			
Course Code	**22UTP13**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	3 Hr

Course Learning objectives:

- To understand the kinematics of fluids, their governing equations, Mechanics of laminar and turbulent flow, NS Equations.
- Advanced knowledge of boundary layer equation, as well as a fundamental understanding of the drag and lift force.
- Understanding of the fundamental of the Flow across Normal Shock and Oblique Shock and Comparison of isentropic and adiabatic processes.
- Knowledge of several practical applications of the theory covered.

Module-1

Review of undergraduate Fluid Mechanics: Introduction: Fluid Statics, Relative Motion of Liquids. Kinematics of Fluids- Review of basics-Velocity potential, Stream function and Vorticity. Fundamental Equations, Applications of Fundamental Equations, Differential Flow analysis-Continuity equation (3D Cartesian, Cylindrical and spherical Coordinates) Navier Stokes equations (3D- Cartesian, coordinates), Energy Equations (3D- Cartesian, coordinates), Elementary in viscid flows; superposition (2D).

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Module-2

Mechanics of Laminar and Turbulent Flow: Introduction; Laminar and turbulent flows; viscous flow at different Reynolds number - wake frequency; laminar plane Poiseuille flow; stokes flow; flow through a concentric annulus. structure and origin of turbulent flow - Reynolds, average concept, Reynolds equation of motion; zero equation model for fully turbulent flows and other turbulence models; turbulent flow through pipes; losses in bends, valves etc; analysis of pipe network - Hard cross method.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Module-3

Exact and Approximate solutions of N-S Equations: Introduction; Parallel flow past a sphere; Oseen ‘s approximation; hydrodynamic theory of lubrication; Hele-Shaw Flow.

Boundary layer over a flat plate: Thickness of boundary layer, displacement and momentum thickness, Prandtl‘s boundary layer equation, Vonkarmann momentum equation – shear stress and drag force, laminar boundary layer, turbulent boundary layer, pressure distribution in the boundary layer, boundary layer separation, drag and lift force – lift on an airfoil.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Module-4

Energy equation: Energy equation for non-flow and flow processes, adiabatic energy equation, stagnation enthalpy, stagnation temperature, stagnation pressure, stagnation velocity of sound, reference velocities, Bernoulli's equation, effect of Mach number on compressibility. **Isentropic Flow with variable Area:** Comparison of isentropic and adiabatic processes, Mach Number variation, Stagnation and critical states, Area ratio as a function of Mach number, impulse function, Mass flow rate, Flow through nozzles and diffusers	
Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.
Module-5	
Flow across Normal Shock and Oblique Shock: Development of a shock wave, rarefaction wave, governing equations, Prandtl-Meyer relation, Mach number downstream of the shock wave, static pressure ratio, temperature ratio, density ratio, and stagnation pressure ratio across the shock. Oblique shock waves fundamental relations, Prandtl's Equation, Rankine – Hugoniot Equation, Variation of flow parameters, Relations and Tables, Numerical Problems.	
Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Textbooks

1. Foundations of fluid mechanics - S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India, 2000.
2. White F.M., Viscous Fluid Flow, 3rd edition, Tata McGraw Hill Book Company, 2011.
3. S.M. Yahya, Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion (SI UNITs), Fifth Edition, New Age International Publishers, New Delhi, 2020.

Reference Books

1. Yunus A. Cengel and John M. Cimbala, Introduction to Fluid Mechanics, Second Edition, Tata McGraw-Hill, 2010.
2. Introduction to fluid dynamics - Principles of analysis & design - Stanley Middleman, Wiley, 1997.
3. D. S. Kumar, Fluid Mechanics and Fluid power engineering, S. K. Kataria & sons, 2010.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/105/112105218/
- https://archive.nptel.ac.in/courses/112105269/
- https://archive.nptel.ac.in/courses/112/105/112105287/
- https://archive.nptel.ac.in/courses/112/106/112106311/
- https://archive.nptel.ac.in/courses/103/102/103102211/
- https://archive.nptel.ac.in/courses/112/103/112103290/

Skill Development Activities Suggested

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Illustrate the basic concepts fluid flow and their governing equations	
CO2	Analyse the laminar and turbulent flow problems.	
CO3	Demonstrate the concept of boundary layer equations and drag and lift force	
CO4	Distinguish normal and oblique shocks and their governing Equations.	
CO5	Explain thePropagation of sound waves and Comparison of isentropic and adiabatic processes in fluid mechanics.	

Mapping of COS and POs

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**1**	**-**	**-**	**1**	**1**
CO2	**3**	**2**	**1**	**2**	**-**	**1**	**1**
CO3	**3**	**2**	**1**	**2**	**-**	**1**	**1**
CO4	**3**	**2**	**1**	**2**	**-**	**1**	**1**

CO5	**3**	**2**	**1**	**-**	**-**	**1**	**1**

01.02.2023

Semester - I

Advanced Thermodynamics and Combustion			
Course Code	**22UTP14**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3 Hr

Course Learning objectives:

- To enhance the understanding of thermodynamics principles and their relevance to the problems of humankind.
- Provide the student with experience in applying thermodynamic principles to predict physical phenomena and to solve engineering problems.
- To clarify availability concept and analyze availability cycles.
- Understanding the fundamental of properties of gas mixtures, chemical reactions, and chemistry of combustion.

Module-1

Review of Basic Thermodynamics: First &Second Law Analysis, Review of entropy, Concept of entropy and entropy generation, Entropy balance for closed & open systems; Concept of exergy & irreversibility, Exergy analyses of open and closed system.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Module-2

Thermodynamic Property Relations: Maxwell relations; Relations involving enthalpy, internal energy, and entropy; Mayer relation, Clausius-Clapeyron equation, Joule-Thompson experiment.
Properties of Gas Mixtures: Composition of Gas mixtures: Mass and Mole fractions: P-V-T behaviour of Gas mixtures Ideal and Real gases. Equations of statesand properties of ideal and real gas mixtures, Property relations for mixtures and Psychrometry, Change in entropy in mixing.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Module-3

Chemical Reactions: Fuels and combustion, Theoretical and actual combustion processes, Enthalpy of formation and enthalpy of combustion, first law analysis of reacting systems, Adiabatic flame temperature, Entropy change of Reacting systems, second law analysis of reacting systems.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Module-4

Concept of Chemical Equilibrium: Criterion for Chemical equilibrium, Gibbs free energy and the equilibrium constant of a chemical reaction (Vant-Hofts equation). Calculation of equilibrium, Composition of a chemical reaction.
Chemistry of Combustion: Combustion Kinetics, Detailed combustion Kinetics, simplified combustion kinetics. Physics of Combustion:Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Module-5

Combustion and Flames: Premixed Flame, laminar premixed flames, burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Turbulent Premixed Flames, Laminar Diffusion Flames, Turbulent Diffusion Flames, Turbulent Mixing, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks.**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs.
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks.**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Textbooks

1. M. J. Moran, H. N. Shapiro, D. D. Boettner and M. B. Bailey, Principles of Engineering Thermodynamics, Eighth Edition, Wiley, New Delhi, 2015
2. Y. U. Cengel and M. A. Boles, Thermodynamics: An Engineering Approach, Fourth Edition, Tata McGraw-Hill, New Delhi, 2003
3. R. H. Dittman and M. W. Zemansky, Heat and Thermodynamics, Seventh Edition, Tata McGraw-Hill, New Delhi, 2007

4. S. R. Turns, An Introduction to Combustion: Concepts and Applications, McGraw Hill International Edition, Singapore, 200
5. K. K. Kuo, Principles of Combustion, Second Edition, Wiley India Pvt. Ltd., New Delhi, 2012
6. Modern Engineering Thermodynamics, Robert Balmer, Elsevier.
7. Advanced Thermodynamics for Engineers, Kenneth Wark, McGraw Hill.

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/112/103/112103307/
https://archive.nptel.ac.in/courses/112/103/112103313/
https://archive.nptel.ac.in/courses/112/106/112106310/
https://archive.nptel.ac.in/courses/103/103/103103162/
https://archive.nptel.ac.in/courses/103/104/103104151/

Skill Development Activities Suggested

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Illustrate the basic concepts on First & Second Law Analysis,entropy, and exergy analysis in thermodynamic systems.	
CO2	Analyse the Thermodynamic property relations and its application to gas mixtures, phase change processes.	
CO3	Demonstrate the Combustion fundamentals involving premixed and non-premixed flames for laminar and turbulent combustion.	
CO4	Explain thefundamental of properties of gas mixtures, chemical reactions, and chemistry of combustion.	
CO5	Applications ofCombustion phenomena in practical occurring applications such IC and GT engines.	

Mapping of COS and POs

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**1**	**-**	**1**	**1**	**1**
CO2	**3**	**2**	**1**	**-**	**1**	**1**	**1**
CO3	**3**	**2**	**1**	**2**	**1**	**1**	**1**
CO4	**3**	**2**	**1**	**-**	**1**	**1**	**1**
CO5	**3**	**2**	**1**	**2**	**1**	**1**	**1**

Semester – I

Finite Element Method in Heat Transfer			
Course Code	22UTP15	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3 Hr

Course objectives:

- The basic concepts of Finite Element methods and its applications to thermal engineering problems.
- The Formulation of Heat Conduction Equations and its Application to Heat Transfer Problems.
- The application of the FEM technique to Nonlinear Heat conduction Analysis, Convective Heat Transfer and Fluid Mechanics Problems.

MODULE-1

Introduction: Historical Perspective of FEM and applicability to Thermal Engineering problems, Types of Governing Equations for Heat Conduction, Initial, boundary and interface conditions, Approximate methods, Rayleigh – Ritz Methods and Galerkin's methods, Different Approaches in FEM, Some Basic Discrete Systems (Heat Conduction and Fluid flow network), Numerical Problems.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

MODULE-2

Finite Element Formulations: Formulation of one dimensional linear and Quadratic element characteristic matrices and vectors. Assembly considerations and boundary conditions, Quadratic elements and their advantages and disadvantages, Two dimensional elements; triangular and quadrilateral elements with parametric representation, Higher order elements, Sub parametric, super parametric and Iso-parametric elements, Problems with one and two dimensional linear and Quadratic elements.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

MODULE-3

Formulation of Heat Conduction Equations: The Variational method and method of weighted residuals of finite element equation for 3-D heat conduction, Requirements for Interpolation Functions.

Steady State Heat Conduction in One Dimension: Heat conduction in Plain walls, Radial Heat Flow in a Cylinder, Conduction–Convection Systems, Two-dimensional Plane Problems, Axisymmetric Problems, Three-dimensional Heat Transfer Problems.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

MODULE-4

Application to Heat Transfer Problems: Straight uniform fin analysis with convection heat loss, Tapered Fin, Fin analysis with quadratic elements.

Nonlinear Heat conduction Analysis: Lumped Heat Capacity System, Galerkin's method to nonlinear transient heat conduction; Governing equation with initial and boundary conditions, One dimensional nonlinear steady-state problems.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

MODULE 5

Convective Heat Transfer: Basic equations, steady convection diffusion problems and transient convection-diffusion problems, Characteristic-based Split (CBS) Scheme.
Applications to Fluid Mechanics Problems: Inviscid and Incompressible flows, Viscous and Non-Newtonian Flows, Stream Function Formulation (using Variational method), Velocity-pressure-formulation (usingGalerkin's method). Examples of heat transfer in a fluid flowing between parallel planes.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of IPCC

1. Two Tests each of **20 Marks.**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks.**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated, and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students must answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student must secure an aggregate of 50% of maximum marks of the course (CIE+SEE).

Suggested Learning Resources:

Books

1. Fundamentals of the Finite Element Method for Heat and Fluid Flow: Roland W. Lewis, Perumal Nithiarasu, Kankanhalli N. Seetharamu: John Wiley & Sons Ltd,2004 ISBN:9780470847886
2. Finite element Method in Engineering: Singiresu S. Rao: 5th Edition, Elsevier, 2012.
3. The Finite Element Method in Heat Transfer and Fluid dynamics: Reddy J.N., Gartling. D.K.: 3rd Edition, CRC Press Taylor & Francis Group, 2010.
4. The Finite Element Method: Zeincowicz: 4 Vol set. 4th Edition, Elsevier 2007.
5. The finite element method in heat transfer analysis - R.W. Lewis, K Morgan, H.R. Thomas, K.N. Seetharamu, John Wiley and Sons,1996.

Web links and Video Lectures (e-Resources):

http://nptel.ac.in/courses/112104116/
https://archive.nptel.ac.in/courses/112/105/112105308/
https://archive.nptel.ac.in/courses/112/103/112103295/
https://archive.nptel.ac.in/courses/112/104/112104116/
https://archive.nptel.ac.in/courses/112/104/112104115/#

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Recall Governing Equations for Heat Conduction for solving 1-D thermal problems using Approximate methods, Rayleigh – Ritz Methods and Galerkin's methods.	
CO2	Formulate the element characteristic for linear and Quadratic matrices and vectors for1-D and 2-D problems.	
CO3	Explain the Formulation of Heat Conduction Equations for 1D, 3-D, Fin, and Nonlinear Heat conduction for developing mathematical models.	
CO4	Demonstrate the Application of numerical methods on heat transfer problems, Convective Heat Transfer and Fluid Mechanics Problems.	

Mapping of COS and POs

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**1**	**2**	**2**	**1**	**1**
CO2	**3**	**2**	**1**	**2**	**2**	**1**	**1**
CO3	**3**	**2**	**1**	**2**	**2**	**1**	**1**
CO4	**3**	**2**	**1**	**2**	**2**	**1**	**1**

Semester - I

Research Methodology and IPR			
Course Code	22RMI16	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3 Hr

Course Learning objectives:

- Identify an appropriate research problem in their interesting domain.
- Understand ethical issues Understand the Preparation of a research project thesis report.
- Understand the Preparation of a research project thesis report
- Understand the law of patent and copyrights.
- Understand the Adequate knowledge on IPR

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. **Defining the Research Problem:** Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. **Research Design:** Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. **Measurement and Scaling:** Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale. **Data Collection**: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Module-4	
Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. **Chi-square Test:** Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.	
Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.
Module-5	
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. **Intellectual Property:** The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.	
Teaching-Learning Process	Effective Lecturing, Active Learning, Digital Learning, Case-Based Learning, Effective Class Discussions and Assignments at home.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks.**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the

COs and POs.

3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks.**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Textbooks

1. Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International,4th Edition, 2018.
2. Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), Ranjit Kumar, SAGE Publications,3rd Edition, 2011.
3. Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.
4. Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
5. Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.
6. Stuart Melville and Wayne Goddard, " Research methodology: an introduction for science & engineering students"

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/110/105/110105091/
https://archive.nptel.ac.in/courses/127/106/127106227/
https://archive.nptel.ac.in/courses/107/108/107108011/

Skill Development Activities Suggested

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss research methodology and the technique of defining a research problem	
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.	
CO3	Explain various research designs, sampling designs, measurement and scaling	

	techniques and different methods of data collections.	
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports	
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR	

Mapping of COS and POs

POs → COs↓	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**3**	**2**	**1**	**-**	**1**	**1**	**1**
CO2	**3**	**2**	**2**	**-**	**1**	**1**	**1**
CO3	**3**	**2**	**2**	**-**	**1**	**1**	**1**
CO4	**3**	**2**	**1**	**2**	**1**	**1**	**1**
CO5	**3**	**2**	**1**	**-**	**1**	**2**	**1**

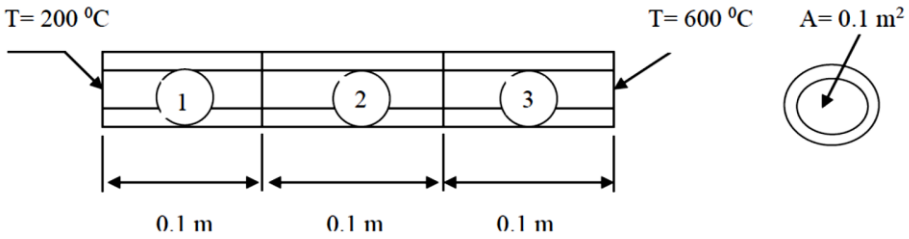
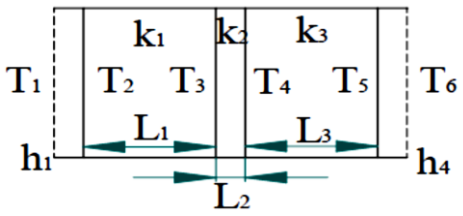
01.02.2023

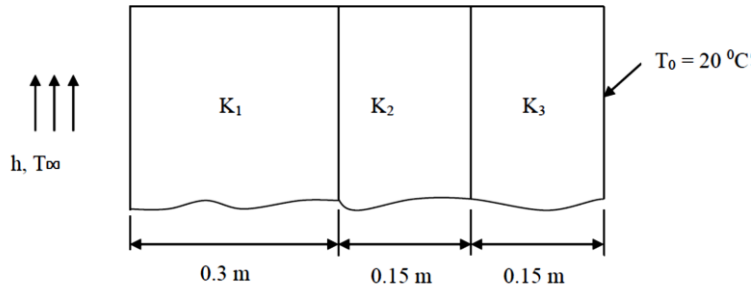
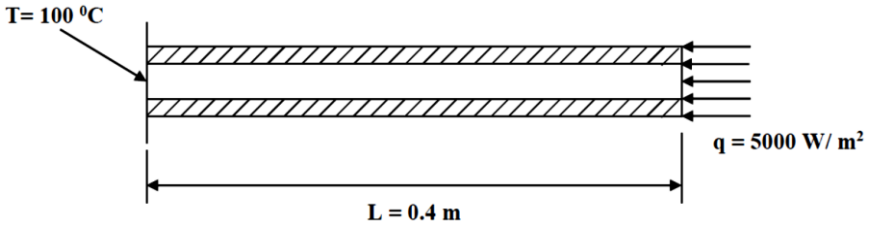
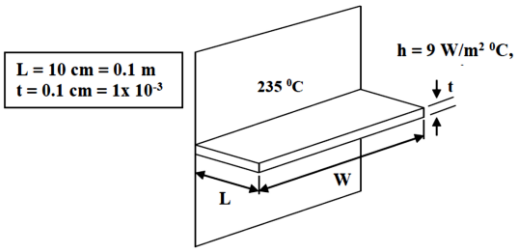
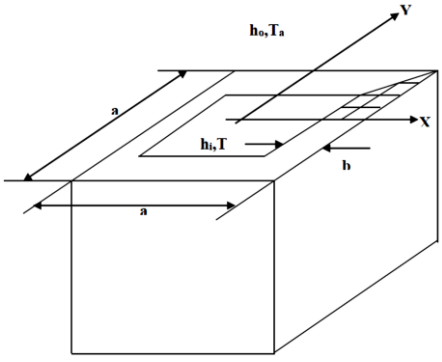
Semester – I

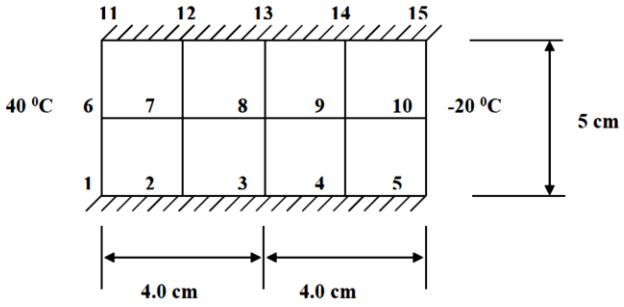
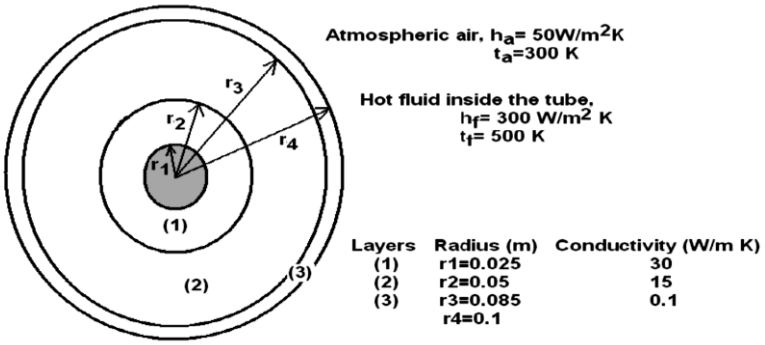
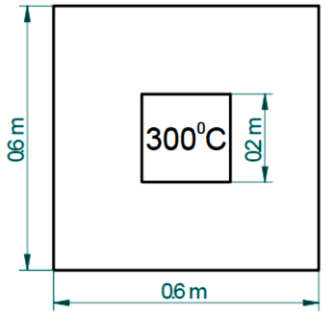
FEM & Simulation Lab			
Course Code	22UTPL17	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	2	Exam Hours	3 hr

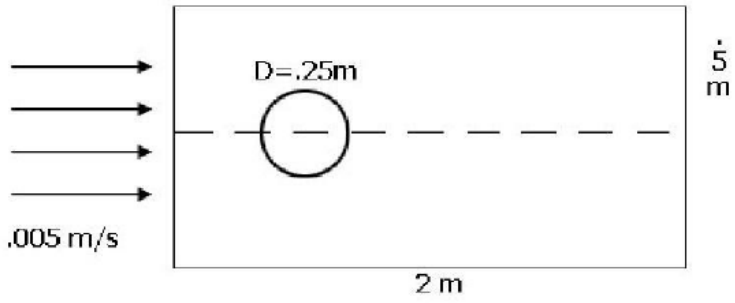
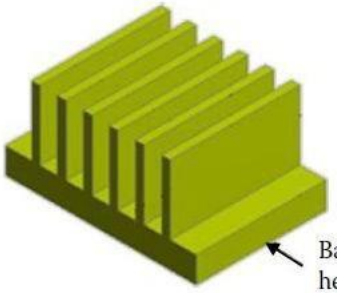
Course objectives:

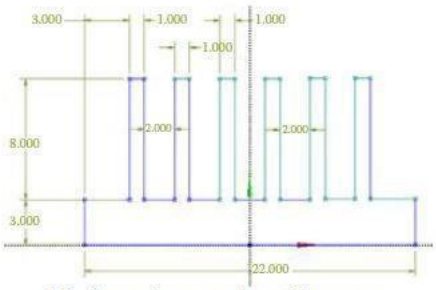
- The basic concepts of Finite Element methods and its applications to thermal engineering problems using ANSYS.
- The Formulation of Heat Conduction Equations and its Application to Heat Transfer Problems solve using ANSYS.
- The application of the FEM technique to Nonlinear Heat conduction Analysis, Convective Heat Transfer and Fluid Mechanics Problems solves using ANSYS.

Sl.NO	Experiments
1	For the composite wall idealized by the 1-D model shown in figure below, determine the interface temperatures. For element 1, let K_1 = 5 W / m °C, for element 2, K_2 = 10 W / m °C and for element 3, K_3 = 15 W / m °C. The left end has a constant temperature of 200 °C and the right end has a constant temperature of 600 °C 
2	A furnace wall is made of inside silica brick (K=1.5 W /mK) and outside magnesia brick (k=4.9W/mK), each 10 cm thick. The inner and outer surfaces are exposed to fluids at temperatures of 820°C and 110°C respectively. The contact resistance is 0.001m^2 K/W the heat transfer co-efficient for inner and outer surfaces is equal to 35W/m^2 K. Find the heat flow through the wall per unit area per unit time and temperature distribution across the wall 
3	A composite wall consists of three materials as shown. The outer temperature is T_0 = 20 °C. Convection heat transfer takes place on the inner surface of the wall with T_∞ = 800°C and h = 25 W/m^2°C. Determine the temperature distribution in the wall. K_1 = 20 W/m°C, K_2 = 30 W/m°C, K_3 = 50 W/m°C, h = 25 W/m^2°C, T_∞ = 800°C.

	
4	The fin shown in figure is insulated on the perimeter. The left end has a constant temperature of 100°C. A positive heat flux q*= 5000 W / m2 acts on the right end. Let Kxx = 6 W/ m°C and cross sectional area A = 0.1 m2 . Determine the temperatures at and $\frac{L}{4}, \frac{L}{2}, \frac{3L}{4}, and\ L$ Where L = 0.4 m. 
5	A metallic fin, with thermal conductivity Kxx = 360 W/m°C, 0.1 cm thick, and 10 cm long, extends from a plane wall whose temperature is 235°C. Determine the temperature distribution and amount of heat transferred from the fin to the air at 20°C with h = 9 W/m^2°C. Take the width of fin to be 1 m. 
6	Determine the temperature distribution and the rate of heat flow "q" per metre of the height for a tall chimney whose cross section is shown below. Assume that the inside gas temp is T_g = 311 K, the inside convection coefficient is h_i, the surrounding air temp is T_a = 255 K and the outside convection coefficient is h_o. 
7	For the body shown in figure, determine the temperature distribution. The body is insulated along the top and bottom edges, Kxx = Kyy = 1.7307 W/m°C. No internal heat generation is

	present. 
8	Obtain the temperature distribution for the composite cylinder inside which a hot fluid is flowing, and the outer surface is exposed to surrounding atmospheric conditions as shown. Assume perfect continuity between the layers. Capture the temperature values at the interface of materials (Use an element size of 0.002m or less). 
9	The cross section of a 20 cm x 20 cm duct made of concrete walls 20 cm thick is shown in figure. The inside surface of the duct is maintained at a temperature of 300°C due to hot gases flowing from a furnace. On the outside the duct is exposed to air with an ambient temperature of 20°C. The heat conduction coefficient of concrete is 1.4 W/m°C. The average convection heat transfer coefficient on the outside of the duct is 27 W/m°C. 
10	Atmospheric air at 20°C flows with a velocity of 5 mm/s over a long horizontal cylinder of diameter 25 cm. Compute and plot the velocity distribution of air over the cylinder.

<table>
<tr><td></td><td> 
</td></tr>
<tr><td></td><td><u>Demonstration Experiments (For CIE) if any</u></td></tr>
<tr><td>11</td><td>Model Fully developed laminar flow and turbulent flow through a circular pipe using ANSYS Workbench</td></tr>
<tr><td>12</td><td>Build a generic IC engine (petrol /diesel) Model in MATLAB Simulink and draw the performance curves (a) torque v/s speed, (b) power v/s speed, (c) overall efficiency v/s brake power (d) specific fuel consumption v/s brake power and analyse the curves for varied Air: Fuel ratio.</td></tr>
<tr><td>13</td><td>Use a comprehensive model for combustion of fuel at atmospheric pressure and develop a computer program to estimate the heat released assuming a single step reaction using MATLAB Simulink.</td></tr>
<tr><td>14</td><td>Heat sinks are commonly used to enhance heat dissipation from electronic devices. In the case study, we conduct thermal analysis of a heat sink made of aluminum with thermal conductivity k = 170 W/(m K), density ρ = 2800 kg/m^3 , specific heat c = 870 J/(kg K), Young's modulus E = 70 GPa, Poisson's ratio ν = 0.3, and thermal expansion coefficient α = 22 × 10^{-6}/°C. A fan forces air over all surfaces of the heat sink except for the base, where a heat flux q′ is prescribed. The surrounding air is 28°C with a heat transfer coefficient of h = 30 W/(m^2 °C).
 

All dimensions are in millimeters.
Material: Aluminum
k = 170 W/(m · K)
ρ = 2800 kg/m^3; c = 870 J/(kg · K)
E = 70 GPa; ν = 0.3
α = 22 × 10^{-6}/°C

Boundary conditions:
Air temperature of 28°C; h = 30 W/(m^2 · °C).

Steady state: q' = 1000 W/m^2 on the base.
Transient: Square wave heat flux on the base.

Initial conditions:
Steady state: Uniform temperature of 28°C.
Transient: Steady-state temperature results.</td></tr>
</table>

Course outcomes (Course Skill Set):

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

CO1	Develop skills in making geometry and meshing for various configurations using ANSYS Workbench.
CO2	Develop knowledge in CFD simulation of Convective heat transfer and phase change problems using ANSYS Workbench.
CO3	Develop knowledge in simulation of lamina and turbulent flow using ANSYS Workbench.
CO4	Develop MATLAB programme for simulation of IC engine performances.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student must secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).
- The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources: