Study& Evaluation

Scheme

Of

Master of Technology

In

Thermal Engineering

[Applicable for 2022-24]

Version 2022

[As per CBCS guidelines given by UGC]

BOS	BOF	BOM
14/5/2022	8/8/2022	20/10/2022 Approved vide agenda number. 8.4.1

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Quantum University, Roorkee

Study & Evaluation Scheme Study Summary

Name of the Faculty	Faculty of Mechanical Engineering
Name of the School	Quantum School of Technology
Name of the Department	Department of Mechanical Engineering
Program Name	Master of Technology in Thermal Engineering
Duration	2 Years
Medium	English

Evaluation Scheme

Type of Papers	Internal Evaluation (%)	End Semester Evaluation (%)	Total (%)
Theory	40	60	100
Practical/ Dissertations/Project Report/ Viva-Voce	40	60	100
Internal Evaluation Components (Theory Papers)			
Sessional Examination I	50 Marks		
Sessional Examination II	50 Marks		
Assignment –I	25 Marks		
Assignment-II	25 Marks		
Attendance	50 Marks		
Internal Evaluation Components (Practical Papers)			
Quiz One	25 Marks		
Quiz Two	25 Marks		
Quiz Three	25 Marks		
Lab Records/ Mini Project	75 Marks		
Attendance	50 Marks		
End Semester Evaluation (Practical Papers)			
ESE Quiz	30 Marks		
ESE Practical Examination	50 Marks		
Viva- Voce	20 Marks		

Structure of Question Paper (ESE Theory Paper)

The question paper will consist of 5 questions, one from each unit. Student has to Attempt all questions. All questions carry 20 marks each. Question Q1 to Q5 will be compulsory and each question will have 3 parts. Each part carries 10 marks each and the student may attempt any 2 parts.

Important Note:

1. *The purpose of examination should be to assess the Course Outcomes (CO) that will ultimately lead to attainment of Programme Specific Outcomes (PSOs). A question paper*

must assess the following aspects of learning: Remember, Understand, Apply, Analyze, Evaluate & Create (reference to Bloom's Taxonomy). The standard of question paper will be based on mapped BL level complexity of the unit of the syllabus, which is the basis of CO attainment model adopted in the university.

2. *Case Study is essential in every question paper (wherever it is being taught as a part of pedagogy) for evaluating higher-order learning. Not all the courses might have case teaching method used as pedagogy.*

3. *There shall be continuous evaluation of the student and there will be a provision of real time reporting on QUMS. All the assignments will evaluated through module available on ERP for time and access management of the class.*

Program Structure – Master of Technology in Thermal Engineering

Introduction

Master of Technology in Thermal Engineering is a course involving studies on an advanced level of concepts of energy efficiency, renewable energy & environmental preservation, and their entwinement with classical energy technologies and recently discovered technologies. The course covers real-time fluid flow and heat transfer applications in Thermal Energy Systems, Cryogenic Engineering, Refrigeration & Air Conditioning, and other fields. Thermal engineering is a branch of mechanical engineering that studies the regulation of heating and cooling processes in enclosed spaces. It ensures to provide students with an effective learning experience with thought-provoking teaching pedagogy. The curriculum is highly demanding and thoughtfully designed to incorporate all the latest development in the field. The curriculum of post graduate program in thermal engineering aims at creating the right mindset which ensures the creation of innovative, thoughtful, and socially aware engineers. It allows establishing a solid understanding of research to continue professional development in thermal engineering. It allows applying for specialist roles at a renowned manufacturing company. Student will develop the ability to use their math, science, engineering, and technology expertise. Understand, analyse, create, and solve issues related to the application of technology in a variety of industrial contexts in great detail. It also entails developing, choosing, and implementing relevant approaches, resources, modern engineering, and information technology tools to tackle complex engineering problems.

We believe in the practical nature of the domain and focus on learning by doing it practically. Students will gain an ability to specify, fabricate, test, operate, validate and complete documentation of thermo-mechanical systems or processes. Students will gain an ability to apply the acquired software's skills for simulation in the controlled environment and provide viable solutions.

Towards enhancing employability and entrepreneurial ability of the postgraduates the Quantum University increase the practical content in the courses wherever necessary. The total number of credits in 4 semesters programme will be around 66 for all the programmes.

In order to harness regional specialties and to meet region-specific needs the Quantum University modify the content of syllabus as per the regional demands.

Project

This course is spread across the semesters, from 3rd semester to fourth semester where student is required to do a project or field work or design/fabrication and test/simulate for a research problem.

B. Choice Based Credit System (CBCS)

Choice Based Credit System (CBCS) is a versatile and flexible option for each student to achieve his target number of credits as specified by the UGC and adopted by our university.

The following is the course module designed for the M.Tech (Thermal Engineering) program:

Core competency: Students will acquire core competency in Thermal aspects of Mechanical Engineering and in its application areas.

Program/Discipline Specific Elective Course (DSEC):

Skilled communicator: The course curriculum incorporates basics and advanced training in order to make a graduate student capable of expressing the subject through technical writing as well as through oral presentation.

Critical thinker and problem solver: The course curriculum also includes components that can be helpful to improve post graduate students to develop critical thinking ability by way of solving problems/numerical using basic & advance knowledge and concepts of Thermal Engineering.

Sense of inquiry: It is expected that the course curriculum will develop an inquisitive characteristic among the students through appropriate questions, planning and reporting experimental investigation.

Skilled project manager: The course curriculum has been designed in such a manner as to enabling a postgraduate student to become a skilled project manager by acquiring knowledge about mathematical project management, writing, planning, study of ethical standards and rules and regulations pertaining to scientific project operation.

Ethical awareness/reasoning: A postgraduate student requires understanding and developing ethical awareness/reasoning which the course curriculums adequately provide.

Lifelong learner: The course curriculum is designed to inculcate a habit of learning continuously through use of advanced ICT technique and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

C. Program Outcomes of M.Tech Thermal Engineering.

Program Outcome (POs) – M. Tech

PO-01	**Engineering knowledge**	Exhibit in-depth knowledge in engineering specialization.
PO-02	**Problem analysis**	Think critically and analyze complex engineering problems to make creative advances in theory and practice.
PO-03	**Design/Development Of Solutions**	An ability to design solutions for engineering problems and to design a component, system, or process that meet the specified needs with appropriate consideration for the public health and safety, along with the cultural, societal, and environmental considerations.
PO-04	**Conduct Investigations of Complex Problems**	Use research methodologies, techniques and tools, and will contribute to the development of technological knowledge
PO-05	**Modern tool usage**	Apply appropriate techniques, modern engineering tools to perform modeling of complex engineering problems with knowing the limitations.
PO-06	**The Engineer and society**	Achieve professional success with an understanding and appreciation of ethical behaviour, social responsibility, and diversity, both as individuals

		and in team environments.
PO-07	**Environment and sustainability**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge for sustainable development to articulate a comprehensive world view that integrates diverse approaches to sustainability
PO-08	**Communication**	Communicate complex engineering problems with the engineering community and society, write and present technical reports effectively
PO-09	**Ethics**	Exhibit professional and intellectual integrity, ethics of research and scholarship and will realize the responsibility towards the community
PO-10	**Individual and Team work**	An ability to analyse the local and global impact of computing on individuals, organizations, and society.
PO-11	**Project Management and Finance**	Demonstrate knowledge and understanding of engineering and management principles and apply the same with due consideration to economical and financial factors.
PO-12	**Life-long learning**	Engage in life-long learning with a high level of enthusiasm and commitment to improve knowledge and competence continuously

Program Specific Outcomes (PSOs)

At the end of this programme, Post Graduates will be able to:

PSO 1: Analyse the complex engineering problems by applying engineering knowledge in the area of thermal engineering systems.

PSO 2: Provide engineering solutions to meet the specified needs with appropriate consideration for comfort, safety, social and environmental aspects.

Program Educational Objectives(PEOs)

In their careers, our post graduates will be able to:

PEO 1: Analyze and solve thermal engineering problems using modern engineering tools in industry or in research.

PEO 2: Play key role in collaborative multidisciplinary scientific research with due consideration to economical and financial factors for leading a successful career in industry or to pursue higher education or being an entrepreneur.

PEO 3: Engage in life-long learning with professional code of conduct.

D. Pedagogy & Unique practices adopted:

""Pedagogy is the method and practice of teaching, especially for teaching an academic subject or theoretical concept". In addition to conventional time-tested lecture method, the institute will emphasize on experiential learning:

Mini projects: students are asked to do or given mini projects for developing an aptitude to critically think and find

solutions for real world problems, learn working with other people, under deadlines and guidance.

Flip Presentations: Students are required to present on latest technology trends in mechanical engineering to enhance their ability to self learn and presentation skill along with developing their confidence level to face an audience.

Field/Live Projects: The students, who take up experiential projects in companies, where senior executives with a stake in teaching guide them, drive the learning. All students are encouraged to do some live project other their regular classes.

MOOCs: Students may earn credits by passing MOOCs as decided by the college. Graduate level programs may award Honors degree provided students earn pre-requisite credits through MOOCs. University allows students to undertake additional subjects/course(s) (In-house offered by the university through collaborative efforts or courses in the open domain by various internationally recognized universities) and to earn additional credits on successful completion of the same. Each course will be approved in advance by the University following the standard procedure of approval and will be granted credits as per the approval. Keeping this in mind, University proposed and allowed a maximum of two credits to be allocated for each MOOC courses. In the pilot phase it is proposed that a student undertaking and successfully completing a MOOC course through only NPTEL could be given 2 credits for each MOOC course.

For smooth functioning and monitoring of the scheme the following shall be the guidelines for MOOC courses, Add-on courses carried out by the College from time to time.

a) It will necessary for every student to take at least one MOOC Course throughout the programme.

b) There shall be a MOOC co-ordination committee in the College with a faculty at the level of Professor heading the committee and all Heads of the Department being members of the Committee.

c) The Committee will list out courses to be offered during the semester, which could be requested by the department or the students and after deliberating on all courses finalize a list of courses to be offered with 2 credits defined for each course and the mode of credit consideration of the student. The complete process shall be obtained by the College before end of June and end of December for Odd and Even semester respectively of the year in which the course is being offered. In case of MOOC course, the approval will be valid only for the semester on offer.

d) Students will register for the course and the details of the students enrolling under the course along with the approval of the Vice Chancellor will be forwarded to the Examination department within fifteen days of start of the semester by the Coordinator MOOC through the Principal of the College.

e) After completion of MOOC course, Student will submit the photo copy of Completion certificate of MOOC Course to the Examination cell as proof.

f) marks will be considered which is mentioned on Completion certificate of MOOC Course.

g) College will consider the credits only in case a student fails to secure minimum required credits then the additional subject(s) shall be counted for calculating the minimum credits required for the award of degree.

Special Guest Lectures (SGL) & Extra Mural Lectures (EML): Some topics/concepts need extra attention and efforts as they either may be high in difficulty level or requires experts from specific industry/domain to make things/concepts clear for a better understanding from the perspective of the industry. Hence, to cater to the present needs of industry we organize such lectures, as part of lecture-series and invite prominent personalities from academia and industry from time to time to deliver their vital inputs and insights.

Student Development Programs (SDP): Harnessing and developing the right talent for the right industry an overall development of a student is required. Apart from the curriculum teaching various student development programs (training programs) relating to soft skills, interview skills, research tools etc. that may be required as per the need of the student and industry trends, are conducted across the whole program. Participation in such programs is solicited through volunteering and consensus.

Industry Focused programmes: Establishing collaborations with various industry partners to deliver the programme on sharing basis. The specific courses are to be delivered by industry experts to provide practice-based

insight to the students.

Special assistance program for slow learners & fast learners: write the note how would you identify slow learners, develop the mechanism to correcting knowledge gap. Terms of advance topics what learning challenging it will be provided to the fast learners.

Induction program: Every year 3 weeks induction program is organized for 1st year students and senior students to make them familiarize with the entire academic environment of university including Curriculum, Classrooms, Labs, Faculty/ Staff members, Academic calendar and various activities.

Mentoring scheme: There is Mentor-Mentee system. One mentor lecture is provided per week in a class. Students can discuss their problems with mentor who is necessarily a teaching faculty. In this way, student's problems or issues can be identified and resolved.

Extra-curricular Activities: organizing & participation in extracurricular activities will be optional for postgraduate students to develop confidence & face audience boldly. It shapes out their leadership qualities along with planning & organizing skills. Students can undertake various cultural, sports and other competitive activities within and outside then campus. This helps them build their wholesome personality.

Career & Personal Counseling: - Identifies the problem of student as early as possible and gives time to discuss their problems individually as well as with the parents. Counseling enables the students to focus on behavior and feelings with a goal to facilitate positive change. Its major role lies in giving: Advice, Help, Support, Tips, Assistance, and Guidance.

Participation in Flip Classes, Project based Learning(A2 Assignment), Workshops, Seminars & writing & Presenting Papers: Departments plan to organize the Flip Classes, Project based Learning(A2 Assignment), workshops, Seminars & Guest lecturers time to time on their respective topics as per academic calendar. Students must have to attend these programs. This participation would be count in the marks of general Discipline & General Proficiency which is the part of course scheme as non-credit course.

Formation of Student Clubs, Membership & Organizing & Participating events: Every department has the departmental clubs with the specific club's name. The entire student's activity would be performed by the club. One faculty would be the coordinator of the student clubs & students would be the members with different responsibility.

Capability Enhancement & Development Schemes: The Institute has these schemes to enhance the capability and holistic development of the students. Following measures/ initiatives are taken up from time to time for the same: Career Counseling, Soft skill development, Remedial Coaching, Bridge Course, Language Lab, Yoga and Meditation, Personal Counseling

Library Visit & Utilization of QLRC: Students may visit the library from morning 10 AM to evening 8 PM. Library created its resources Database and provided Online Public Access Catalogue (OPAC) through which users can be accessed from any of the computer connected in the LAN can know the status of the book. Now we are in process to move from OPAC to KOHA.

Quantum School of Technology
Master of Technology in Thermal Engineering – PC: 01-4-01

CURRICULUM (2022-24), V 1.0

BREAKUP OF COURSES

Sr. No	CATEGORY	CREDITS
1	Program Core (PC)	27
2	Program Electives (PE)	15
3	Project	15
4	Seminar	6
5	General Proficiency (GP)	3
TOTAL NO. OF CREDITS		**66**

SEMESTER-WISE BREAKUP OF CREDITS

Sr. No	CATEGORY	SEM 1	SEM 2	SEM 3	SEM 4	TOTAL
1	Program Core	19	5	3	-	27
2	Program Electives	-	9	6	-	15
3	Projects/Dissertation	-	-	4	11	15
4	Seminar	2	2	2	-	6
5	GP	1	1	1		3
	TOTAL	**22**	**17**	**16**	**11**	**66**

SEMESTER 1

Course Code	Category	Course Title	L	T	P	C	Version	Course Prerequisite
ME4107	PC	Optimization Techniques	2	2	0	3	1.0	Nil
ME4101	PC	Advanced Fluid Mechanics	3	1	0	4	1.0	Nil
ME4109	PC	Advanced Thermal Engineering	3	1	0	4	1.0	Nil
ME4103	PC	Advanced Heat Transfer	3	1	0	4	1.0	Nil
ME4110	PC	Steam Engineering	3	0	0	3	1.0	Nil
ME4170	FW	Seminar I	2	0	0	2		
ME4140	PC	Advanced Thermal Engineering Lab	0	0	2	1	1.0	Nil
GP4101	GP	General Proficiency	0	0	0	1		
		Total	**16**	**5**	**2**	**22**		

Contact Hrs: 23

SEMESTER 2

Course Code	Category	Course Title	L	T	P	C	Version	Course Prerequisite
ME4201	PC	Simulation Modeling and Analysis	3	2	0	4	1.0	Nil
	PE	Program Elective I	3	0	0	3		Nil
	PE	Program Elective II	3	0	0	3		Nil
	PE	Program Elective III	3	0	0	3		Nil
ME4240	PC	Simulation Lab	0	0	2	1	1.0	Nil
ME4270	FW	Seminar II	2	0	0	2		
GP4201	GP	General Proficiency	0	0	0	1		
		Total	**14**	**2**	**2**	**17**		

Contact Hrs: 18

SEMESTER 3

Course Code	Category	Course Title	L	T	P	C	Version	Course Prerequisite
ME4307	PC	Research Methodology	2	0	0	2	1.0	Nil
	PE	Program Elective IV	3	0	0	3		Nil
	PE	Program Elective V	3	0	0	3		Nil
ME4340	PC	Research Methodology Lab	0	0	2	1	1.0	Nil
ME4370	FW	Seminar III	2	0	0	2		Nil
ME4371	FW	Project	0	0	8	4		Nil
GP4301	GP	General Proficiency	0	0	0	1		
		Total	**10**	**0**	**10**	**16**		

Contact Hrs: 20

SEMESTER 4

Course Code	Category	Course Title	L	T	P	C	Version	Course Prerequisite
ME4470	FW	Dissertation	0	0	4	11		
		Total	**0**	**0**	**4**	**11**		

Contact Hrs: 04

Program Electives

Elective	Course Code	Course Title	L	T	P	C	Version	Course Prerequisite
I	ME4202	Cryogenic Engineering	3	0	0	3	1.0	Nil
	ME4212	Research ethics and IPR	3	0	0	3	1.0	Nil
	ME4206	Refrigeration Machinery	3	0	0	3	1.0	Nil
II	ME4213	Numerical Solution of Partial Differential Equations	3	0	0	3	1.0	Nil
	ME4205	Computational Fluid Dynamics	3	0	0	3	1.0	Nil
	ME4210	Design of Heat Exchangers	3	0	0	3	1.0	Nil
III	ME4207	Jet & Rocket Propulsion Systems	3	0	0	3	1.1	Nil
	ME4208	Gas Turbine and Compressor	3	0	0	3	1.0	Nil
	ME4211	New Venture Creation	3	0	0	3	1.1	Nil
IV	ME4301	Alternative Fuels	3	0	0	3	1.0	Nil
	ME4302	Solar Energy Technology	3	0	0	3	1.0	Nil
	ME4310	Modelling of IC Engine	3	0	0	3	1.0	Nil
V	ME4303	Energy Storage Techniques	3	0	0	3	1.0	Nil
	ME4305	Energy Management In Thermal Systems	3	0	0	3	1.0	Nil
	ME4309	Air-Conditioning System Design	3	0	0	3	1.0	Nil

ME4107	Title: Optimization Techniques	L T P C 2 2 0 3
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Classical Optimization	9
Introduction to Optimization: Classification of Optimization, Design vector and constraints, Constraint surface, Objective function, Classification of Optimization Problems. Single variable optimization, Multi-variable: Direct substitution method, Lagrange's method of multipliers, Karush-Kuhn-Tucker conditions.		
Unit II	Linear Programming	7
Linear Programming: Statement of an LP problem, Simplex method, Dual simplex method.		
Unit III	One Dimensional Optimization	8
Unimodal function, Unrestricted search, Exhaustive search, Dichotomous search, Interval halving method, Fibonacci method, Golden section method, Direct root methods: Newton-Raphson and Quasi Newton methods.		
Unit IV	Unconstrained Optimization Techniques	6
Direct Search Methods: Random search methods, Grid search method, Univariate method, Hookes and Jeeves' method, Powell's method, Dynamic Programming.		
Unit V	Modern Methods of Optimization	6
Genetic algorithms, simulated annealing, fuzzy optimization, neural-network based methods, Aunt and colony approach.		
Text Books	1. Singiresu S. Rao, Engineering Optimization: Theory and Practice, John Wiley and Sons 2. Fox, R. L., Optimization Methods for Engineering Design, Addison Wesley	
Reference Books	1. H N Wagner, Operations Research, Prentice Hall 2. N D Vohra, Quantitative Techniques in Management, Tata McGraw-Hill	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	24.03.2018	
Date of approval by the Academic Council	11.06.2018	

Course Outcome For ME4107

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to first develop a basic understanding of different optimization techniques and then apply them through numerical problems for some of the important techniques of classical optimization	3	s
CO2	Students should be able to understand the principles of optimization through linear programming and applying the learnings though numerical problems	3	s
CO3	Students should be able to understand the different techniques of one dimensional optimization and applying the learnings though numerical problems	3	em
CO4	Students should be able to understand the different unconstrained optimization techniques and applying the learnings though numerical problems	2	em
CO5	Students should be able to understand the modern methods of optimization techniques and applying the learnings though numerical problems	2	em

CO-PO Mapping for ME4107

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	3	3	3	2	0	0	2	0	1	1	2	3	2	3	2	1
CO 2	3	2	3	3	2	0	0	2	0	1	2	1	3	1	3	2	2
CO 3	3	3	2	3	2	0	0	2	0	1	2	2	3	2	2	2	2
CO 4	2	3	2	3	3	0	0	2	0	1	1	2	3	2	3	2	1
CO 5	2	3	3	3	2	0	0	1	0	1	2	2	3	2	2	2	2
Avg	2.6	2.8	2.6	3	2.2	0	0	1.8	0	1	1.6	1.8	3	1.8	2.6	2	1.3

ME4101	Title: Advanced Fluid Mechanics	L T P C 3 1 0 4
Version No.	2.0	
Course Prerequisites	Nil	
Objectives	To understand the laws of fluid flow for ideal and viscous fluids and to represent the real solid shapes by suitable flow patterns and to analyze the same for aerodynamics performances.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Non Viscous Flow	7
Lagrangian and Eulerain Descriptions of fluid motion- Path lines, Stream lines, Streak lines, stream tubes , velocity of a fluid particle, types of flows, Equations of three dimensional continuity equation- Stream and Velocity potential functions.		
Unit II	Experimental Techniques	7
Role of experiments in fluid, layout of fluid flow experiments, sources of error in experiments, data analysis, design of experiments, review of probes and transducers, Introduction to Hot wire Anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry		
Unit III	Principles of Viscous Flow	7
Derivation of Navier-Stoke's Equations for viscous compressible flow, Exact solutions to certain simple cases: Plain Poisoulle flow, Coutte flow with and without pressure gradient, Hagen Poisoulle flow, Blasius solution.		
Unit IV	Turbulent Flow	8
Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shear stress models, universal velocity distribution		
Unit V	Compressible Fluid Flow	7
Thermodynamic basics, Equations of continuity, Momentum and Energy, Acoustic Velocity Derivation of Equation for Mach Number, Flow Regimes, Mach Angle, Mach Cone, Stagnation State Area Variation, Property Relationships in terms of Mach number, Nozzles, Diffusers, Isothermal Flow in Long Ducts, Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks, Supersonic.		
Text Books	1. Schlichting H, Layer Theory, Springer Publications 2. Yuman S.W, Foundations of Fluid Mechanics, Prentice-Hall of India	
Reference Books	1. D. Rama Durgaiah, Fluid Mechanics and Machinery, New Age Pub 2. William F. Hughes and John A. Brighton, Fluid Dynamics, Tata Mc.	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	14.05.2022	
Date of approval by the Academic Council		

Course Outcome For ME4101

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to understand about basics of fluid mechanics and concepts related to fluid statics.	3	s
CO2	Students should be able to know advanced techniques for experimental analysis of fluid flow	2	s
CO3	Students should be able to understand the various concets related to principle to viscous flow.	2	s
CO4	Students should be able to understand the turbulent flow concept in depth .	3	s
CO5	Students should be able to understand concepts related to compressible fluid flow	3	em

CO-PO Mapping for ME4101

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	2	2	1	2	1	0	0	1	0	3	3	2	3	2	2
CO 2	3	2	1	2	3	1	1	0	0	0	0	3	3	2	3	1	2
CO 3	3	3	3	1	2	2	2	0	0	0	1	3	3	3	3	2	2
CO 4	3	3	3	1	1	1	1	0	0	0	1	3	3	3	3	1	3
CO 5	3	3	2	2	2	2	2	0	0	0	1	3	3	3	3	2	3
Avg	2.6	2.8	2.4	1.6	1.8	1.6	1.5	0	0	.3	1.6	1.8	3	1.8	2.6	2	1.3

ME4109	Title: Advanced Thermal Engineering	L T P C 3 1 0 4
Version No.	1.0	
Course Prerequisites	Nil	
Course Prerequisites	To develop the ability to use the thermodynamics concepts for various applications like availability analysis and thermodynamic relations, to analyses the real gas behavior and chemical thermodynamics.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	REVIEW OF THERMODYNAMIC LAWS AND COROLLARIES	7
Transient flow analysis, Second law thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation, Evaluation of thermodynamic properties of working substance.		
Unit II	FINITE DIFFERENCE METHODS FOR CONDUCTION	7
ID & 2D steady state and simple transient heat conduction problems-implicit and explicit methods. Forced Convection: Equations of fluid flow-concepts of continuity, momentum equations-derivation of energy equationmethods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept of exact solution. Approximate method-integral analysis.		
Unit III	Viscous Flow	7
Derivation of Navier-Stoke's Equations for viscous compressible flow – Exact solutions to certain simple cases: Plain Poisoulle flow - Coutte flow with and without pressure gradient - Hagen Poisoulle flow - Blasius solution..		
Unit IV	POWER CYCLES	8
Review binary vapour cycle, co generation and combined cycles, Second law analysts of cycles. Refrigeration cycles, Thermodynamics off irreversible processes, Introduction, Phenomenological laws, Onsaga Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits		
Unit V	GAS DYNAMICS	7
Fundamental thermodynamic concepts, isentropic conditions, mach numbers and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas, Supersonic flow, oblique shock waves, Normal shock recoveries, detached shocks, Aerofoil theory		
Text Books	1. P.K. Nag, Basic and Applied Thermodynamics, TMH 2. Holman, Thermodynamics, Mc Graw Hill	
Reference Books	1. Michael Boles and Yunus Cengel, Thermodynamics: An Engineering Approach, TMH 2. G.J. Van Wylen, Thermodynamics 3 Thermal Engineering / Rathore / TMH 4. Sonntag R.E. and Van Wylen, G., Introduction to Thermodynamics, Classical and Statistical Themodynamics, John Wiley and Sons.	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	14.05.2022	
Date of approval by the Academic Council		

Course Outcome For ME4109

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to understand fundamentals of thermodynamic laws	3	Em
CO2	Students should be able to understand the finite difference methods of conduction	3	s
CO3	Students should able to understand about the viscous flow behaviour	3	s
CO4	Students should able to know and apply the advanced concepts of power cycles	4	s
CO5	Students should be able to understand about gas dynamics concepts	3	em

CO-PO Mapping for ME4109

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	3	1	0	2	0	0	0	0	0	3	2	2	1	3	3
CO 2	3	2	3	3	0	2	2	0	0	0	0	3	3	2	3	3	3
CO 3	2	3	3	3	0	3	2	3	0	0	2	3	3	2	3	3	3
CO 4	2	2	3	2	0	3	3	3	0	1	2	3	3	2	3	3	3
CO 5	3	3	2	2	1	3	0	0	0	0	0	3	3	2	2	3	2
Avg	2.6	2.8	2.4	2.1	0.2	2.6	1.5	0	0	.3	1.6	1.8	3	2	2.6	2	1.3

ME4103	Title: Advanced Heat Transfer	L T P C 3 1 0 4
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To develop the ability to use the heat transfer concepts for thermal analysis and sizing of heat exchangers and to achieve an understanding of the basic concepts of phase change processes.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction	7
Brief Introduction to different Modes of heat transfer- Conduction- General heat conduction equation, Boundary conditions , Steady simplified heat transfer in Cartesian coordinates , Finned surfaces- 1-D Heat transfer with internal heat generation.		
Unit II	Transient heat conduction	8
Lumped system analysis, Heisler charts, Semi-infinite solid, Product solution- 2D, steady state heat conduction, Use of conduction shape factors-Transient heat conduction, Analytical solution- Finite Difference methods for Heat Conduction Problems- 1 D and 2 D steady state and Unsteady heat conduction, Implicit and Explicit methods.		
Unit III	Convection	8
Concept of boundary layer- Hydrodynamic and Thermal boundary layer concepts-Equations of Motion and Energy-Methods to determine heat transfer coefficient- Dimensional Analysis, Importance of Non , Dimensional numbers, Analogies between Heat and Momentum Transfer-External flows and integral methods for flow over a flat plate-Application of empirical relations to various geometrics. Dimensionless parameters of Free convection-An Approximate Analysis of Laminar Free Convection on Vertical Plate-Free convection on a Horizontal Plate, Cylinder and Sphere- Combined free and forced convection.		
Unit IV	Boiling and condensation	5
Boiling curve, Correlations, Nusselt's theory of film condensation on a vertical plate, Assumptions and correlations of film condensation for different geometrics.		
Unit V	Radiation	8
Concept of View factor- Methods of Determining View factors-Radiant heat exchange in Grey, Non- Grey bodies with Transmitting, Reflecting and Absorbing media- Secular surface, gas radiation, Radiation from flames		
Text Books	1. Yunus A.Cengal, Heat and Mass Transfer: A practical Approach, Tata McGraw - Hill 2. O P Single, Heat and Mass Transfer, Macmillan India Ltd.	
Reference Books	1. P.S. Ghoshdastidar, Heat Transfer, Oxford Press 2. Sarit K. Das, Engg. Heat and Mass Transfer, Dhanpat Rai 3. F.P. Incropera and D.P. DeWitt, Fundamentals of Heat and Mass Transfer, John Wiley and Sons	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	24.03.2018	
Date of approval by the Academic Council	11.06.2018	

Course Outcome For ME4103

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to Understand the modes of heat transfer and its governing laws and also acquire skills to calculate heat transfer in steady state conditions in one dimension	3	Em
CO2	Students should be able to understand and calculate the 1D and 2D heat transfer in transient conditions and also able to solve problems using finite difference technique.	3	s
CO3	Students should be able to analyse convective heat transfer in different geometries and should know the use of emperical relations	3	s
CO4	Students should able to analyse different phase change heat transfer.	3	s
CO5	Students should be able to evaluate heat transfer by radiation from different complex geometries.	4	s

CO-PO Mapping for ME4103

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	3	1	0	2	0	0	0	0	0	3	2	2	1	3	3
CO 2	3	2	2	3	0	2	2	0	0	0	0	3	3	1	3	3	3
CO 3	3	3	2	3	0	2	2	3	0	0	2	3	3	2	3	3	3
CO 4	3	3	3	3	0	3	2	3	0	0	2	3	3	2	3	3	3
CO 5	3	3	2	2	0	3	0	0	0	0	0	3	3	2	2	3	2
Avg	3	2.8	2.2	2.2	0	2.3	1.1	1.1	0	0	0.5	3	2.8	1.8	2.2	3	2.8

ME4110	Title: Steam Engineering	L T P C 3 0 0 3
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To develop the ability to design and develop, controls and instrumentation for effective monitoring of the process in steam power plant.	
Expected Outcome	1. Students will have the ability to explain working of different boilers and significance of mountings and accessories. 2. Students will have the ability to use techniques, skills, and modern engineering tools necessary for boiler performance assessment. 3. Students will have a theoretical and practical background in thermal systems, and will have a good understanding of energy conservation fundamentals. Students will have the ability to analyze thermal systems for energy conservation. 4. Students will have the ability to design a steam piping system, its components for a process and also design economical and effective insulation. 5. Students will have the ability to analyze a thermal system for sources of waste heat design a systems for waste heat recovery.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction	7
Instrument Classification, Characteristics of Instruments – Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments		
Unit II	Piping & Insulation	8
Data logging and acquisition – elements of microcomputer interfacing, intelligent instruments in use		
Unit III	Steam Systems	7
Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.		
Unit IV	Boiler Performance Assessment	7
Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, Heat flux sensors, Telemetry in measurement.		
Unit V	Instrumentation & Control	7
Process instrumentation; control and monitoring. Flow, pressure and temperature measuring and controlling instruments, its selection		
Text Books	1. T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication 2. Domkundwar; A Course in Power Plant Engineering; Dhanapat Rai and Sons 3. Yunus A. Cengel and Boles, "Engineering Thermodynamics ",Tata McGraw-Hill Publishing Co. Ltd	
Reference Books	4. Book II - Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency 5. Book IV - Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency 6. Edited by J. B. Kitto & S C Stultz; Steam: Its Generation and Use; The Babcock and Wilcox Company 7. P. Chatopadhyay; Boiler Operation Engineering: Questions and Answes; Tata McGrawHill Education Pvt Ltd, N Delhi	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	14.05.2022	
Date of approval by the Academic Council		

Course Outcome For ME4110

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students will have the ability to explain working of different boilers and significance of mountings and accessories.	3	Em
CO2	Students will have the ability to use techniques, skills, and modern engineering tools necessary for boiler performance assessment.	3	s
CO3	Students will have a theoretical and practical background in thermal systems, and will have a good understanding of energy conservation fundamentals. Students will have the ability to analyze thermal systems for energy conservation.	3	s
CO4	Students will have the ability to design a steam piping system, its components for a process and also design economical and effective insulation.	3	s
CO5	Students will have the ability to analyze a thermal system for sources of waste heat design a systems for waste heat recovery.	4	s

CO-PO Mapping for ME4110

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	3	1	0	2	0	0	0	0	0	3	2	2	1	3	3
CO 2	3	2	2	3	0	2	2	0	0	0	0	3	3	1	3	3	3
CO 3	3	3	2	3	0	2	2	3	0	0	2	3	3	2	3	3	3
CO 4	3	3	3	3	0	3	2	3	0	0	2	3	3	2	3	3	3
CO 5	3	3	2	2	0	3	0	0	0	0	0	3	3	2	2	3	2
Avg	3	2.8	2.2	2.2	0	2.3	1.1	1.1	0	0	0.5	3	2.8	1.8	2.2	3	2.8

ME 4140	Title: Advanced Thermal Engineering Lab	L T P C 0 0 2 1
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	The lab is mainly intended to conduct experiments on various Thermal Engineering devices to study the performance and its applications.	

List of Experiments

1. Study Compressibility factor measurement of different real gases.
2. To calculate Dryness fraction estimation of steam.
3. Performance analysis of two stage reciprocating compressor.
4. Performance test and analysis of exhaust gases of an I.C. Engine.
5. Heat Balance sheet, Volumetric Efficiency and air fuel ratio estimation of an I.C. Engine.
6. Performance analysis of Air conditioning unit.
7. Performance analysis of heat pipe.
8. Study of solar flat plate collector.

Mode of Evaluation	Internal and External Examinations
Recommendation by Board of Studies on	24.03.2018
Date of approval by the Academic Council	11.06.2018

Course Outcome For ME4140

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should able to understand intricacies of solar plate collector and behaviour of different real gas.	2	Em
CO2	students should able to evaluate the performance parameters of IC engine, heat pipe, AC unit and receprocating compressor	5	S
CO3	students should able to evaluate the dryness fraction of steam	5	S

CO-PO Mapping for ME4140

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	3	0	0	0	2	0	0	0	0	0	3	2	1	3	3	1
CO 2	3	3	1	3	0	2	0	0	0	0	0	3	3	2	3	2	3
CO 3	3	3	2	2	0	2	2	0	0	0	0	3	3	2	2	2	3
Avg	3	3	1	1.6	0	2	0.6	0	0	0	0	3	2.8	1.6	2.6	2.6	2.6

ME4201	Title: Simulation Modeling and Analysis	L T P C 3 2 0 4
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To develop representational modes of real processes and systems.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction	6
A review of basic probability and statistics, random variables and their properties, Estimation of means variances and correlation.		
Unit II	Physical Modeling	6
Concept of System and environment, Continuous and discrete systems, Linear and non-linear systems, Stochastic activities, Static and Dynamic models, Principles of modeling, Basic Simulation modeling, Role of simulation in model evaluation and studies, advantages of simulation		
Unit III	System Simulation	8
Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages.		
Unit IV	System Dynamics	8
Growth and Decay models, Logistic curves, System dynamics diagrams. Probability Concepts in Simulation: Stochastic variables, discrete and continuous probability functions, Random numbers, Generation of Random numbers, Variance reduction techniques, Determination of length of simulation runs.		
Unit V	Simulation of Mechanical Systems	8
Simulation of Mechanical Systems: Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic systems.		
Text Books	1. Bernard Zeigler Tag Kim Herbert Praehofer, Theory of Modeling and Simulation, Springer 2. VP Singh, System Modelling and Simulation, New Age International Limited Publication	
Reference Books	1. Mohsen Guizani, Ammar Rayes, Bilal Khan, Ala Al-Fuqaha, Network Modeling and Simulation: A Practical Perspective 2. Birta,Luois, Modelling and Simulation, Springer	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	24.03.2018	
Date of approval by the Academic Council	11.06.2018	

Course Outcome For ME4201

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to understand the basic probability and statistic, random variables and their properties	2	Em
CO2	Students should be able to understand the Physical modeling methods and Various techniques	2	Em
CO3	Students should be able to study the various methods which is use in system simulation	2	S
CO4	Students should be able to understand the concept and techniques of system dynamics	2	s
CO5	Students should be able to understand the methods which is use to for the simulation of mechanical system	2	s

CO-PO Mapping for ME4201

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	2	3	2	3	3	0	0	0	0	0	0	3	2	2	2	2	3
CO 2	2	2	3	3	2	0	0	0	0	0	0	3	2	2	2	2	3
CO 3	3	3	2	3	2	0	0	0	0	0	0	3	2	2	2	3	3
CO 4	2	3	2	2	2	0	0	0	0	0	0	3	2	3	2	2	2
CO 5	2	3	2	2	3	0	0	0	0	0	0	2	2	3	3	3	3
Avg	2.2	2.8	2.2	2.6	2.	0	0	0	0	0	0	3	2	2.2	2.2	2.2	2.8

ME4240	Title: Simulation Lab	L T P C 0 0 2 1
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To learn the modeling and simulation analysis of various thermal engineering application using analysis software.	

List of Experiments

1. Study of Simulation software.
2. Analysis of Discharge of Water from a Reservoir.
3. Simulation of 2-D steady state heat conduction in a slab.
4. Simulation of counter flow heat exchanger.
5. Analysis of Transient Temperature Distribution in a Slab.
6. Analysis of Temperature Distribution on an Insulated Wall.
7. Analysis of auto pilot system.
8. Analysis of servomotor system.

Mode of Evaluation	Internal and External Examinations
Recommendation by Board of Studies on	24-03-2018
Date of approval by the Academic Council	11-06-2018

Course Outcome For ME4240

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to study the simulation software	2	Em
CO2	Students should be able to simulate the various heat transfer processes	3	S
CO3	Students should be able to analysis of various heat transfer instruments by using simulation software	4	S

CO-PO Mapping for ME4240

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	2	3	2	2	3	0	0	0	0	0	0	3	3	2	3	2	3
CO 2	3	3	2	2	2	0	0	0	0	0	0	2	3	2	3	2	3
CO 3	2	3	3	3	2	0	0	0	0	0	0	2	3	2	3	2	3
Avg	2.6	3	2.3	2.3	2.3	0	0	0	0	0	0	2.3	3	2	3	2	3

ME4307	Title: Research Methodology	L T P C 2 0 0 2
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	Understand some basic concepts of research and its methodologies Select and define appropriate research problem and parameters Write a research report and thesis	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction	4
Objectives of Research – Limitations in Research – Qualities of a Good Research Worker – Criteria of Good Research – Limitations of Research Concept of Applied and Basic research – Quantitative and Qualitative Research Techniques – Need for theoretical frame work – Hypothesis development – Hypothesis testing with quantitative data. Research design – Purpose of the study: Exploratory, Descriptive, Hypothesis Testing.		
Unit II	Experimental Design	5
Laboratory and the Field Experiment – Internal and External Validity – Factors affecting Internal validity. Measurement of variables – Scales and measurements of variables. Developing scales – Rating scale and attitudinal scales – Validity testing of scales – Reliability concept in scales being developed – Stability Measures.		
Unit III	Data Collection	5
Interviewing, Questionnaires, etc. Secondary sources of data collection. Guidelines for Questionnaire Design – Electronic Questionnaire Design and Surveys. Special Data Sources: Focus Groups, Static and Dynamic panels. Review of Advantages and Disadvantages of various Data-Collection Methods and their utility. Sampling Techniques – Probabilistic and non-probabilistic samples. Issues of Precision and Confidence in determining Sample Size. Hypothesis testing, Determination of Optimal sample size.		
Unit IV	Multivariate Statistical Techniques	5
Data Analysis – Factor Analysis – Cluster Analysis -Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation – Application of Statistical(SPSS) Software Package in Research		
Unit V	Research Report	5
Purpose of the written report – Concept of audience – Basics of written reports. Integral parts of a report – Title of a report, Table of contents, Abstract, Synopsis, Introduction, Body of a report – Experimental, Results and Discussion – Recommendations and Implementation section – Conclusions and Scope for future work		
Text Books	1. C R Kothari, Research Methodology, New Age International 2. C. Murthy, Research Methodology, Vindra Publications Ltd.	
Reference Books	1. Donald Cooper and Pamela Schindler, Business Research Methods, TMGH 2. Alan Bryman and Emma Bell, Business Research Methods, Oxford University Press 3. Ranjit Kumar, Research Methodology, Sage Publications, London	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	06.06.2019	
Date of approval by the Academic Council	13.07.2019	

Course Outcome For ME4307

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to Objectives of Research, Research Techniques, Hypothesis development	3	S,Em
CO2	Students should be able to Internal and External Validity, Reliability concept in scales, Stability Measures.	2	S
CO3	Students should be able to Interviewing, Questionnaires, Probabilistic, Precision and Optimal sample size.	3	S
CO4	Students should be able to Data Analysis, Factor Analysis, Cluster Analysis, Statistical (SPSS) Software	2	S
CO5	Students should be able to written reports, Abstract, Synopsis, Experimental, Results and Conclusions	2	S,Em

CO-PO Mapping for ME4307

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	2	1	3	0	3	0	2	2	2	3	3	0	1	2	2
CO 2	3	2	1	2	0	0	0	0	1	2	0	2	3	1	1	2	3
CO 3	3	3	2	2	2	0	2	0	1	0	2	0	3	3	1	2	2
CO 4	3	2	3	3	2	0	1	0	1	1	2	0	3	2	1	1	3
CO 5	3	2	3	3	2	0	2	0	2	2	0	0	3	2	2	3	3
Avg	3	2.2	2.2	2.2	2.2	0	1.8	0	1.6	1.4	1.3	1	3	2.2	1.2	2	2.6

ME4340	Title: Research Methodology Lab	L T P C 0 0 2 1
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To learn to prepare reports and charts	

List of Experiments

1. Basics of Excel- data entry, editing and saving, establishing and copying a formula.
2. Functions in excel, copy and paste and exporting to MS word document
3. Graphical presentation of data -Histogram, frequency polygon, pie-charts and bar diagrams.
4. SPSS, opening SPSS, layout, menu and icons analyzing the data using different statistical techniques.

Mode of Evaluation	Internal and External Examinations
Recommendation by Board of Studies on	06.06.2019
Date of approval by the Academic Council	13.07.2019

Course Outcome For ME4340

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to understand and use the Basics Excel commands	3	S, Em
CO2	Students should be able to understand the Graphical presentation of data -Histogram, frequency polygon, pie-charts and bar diagrams	4	S
CO3	Students should be able to understand the SPSS, layout, menu and analyzing the data using different statistical techniques.	4	S

CO-PO Mapping for ME4340

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	3	2	2	2	0	2	0	0	0	2	2	3	3	0	2	2
CO 2	3	2	3	3	2	0	1	0	0	1	2	2	3	2	1	1	3
CO 3	3	3	3	3	3	0	2	0	0	2	0	2	3	2	2	3	3
Avg	3	2.6	2.6	2.6	2.3	0	1.6	0	0	1	1.2	2	3	2.2	1	2	2.3

Program Electives

ME4202	Title: Cryogenic Engineering	L T P C 3 0 0 3
Version No.	1.1	
Course Prerequisites	Nil	
Objectives	To build a foundation in the fundamentals of cryogenics and to encourage a hands on approach to solving cryogenic problems	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction to cryogenic engineering	7
Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of Cryogenics- Mechanical, Space, Medicine, Gas industry, High energy physics, Superconductivity		
Unit II	Liquefaction Cycle	8
Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve- Joule Thomson, Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claude Cycle Dual Pressure Cycle, Ortho-Para hydrogen conversion, Critical Components in Liquefaction Systems		
Unit III	Separation of Cryogenic Gases	7
Binary Mixtures, T-C and H-C Diagrams , Principle of Rectification, Rectification Column, Analysis-McCabe Thiele Method , Adsorption Systems for purification.		
Unit IV	Cryogenic refrigerants	7
Joule-Thomson (J.T.) Cryocoolers, Stirling Cycle Refrigerators, Gifford-McMahon (G.M.) Cryocoolers, Pulse Tube Refrigerators Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators		
Unit V	Handling of cryogens	7
Cryogenic Dewar design, Cryogenic Transfer Lines, Insulations in Cryogenic Systems, Operating principle of different Types of Vacuum Pumps, Instruments to measure Flow, Level and Temperature operating principles.		
Text Books	1. Randall F. Barron, Cryogenic Systems, McGraw-Hill 2. Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press New York	
Reference Books	1. Robert W. Vance, Cryogenic Technology, John wiley and Sons 2. Mamata Mukhopadhay, Fundamentals of Cryogenic Engineering, PHI Learning 3. R.B. Scott, Cryogenic Engineering, Van Nostrand and Co.	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	06.06.2019	
Date of approval by the Academic Council	13.07.2019	

Course Outcome For ME4202

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to understand fundamentals of cryogenic engineering.	3	Em
CO2	Students should be able to understand the liquefaction cycles and its related terminologies	2	none
CO3	Students should be able to understand the separation storage and transportation of cryogenic liquids	3	Em
CO4	Students should be able to understand the different cryogenic refrigerants	2	S
CO5	Students should be able to understand the handling of cryogen and its operating principles.	2	S

CO-PO Mapping for ME4202

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	2	1	3	0	3	0	2	2	2	3	3	0	1	2	2
CO 2	3	2	1	2	0	1	0	0	1	2	0	2	3	1	1	2	3
CO 3	3	3	2	2	2	1	2	0	1	0	2	1	3	3	1	2	2
CO 4	3	2	3	3	2	1	1	0	1	1	2	1	3	2	1	1	3
CO 5	3	2	3	3	2	0	2	0	2	2	0	1	3	2	2	3	3
Avg	3	2.2	2.2	2.2	2.2	0.6	1.8	0	1.6	1.4	1.3	1.8	3	2.2	1.2	2	2.6

ME4212	Title: Research ethics and IPR	L T P C 3 0 0 3
Version No.	1.1	
Course Prerequisites	Nil	
Objectives	To understand research problem formulation and Analyze research related information	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction	7
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations		
Unit II	Processing	8
Effective literature studies approaches, analysis Plagiarism, Research ethics		
Unit III	Nature of Intellectual Property	7
Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.Indian Patent Act		
Unit IV	Patent Rights	7
Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.		
Unit V	New Developments in IPR	7
Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.		
Text Books	1. Alan Rodes, Principles of Industrial Microbiology, Pregmon International Pub. 2. Ibraham Dincer, Heat Transfer in Food Cooling Applications, Tailor and Francis Pub.	
Reference Books	1. Clive V.I. Dellino, Cold and Chilled Storage Technology, Van Nostrand Reinhold Pub., New York, 2. C.P. Arora, Refrigeration and Air conditioning, McGraw-Hill Pub.	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	14.05.2022	
Date of approval by the Academic Council		

Course Outcome For ME4212

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	To know about research ethics and its significance	2	S,Em
CO2	To know about Plagiarism and approaches for originality in reporting	2	S
CO3	To know about IPR	2	S
CO4	To know about patent rights	2	S
CO5	To know about new development in IPR	2	S,Em

CO-PO Mapping for ME4212

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	1	2	2	1	1	2	3	0	2	2	2	3	2	2	1	2	2
CO 2	1	2	1	2	0	2	0	0	1	2	0	2	1	1	1	2	3
CO 3	2	1	2	2	2	2	2	0	1	0	2	0	1	3	1	2	2
CO 4	2	2	2	2	2	2	1	0	1	1	2	0	1	2	1	1	3
CO 5	1	2	2	2	2	2	2	0	2	2	0	0	2	2	2	3	3
Avg	1.7	1.8	1.8	1.8	1.2	2	1.8	0	1.6	1.4	1.3	1	1.6	2.2	1.2	2	2.6

ME4206	Title: Refrigeration Machinery	L T P C 3 0 0 3
Version No.	1.1	
Course Prerequisites	Nil	
Objectives	To master how refrigeration components and systems. To identify and explain various system accessories and controls in refrigeration systems.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Refrigerant compressors	7
Hermetic compressors - Reciprocating, Rotary, Scroll compressors, Open type compressors - Reciprocating, Centrifugal, Screw Compressors. Semi hermetic compressors - Construction, working and Energy Efficiency aspects. Applications of each type.		
Unit II	Refrigeration system components	7
Evaporators and condensers-Different types, capacity control, circuitry, Oil return, Oil separators- Different types Refrigerant driers strainers, Receivers, Accumulators, Low pressure receivers, Air Washers, Spray ponds.		
Unit III	Hydronic systems	8
Water piping in Chilled Water Systems, Multiple Fan Coil Units, Condensers - Multiple Condensers and Cooling Towers. System components , Expansion tank, Balancing valves, Pumping systems, Pump selection, Freeze prevention		
Unit IV	Appliances and accessories	7
Special components for refrigeration, air Conditioning in Automobiles, Railway Wagons, Marine Vessels, Aircraft and Other Commercial Applications.		
Unit V	System accessories and controls	7
Refrigerant Pumps, Cooling Tower fans, Compressor Motor protection devices, Oil equalizing in multiple evaporators. Different Defrosting and capacity control methods and their implications.		
Text Books	1. R.J. Dosset, Principles of Refrigeration, John Wiley and Sons 2. Hains, Automatic Control of Heating and Airconditioning, J.B. Mc Graw Hill	
Reference Books	1. Althose, A.D. and Turnquist, C.H, Good Heart, Modern Refrigeration and Airconditioning, Wilcox Co.Inc. 2. ASHRAE Hand book - Fundamentals and Equipments	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	06.06.2019	
Date of approval by the Academic Council	13.07.2019	

Course Outcome For ME4206

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to understand basic concepts and working of compressors.	3	S,Em
CO2	Students should be able to understand refrigeration system component	2	S,Em
CO3	Students should be able to deeply understand various hydraunic system	3	S
CO4	Students should be able to understand ppliances and accessories	3	S
CO5	Students should be able to know about various system accessories and controls.	3	S,Em

CO-PO Mapping for ME4206

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	3	2	1	1	1	3	0	1	1	2	3	3	1	3	2	2
CO 2	3	3	2	2	2	1	0	0	1	0	0	2	3	2	2	2	3
CO 3	3	3	1	2	1	1	2	0	1	0	2	2	3	3	3	2	2
CO 4	3	2	2	2	1	1	1	0	1	1	2	2	3	2	3	1	3
CO 5	3	2	2	2	2	1	2	0	1	1	0	2	3	2	2	3	3
Avg	3	2.2	1.8	1.8	1.3	1	1.8	0	1	0.5	1.3	2.2	3	2.2	2.6	2.2	2.6

ME4213	Numerical Solution of Partial Differential Equations	L T P C 2 1 0 3
Version No.	1.0	
Course Prerequisites	NIL	
Objectives	To provide the concepts of various classical and modern methods of for solving the partial difference equation with numerical techniques.	
Expected Outcome	Students will be able to solve partial differential problems, understand and apply the concept of differential equation in various mechanical engineering problems.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Partial Difference Equation and Finite difference method	4
Classification of partial differential equation, Introduction to Finite Difference Methods, Finite Difference scheme for one dimensional PDE		
Unit II	Parabolic Equation	8
one dimensional parabolic equations, difference formulae, explicit and implicit difference methods, Schmidt method, Laasonen method, Crank-Nicolson Method, Dufort-Frankel Method. Tridiagonal systems, convergence and stability of different methods. Two dimensional parabolic equations: Alternating Direction Implicit (Peaceman-Rechford) method, Derivative boundary conditions. Simple non-linear initial boundary value-problem.		
Unit III	Hyperbolic Equation	6
First order hyperbolic equations, explicit and implicit difference method, Difference methods in second order hyperbolic equations in one and two space dimensions, its stability. Lax-wendrof scheme.		
Unit IV	Elliptical Equation	6
Two dimensional elliptic equations; Dirichlet's, Neumann and mixed boundary problems. Equation in polar co-ordinates (Simple problems), Quasi elliptic equations.		
Unit V	Finite element method	4
Introduction to finite element method and Multigrid method for simple problems, Weighted Residual methods,Golerkin jmethod, Multigrid method, Galerkin Method/with triangular elements		
Text Books	1. Computational Methods for Partial Differential Equation, M.K. Jain, S.R.K. Iyengar & R.K. Jain, Wiley Eastern Ltd. 2. Introduction to Finite element method , J.KN. Reed, MC Graw-Hill Inc.	
Reference Books	2. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI New Delhi.	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	14.05.2022	
Date of approval by the Academic Council		

Course Outcome For ME4213

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to understand application of finite difference method in one dimension PDE	3	S,Em
CO2	Students should be able to apply and solve parabolic equations for different boundary conditions	3	S,Em
CO3	Students should be able to solve hyperbolic equations for various boundary conditions	3	S
CO4	Students should be able to solve elliptical equations for different boundary conditions	3	S
CO5	Students should be able to know about finite element method for solving problems	3	S,Em

CO-PO Mapping for ME4213

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	3	2	2	1	0	3	0	1	1	2	3	3	1	3	2	2
CO 2	3	3	2	2	2	0	0	0	1	0	0	2	3	2	2	2	3
CO 3	3	3	2	2	1	0	2	0	1	0	2	2	3	3	3	2	2
CO 4	3	2	2	2	0	0	1	0	1	1	2	2	3	2	3	1	3
CO 5	3	2	2	2	0	0	2	0	1	1	0	2	3	2	2	3	3
Avg	3	2.2	2	2	0.8	0	1.8	0	1	0.5	1.3	2.2	3	2.2	2.6	2.2	2.6

ME4205	Title: Computational Fluid Dynamics	L T P C 3 0 0 3
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To develop an understanding for the major theories, approaches and methodologies used in CFD.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction	7
Introduction: Computational Fluid Dynamics as a Research and Design Tool, Applications of Computational Fluid Dynamics. Governing Equations of Fluid Dynamics: Introduction, Control Volume, Substantial Derivative, Divergence of Velocity, Continuity Equation, Momentum Equation and Energy Equation		
Unit II	Partial Differential Equations	7
Introduction, Classification of Quasi-Linear Partial Differential Equations, Eigen Value Method, Hyperbolic Equations, Parabolic Equations, Elliptic Equations		
Unit III	Discretization	8
Introduction of Finite Differences, Difference Equations, Explicit and Implicit Approaches, Errors and Stability Analysis, Grid Generation, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.		
Unit IV	Finite Volume Method	7
Introduction, Implicit Crank-Nicholson Technique, Pressure Correction Method, SIMPLE and SIMPLER algorithms, Computation of Boundary Layer Flow		
Unit V	Turbulence and its modeling	7
Description of turbulent flow, free turbulent flows, flat plate boundary layer and pipe flow. Algebraic Models, One equation model		
Text Books	1. J D Anderson Jr., Computational Fluid Dynamics: The Basics With Applications McGraw Hill, Inc. 2. S.P. Patankar, Numerical Heat Transfer and Fluid flow, CRC Press	
Reference Books	1. K Murlidhar and T Sundara Rajan, Computational fluid flow and heat transfer, Narosa Publishing House. 2. D.A. Anderson, J.I. Tannehill and R.H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Hemisphere Publishing Corporation 3. T.K. Bose, Numerical Fluid Dynamics, Narosa Publishing House. 4. C.A.J. Fletcher, Computational Techniques for Fluid Dynamics 1, Springer 5. C.A.J. Fletcher, Computational Techniques for fluid Dynamics 2, Springer	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	24.03.2018	
Date of approval by the Academic Council	11.06.2018	

Course Outcome For ME4205

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to develop an understanding for the major theories, approaches and methodologies used in CFD.	3	S,Em
CO2	Students should be able to analyse the partial differential equation	4	S,
CO3	Students should be able to analyse discrete structures.	4	S
CO4	Students should be able to numerically solve the governing equations for fluid flow problems	4	S
CO5	Students should be able to analyse fluid flow and also able to do its modeling.	3	S

CO-PO Mapping for ME4205

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	3	2	2	2	1	1	0	0	0	2	3	3	1	3	2	2
CO 2	3	3	2	3	2	1	0	0	1	0	0	2	3	2	2	2	3
CO 3	3	3	1	3	2	1	1	0	0	0	2	2	3	3	3	2	2
CO 4	3	2	2	3	2	1	1	0	0	0	2	2	3	2	3	1	3
CO 5	3	2	2	2	2	1	1	0	1	0	0	2	3	2	2	3	3
Avg	3	2.2	1.8	2.6	2	1	0.8	0	0.2	0	1.3	2.2	3	2.2	2.6	2.2	2.6

ME4210	Title: Design of Heat Exchangers	L T P C 3 0 0 3
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To learn the thermal and stress analysis on various parts of the heat exchangers and to analyze the sizing and rating of the heat exchangers for various applications	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Fundamentals of Heat Exchanger	7
Temperature distribution and its implications types, shell and tube heat exchangers, regenerators and recuperators, analysis of heat exchangers, LMTD and effectiveness method.		
Unit II	Flow And Stress Analysis	8
Effect of turbulence, friction factor, pressure loss, stress in tubes, header sheets and pressure vessels, thermal stresses, shear stresses, types of failures.		
Unit III	Design Aspects	8
Comparison of air standard and fuel air cycles, effect of operating variables, comparison of air standard and actual cycles, effect of time loss, heat loss and exhaust loss in Petrol and Diesel engines, valve and port timing diagrams		
Unit IV	Compact And Plate Heat Exchangers	7
Types, merits and demerits, design of compact heat exchangers, plate heat exchangers, performance influencing parameters, limitations.		
Unit V	Mechanical Design of Heat Exchangers	6
Design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges and nozzles. Introduction to simulation and optimization of heat exchangers, flow induced vibrations.		
Text Books	1. Sadik Kakac and Hongtan Liu, Heat Exchangers Selection, Rating and Thermal Design, CRC Press 2. Arthur P Frass, Heat Exchanger Design, John Wiley and Sons	
Reference Books	1. Taborek.T, Hewitt.G.F and Afgan.N, Heat Exchangers-Theory and Practice, McGraw-Hill Book Co. 2. G.F. Hewitt, G.L. Shires and T.R. Bott, Process Heat Transfer, CRC Press	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	14.05.2022	
Date of approval by the Academic Council		

Course Outcome For ME4210

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should able to develop good understanding of the intricacies of heat exchanger design.	2	S,Em
CO2	Students should learn about the flow and stresses in heat exchanger	2	None
CO3	Students should aware about different design aspacts of heat exchangers	2	Em
CO4	Students should gain knowledge of different heat exchanger in thermal power plant.	2	Em
CO5	Students should able to know the designing and optimization of heat excahnger	3	S

CO-PO Mapping for ME4210

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	2	1	2	2	3	0	0	0	0	0	0	3	2	0	0	2	3
CO 2	2	2	2	2	0	0	0	0	0	0	0	2	3	1	0	2	3
CO 3	1	2	3	2	0	2	0	0	0	0	2	3	3	3	0	2	2
CO 4	2	2	3	3	2	1	0	1	0	1	2	3	2	2	1	1	3
CO 5	2	2	3	3	2	1	0	1	0	2	0	2	3	2	2	3	3
Avg	1.8	1.8	2.6	2.3	1.6	0.8	0	.3	0	.6	0.3	2.6	2.6	1.6	0.6	2	2.6

ME4207	Title: Jet & Rocket Propulsion Systems	L T P C 3 0 0 3
Version No.	1.1	
Course Prerequisites	Nil	
Objectives	To develop an understanding of how air-breathing engines and chemical rockets produce thrust.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Turbo Jet Propulsion System	6
Turbo Jet Propulsion System: Gas turbine cycle analysis, layout of turbo jet engine. Turbo machinery- compressors and turbines, Combustor, blade aerodynamics, engine off design performance analysis. Flight Performance: Forces acting on vehicle, Basic relations of motion , multi stage vehicles.		
Unit II	Principles	8
Principles of Jet Propulsion and Rocketry: Fundamentals of jet propulsion, Rockets and air breathing jet engines, Classification , turbo jet , turbo fan, turbo prop, rocket (Solid and Liquid propellant rockets) and Ramjet engines. Nozzle Theory and Characteristics Parameters: Theory of one dimensional convergent , divergent nozzles, aerodynamic choking of nozzles and mass flow through a nozzle , nozzle exhaust velocity , thrust, thrust coefficient, Supersonic nozzle shape, non-adapted nozzles, summer field criteria, departure from simple analysis ,characteristic parameters , relationship between the characteristic parameters		
Unit III	Solid Propulsion System	8
Review of properties of mixture of gases , Gibbs , Dalton laws , Equivalent ratio, enthalpy changes in reactions, heat of reaction and heat of formation Solid Propulsion System: Solid propellants, classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods. Composite propellant oxidizers and binders. Burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates. Solid propellant rocket engine, Heat transfer considerations in solid rocket motor design. Ignition system, simple pyro devices.		
Unit IV	Liquid Rocket Propulsion System	7
Liquid propellants, classification, Mono and Bi propellants, Cryogenic and storage propellants. Liquid propellant rocket engine, system layout, pump and pressure feed systems, feed system components. Design of combustion chamber, characteristic length, constructional features, and chamber wall stresses. Heat transfer and cooling aspects. Uncooled engines, injectors, various types, injection patterns, injector characteristics, and atomization and drop size distribution, propellant tank design.		
Unit V	Ramjet Propulsion System	7
Fuel rich solid propellants, gross thrust, gross thrust coefficient, combustion efficiency of ramjet engine, air intakes and their classification , critical, super critical and sub-critical operation of air intakes, engine intake matching, classification and comparison of IIRR propulsion systems.		
Text Books	1. M.L. Mathur, Gas Turbine and Jet Rocket Propulsion, ST and ARD Publishers 2. H.I.H. Saravana Muttoo, G.F.C. Rogers, H. Cohen, Gas Turbine Theory, Pearson Publication	
Reference Books	1. Ganesan, Gas Turbines, TMH 2. Khajuria and Dubey, Gas Turbines and Propulsive Systems, Dhanpatrai	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	06.06.2019	
Date of approval by the Academic Council	13.07.2019	

Course Outcome For ME4207

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to understand working of various propulsion systems.	2	S,Em
CO2	Students should be able to understand the principles of jet propulsion and rocketry.	2	S
CO3	Students should be able to review the properties of mixture of gases and understand the solid propulsion system.	3	S
CO4	Students should be able to understand the liquid rocket propulsion system.	2	None
CO5	Students should be able to understand the ramjet propulsion system	2	none

CO-PO Mapping for ME4207

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	2	1	3	0	3	0	2	2	2	3	3	0	3	2	2
CO 2	3	2	1	1	`1	0	0	0	1	2	0	2	3	1	2	2	3
CO 3	2	3	2	1	2	0	2	0	1	0	2	2	3	3	2	2	2
CO 4	3	2	3	3	2	0	1	0	1	1	2	2	3	2	2	1	3
CO 5	3	2	3	3	2	0	2	0	2	2	0	2	3	2	2	3	3
Avg	2.8	2.2	2.2	1.8	2	0	1.8	0	1.6	1.4	1.3	2.2	3	2.2	2.2	2	2.6

ME4208	Title: Gas Turbine and Compressors	L T P C 3 0 0 3
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	The course is intended to impart knowledge on theory and practice of gas turbines and compressors	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction	6
Gas turbines -Open and closed cycles -Requirements of working medium -Applications. Ideal cycles and their analysis - Simple cycle and its modifications with reheat, regeneration and inter cooling -Ericsson cycle.		
Unit II	Design Cycles	8
Real cycles -Compressor and turbine efficiencies -Heat exchanger effectiveness -Flow losses - Incomplete combustion - Cycle efficiency -Performance prediction of simple gas turbines -Off Design operations -Methods of improving part load operations -Transient behavior Performance deterioration.		
Unit III	Axial Flow Gas Turbines	8
Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Design cascade analysis, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, off design Performance.		
Unit IV	Centrifugal Compressor	7
Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance.		
Unit V	Axial Flow Compressors	7
Flow Analysis, Work and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance. Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.		
Text Books	1. Yahya, Elements of Gas Dynamics, New Age Publication 2. V Ganesan, Gas Turbines, Tata McGraw-Hill Pub.	
Reference Books	1. D.G. Shepherd, Principles of Turbo Machinery, The Macmillan Company 2. Dixon, Fluid Mechanics, Thermodynamics of Turbo Machinery, Pergamon Press	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	24.03.2018	
Date of approval by the Academic Council	11.06.2018	

Course Outcome For ME4208

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to develop Basic understanding of gas turbine and related working cycles	2	S,Em
CO2	Students should be able to understand designing concepts of gas turbines	3	S
CO3	Students should be able to understand velocity triangle and axial flow turbine	3	S
CO4	Students should be able to understand centrifugal compressor basics and their performance evaluation	3	S
CO5	Students should be able to understand the concept of degree of reaction for axial flow compressors.	2	S,Em

CO-PO Mapping for ME4208

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	2	1	1	1	1	0	1	0	0	1	1	2	2	1	2	1	1
CO 2	3	3	3	2	2	2	2	1	1	2	1	3	3	3	3	3	2
CO 3	3	3	2	2	2	0	2	0	0	0	2	2	3	3	1	2	2
CO 4	3	2	3	3	2	0	1	0	0	1	2	3	3	2	3	2	3
CO 5	3	3	2	2	2	2	2	1	1	2	1	2	3	3	2	2	2
Avg	2.8	2.2	2.2	2	1.9	0.4	1.8	0.2	0.2	1.2	1.8	2.2	2.8	2.2	2.2	2	2

ME4211	Title: New Venture Creation	L T P C 3 0 0 3
Version No.	1.1	
Course Prerequisites	Nil	
Objectives	To understand initiation and propagation of a Fire along with techniques of fire detection and suppression.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Entrepreneur and Entrepreneurship	6
Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises		
Unit II	Planning a New Enterprise	8
Opportunity Scanning and Identification; Creativity and product development process; The technology challenge - Innovation in a knowledge based economy, Sources of Innovation Impulses – Internal and External; Drucker's 7 Sources of Innovation Impulses, General Innovation Tools, Role of Innovation during venture growth; Market survey and assessment; choice of technology and selection of site.		
Unit III	Establishing a New Enterprises	8
Forms of business organization/ownership; Financing new enterprises - Sources of capital for early-stage technology companies; Techno Economic Feasibility Assessment; Engineering Business Plan for grants, loans and venture capital		
Unit IV	Operational Issues in SSE	7
Develop a strategy for protecting intellectual property of the business with patent, trade secret, trademark and copyright law; Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws. Startup India policy and Uttarakhand state policies and framework		
Unit V	Performance appraisal and growth strategie	7
Strategies to anticipate and avoid the pitfalls associated with launching and leading a technology venture; Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.		
Text Books	1. S.S. Khanka, 'Entrepreneurial Development' (4th ed.), S Chand & Company Ltd., 2012. 2. Vasant Desai, 'Management of Small Scale Enterprises', Himalaya Publishing House, 2004.	
Reference Books	Byers, Dorf, and Nelson. 'Technology Ventures: From Ideas to Enterprise'. McGraw Hill. ISBN-13: 978-0073380186., 2010. 2. Bruce R Barringer and R Duane Ireland, 'Entrepreneurship: Successfully Launching New Ventures', 3rd ed., Pearson Edu., 2013. 3. D.F. Kuratko and T.V. Rao, 'Entrepreneurship: A South-Asian Perspective', Cengage Learning, 2013	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	14.05.2022	
Date of approval by the Academic Council		

Course Outcome For ME4211

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Understand entrepreneurship and entrepreneurial process and its significance in economic development.	3	En
CO2	Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship. .	2	En
CO3	Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.	3	En
CO4	Develop a framework for technical, economic and financial feasibility.	2	En
CO5	Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.	2	En

CO-PO Mapping for ME4211

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	2	2	2	1	2	0	3	0	2	2	2	2	2	0	1	2	2
CO 2	2	2	1	1	0	0	0	1	1	2	2	2	2	1	2	2	3
CO 3	1	1	2	0	2	1	2	1	2	0	2	1	2	3	1	2	2
CO 4	2	2	2	0	2	2	1	1	2	2	2	1	2	2	1	1	3
CO 5	2	2	1	1	2	1	2	0	2	2	2	1	2	2	2	3	3
Avg	1.8	1.6	1.2	0.6	1.8	0.8	1.8	0.6	1.6	1.4	2	1.4	2	2.2	1.4	2	2.6

ME4301	Title: Alternative Fuels	L T P C 3 0 0 3
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To know about the types of alternative fuels and energy sources for IC engines.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction	7
Working process of I.C. Engine. Study of various parameters related to properties of different types of fuel (Rating of fuel, Ignition quality, volatility, calculations of Air-Fuel ratio, Calorific Value) as input and output in terms of results (Fuel efficiency, Fuel requirement, Engine efficiency and Engine life). Sources of fossil fuel, scope of availability of fossil fuel in future.		
Unit II	Need for Alternative Fuels	7
Effects of constituents of Exhaust gas emission on environmental condition of earth, Pollution created by Exhaust gas emission in atmosphere. Greenhouse effect, Factors affecting greenhouse effect. Study of Global Carbon Budget, Carbon foot print and Carbon credit calculations. Emission norms as per Bharat Standard up to BS - VI and procedures for confirmation on production.		
Unit III	Alcohol and Bio Diesel	7
Sources of Methanol and Ethanol, methods of its production. Properties of methanol and ethanol as engine fuels, Use of alcohols in S.I. and C.I. engines, performance of blending methanol with gasoline. Emulsification of alcohol and diesel. Dual fuel systems. Base materials used for production of Bio Diesel, Process of separation of Bio Diesel. Properties Diesel blended with vegetable oil, and difference in performance of Engine.		
Unit IV	Hydrogen and Biogas	8
Hydrogen as a substitute fuel. Study Properties, Sources and methods of Production of Hydrogen, Storage and Transportation of hydrogen. Advantages of hydrogen (Liquid hydrogen) as fuel, Cost estimation. Layout of a hydrogen car. Fuel Cells: Concept of fuel cells based on usage of Hydrogen and Methanol. Power rating and performance. Introduction to Biogas system, Factors affecting biogas formation. Usage of Biogas in SI engine and CI engine.		
Unit V	Vegetable Oils, LPG and CNG	7
Vegetable oils for Engines, Esterification, Performance and emission characteristics. Synthetic Alternative Fuels: Di-Methyl Ether (DME), P-Series, Eco Friendly Plastic fuels (EPF). LPG and CNG: Properties of LPG and CNG as engine fuels, fuel metering systems, combustion characteristics, effect on performance, emission, cost and safety.		
Text Books	1. S.S. Thipse, Alternative Fuels: Concepts, Technologies and Developments, Jaico Publishing House 2. Zainul, Abdul, Alternative Fuels for CI Engines, Springer Publications	
Reference Books	1. Dr. G. Devaradjane, Dr. M. Kumaresan, Automobile Engineering, AMK Publishers. 2. Richard L Bechtold P.E., Alternative Fuels Guide Book, Society of Automotive Engineers 3. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	06.06.2019	
Date of approval by the Academic Council	13.07.2019	

Course Outcome For ME4301

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should able to understand the basic concepts of IC engine	2	S,Em
CO2	Students should aware about the need of alternative fuel in different fields	2	S,Em
CO3	Students should able to understand and analyze the application of alcohol and biodiesel in IC engine	3	S
CO4	Students should able to understand the application Hydrogen and biogas	2	None
CO5	Students should able to apply the basics of chemistry in the preparation of biodiesel	2	S

CO-PO Mapping for ME4301

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	1	0	0	3	1	2	0	0	0	0	3	3	0	0	2	3
CO 2	3	2	1	2	0	1	2	0	0	0	0	2	3	1	0	2	3
CO 3	3	3	2	2	0	1	2	0	0	0	2	1	3	3	0	2	2
CO 4	3	2	3	3	2	1	1	0	0	1	2	1	3	2	1	1	3
CO 5	3	2	3	3	2	1	2	0	0	2	0	1	3	2	2	3	3
Avg	3	2	1.8	2	1.6	1	1.8	0	0	0.6	0.	1.8	3	2.2	1.2	2	2.6

ME4302	Title: Solar Energy Technology	L T P C 3 0 0 3
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	The course will deliver fundamental knowledge of the solar energy technologies, both, thermal and photovoltaic.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction	8
Solar angles, day length, angle of incidence on tilted surface; Sunpath diagrams; Shadow determination; Extraterrestrial characteristics; Effect of earth atmosphere; Measurement and estimation on horizontal and tilted surfaces; Analysis of Indian solar radiation data and applications. Flat-plate Collectors - Effective energy losses; Thermal analysis; Heat capacity effect; Testing methods; Evacuated tubular collectors; Air flat-plate Collectors: types; Thermal analysis; Thermal drying. Selective Surfaces - Ideal coating characteristics; Types and applications; Anti-reflective coating; Preparation and characterization.		
Unit II	Concentrating Collector Designs	6
Concentrating Collector Designs - Classification, design and performance parameters; Tracking systems; Compound parabolic concentrators; Parabolic trough concentrators; Concentrators with point focus; Heliostats; Comparison of various designs: Central receiver systems, parabolic trough systems; Solar power plant; Solar furnaces		
Unit III	Solar Heating and Cooling and Energy Storage	8
Solar Heating and Cooling System - Liquid based solar heating system; Natural, forced and gravity flow, mathematical modeling, Vapour absorption refrigeration cycle; Water, ammonia and lithium bromide-water absorption refrigeration systems; Solar operated refrigeration systems; Solar desiccant cooling. -Solar Thermal Energy Storage - Sensible storage; Latent heat storage; Thermo-chemical storage. Solar still; Solar cooker: Solar pond; Solar passive heating and cooling systems: Trombe wall; Greenhouse technology: Fundamentals, design, modeling and applications.		
Unit IV	Solar Cell Physics	7
Solar Cell Physics , P-N junction: homo and hetro junctions, Metal-semiconductor interface; Dark and illumination characteristics; Figure of merits of solar cell; Efficiency limits; Variation of efficiency with band-gap and temperature; Efficiency measurements; High efficiency cells, Tandem structure.		
Unit V	SPV systems	7
SPV Applications - Centralized and decentralized SPV systems; Stand alone, hybrid and, grid connected system, System installation, operation and maintenances; Field experience; PV market analysis and economics of SPV systems , Government Schemes and Polices		
Text Books	1. H.P. Garg, J. Prakash, Solar Energy: Fundamentals and Applications, Tata McGraw Hill, 2. S P Sukhatme, Solar Energy, Tata McGraw Hill	
Reference Books	1. J.F. Kreider and Frank Kreith,Solar Energy Handbook, McGraw Hill 2. D.Y. Goswami, Frank Kreith and J F Kreider, Principles of Solar Engineering, Taylor and Francis	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	06.06.2019	
Date of approval by the Academic Council	13.07.2019	

Course Outcome For ME4302

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to conceptual knowledge of the solar energy technology, economics and regulation related issues associated with solar power development and management.	2	Em
CO2	Students should be able to concentrating collector designs of solar energy technology, solar power plant; solar furnaces.	2	Em
CO3	Students should be able to solar heating and cooling system – of solar energy system.	2	S
CO4	Students should be able to solar cell physics variation of efficiency with band-; high efficiency cells, tandem structure of the solar.	2	S
CO5	Students should be able to develop a comprehensive technological understanding in solar pv system components.	2	S

CO-PO Mapping for ME4302

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	2	1	3	0	3	0	2	2	2	3	3	0	1	2	2
CO 2	3	2	1	2	0	0	0	0	1	2	0	2	3	1	1	2	3
CO 3	3	3	2	2	2	0	2	0	1	0	2	0	3	3	1	2	2
CO 4	3	2	3	3	2	0	1	0	1	1	2	0	3	2	1	1	3
CO 5	3	2	3	3	2	0	2	0	2	2	0	0	3	2	2	3	3
Avg	3	2.2	2.2	2.2	2.2	0	1.8	0	1.6	1.4	1.3	1	3	2.2	1.2	2	2.6

ME4310	Title: Modelling of IC Engine	L T P C 3 0 0 3
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To learn thermodynamics of combustion, characteristics, principles governing modeling of IC engine.	
Expected Outcome	1. Students will demonstrate a basic understanding of several types of engine models that will include zero dimensional thermodynamic model, one dimensional and multi-dimensional, single zone, two zone etc models. 2. Students will develop models and simulate them for diesel engine petrol engine, gas engine. 3. Students will demonstrate the performance evaluation and emission standards for such modeled engines	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Fundamentals	7
Governing equations, Equilibrium charts of combustion chemistry, chemical reaction rates, and approaches of modeling, model building and integration methods, gas exchange through valves, engine and porting geometry, exhaust gas recirculation, valve lift curves.		
Unit II	Thermodynamic Combustion Models of CI Engines	8
Single zone models, premixed and diffusive combustion models, combustion heat release using wiebe function, wall heat transfer correlations, ignition delay, internal energy estimations, two zone model, application of heat release analysis.		
Unit III	Reprocessing	8
Nuclear fuel cycles - spent fuel characteristics - role of solvent extraction in reprocessing - solvent extraction equipment.		
Unit IV	Fuel spray behavior	7
Fuel injection, spray structure, fuel atomization, droplet turbulence interactions, droplet impingement on walls. Modeling of charging system: Constant pressure and pulse turbo charging, compressor and turbine maps, charge air cooler.		
Unit V	Mathematical models of SI Engines	6
Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Autoignition modeling, single zone models, mass burning rate estimation, SI Engine with stratified charge. Friction in pumping, piston assembly, bearings and valve train etc. friction estimation for warm and warm up engines.		
Text Books	1. Haywood, "I.C. Engines", Mc Graw Hill. 2. Ramos **J** (1989**)** Internal Combustion Engine Modeling**.** Hemisphere Publishing Company	
Reference Books	3. C. D. Rakopoulos and E. G. Giakoumis, "Diesel Engine Transient 4. Operation Principles of Operation and Simulation Analysis", Springer, 2009. 5. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 1996. 6. P.A. Lakshminarayanan and Y. V. Aghav, " Modelling Diesel Combustion" Springer, 2010 7. Bernard Challen and Rodica Baranescu, "Diesel Engine Reference Book" Butterworth- Heinemann, 1999.	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	14.05.2022	
Date of approval by the Academic Council		

Course Outcome For ME4310

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Student will know about concepts and governing equations	3	S,Em
CO2	Student will know about heat release analysis and combustion models of CI engine	3	S
CO3	Student will know about reprocessing of nuclear fuel	2	S
CO4	Student will know about fuel spray behavior	2	S
CO5	Student will know about mathematical model of SI engine	3	S

CO-PO Mapping for ME4310

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	1	1	1	2	2	0	0	0	0	1	3	2	2	2	1
CO 2	3	2	1	1	1	2	2	0	0	0	0	1	3	2	3	1	1
CO 3	3	2	1	1	1	1	2	0	0	0	0	1	3	2	2	2	1
CO 4	3	2	1	1	1	2	2	0	0	0	0	1	3	2	2	1	1
CO 5	3	2	1	1	1	0	2	0	0	0	0	1	3	2	2	1	1
Avg	3	2	1	1	1	0.8	2	0	0	0	0	1	3	2	2.2	1.4	1

ME4303	Title: Energy Storage Techniques	L T P C 3 0 0 3
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	The objective of this course is to learn fundamentals of energy storage methods	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction	7
Introduction to energy storage, Need of Energy storage, Different modes of energy storage, Technology Types. Mechanical energy storage: flywheels, compressed air and pumped hydro electric storage- advantages and application		
Unit II	Battery storage	7
Principle of operation Battery components and design Electrode, cell and battery fabrications Building block cells, battery modules and packs Li-polymer batteries, Li-ion batteries ,Advance Ni-MH batteries for transportation Future prospects of Ni-MH batteries vs. lithium ion batteries, Lead-acid battery		
Unit III	Magnetic and Electric Storage	7
Supercapacitor energy storage, Advance battery-supercap hybrids for auto, space and marine applications Superconducting Magnetic Energy Storage-Advantages, disadvantages, applications		
Unit IV	Fuel Cell and Hydrogen Storage	7
Advance fuel cells Introduction to fuel cells PEM and alkaline fuel cells for transportation Solid oxide fuel cells Hydrogen storage systems Solid state hydrogen storage tanks Gas phase hydrogen storage tanks Cryogenic hydrogen storage tanks Liquid phase hydrogen storage tanks Fuel reformers Advanced fuel reformers		
Unit V	Thermal Storage	8
Thermal storage in buildings, Earth storage, Aquifers storage. Basics of Latent heat storage, Phase change materials (PCM)		
Text Books	1. Pendse, Energy Storage Science and Technology, SBS Publishers 2. Mullick, Garg and Vijay Bhargava, Solar Thermal Energy Storage, Springer	
Reference Books	1. Detlef Stolten, Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications, Wiley 2. Jiujun Zhang, Lei Zhang, Electrochemical Technologies for Energy Storage and Conversion, John Wiley and Sons. 3. Batteries for Renewable Energy Storage, The Electrochemical Society, New Jersy 4. H.A Kiehne, Battery Technology Handbook, CRC Press book	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	06.06.2019	
Date of approval by the Academic Council	13.07.2019	

Course Outcome For ME4303

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should able to understand the energy storage systems	2	S,Em
CO2	Students should able to understand the working of battery storage systems	2	S
CO3	Students should able to understand the working of magnetic and electric storage systems	2	S
CO4	Students should able to understand the working of fuel cell and hydrogen storage systems	2	S
CO5	Students should able to understand the thermal storage systems	2	S,Em

CO-PO Mapping for ME4303

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	1	1	1	2	2	0	0	0	0	1	3	2	2	2	1
CO 2	3	2	1	1	1	2	2	0	0	0	0	1	3	2	3	1	1
CO 3	3	2	1	1	1	1	2	0	0	0	0	1	3	2	2	2	1
CO 4	3	2	1	1	1	2	2	0	0	0	0	1	3	2	2	1	1
CO 5	3	2	1	1	1	0	2	0	0	0	0	1	3	2	2	1	1
Avg	3	2	1	1	1	0.8	2	0	0	0	0	1	3	2	2.2	1.4	1

ME4305	Title: Energy Management in Thermal System	L T P C 3 0 0 3
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To learn the instruments suitable for energy auditing and to study the various measures for energy conservation and financial implications for various thermal utilities.	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Introduction	8
Energy Scenario, world and India. Energy Resources Availability in India. Energy consumption pattern. Energy conservation potential in various Industries and commercial establishments. Energy intensive industries, an overview. Energy conservation and energy efficiency, needs and advantages. Energy auditing, types, methodologies, barriers. Role of energy manager, Energy audit questionnaire, energy Conservation Act 2003.		
Unit II	Instruments for Energy Auditing	8
Instrument characteristics, sensitivity, readability, accuracy, precision, hystersis. Error and calibration. Measurement of flow, velocity, pressure, temperature, speed, Lux, power and humidity. Analysis of stack, water quality, power and fuel quality.		
Unit III	Thermal Utilities: Operation and Energy Conservation	6
Boilers, Thermic Fluid Heaters, Furnaces, Waste Heat Recovery Systems, Thermal Storage.		
Unit IV	Thermal Energy Transmission	6
Steam traps, refractories, optimum insulation thickness, Insulation , piping design.		
Unit V	Financial Management	8
Investment , need, appraisal and criteria, financial analysis techniques , break even analysis , simple pay back period, return on investment, net present value, internal rate of return, cash flows, DSCR, financing options, ESCO concept.		
Text Books	1. C.B. Smith, Energy Management Principles, Pergamon Press, NewYork,	
Reference Books	1. PR Trivedi, KR Jolka, Energy Management, Commonwealth Publication 2. Write, Larry C, Industrial Energy Management and Utilization, Hemisphere Publishers, Washington 3. Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case Study, Washington	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	06.06.2019	
Date of approval by the Academic Council	13.07.2019	

Course Outcome For ME4305

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to the course is intended to introduce principles of energy auditing and to provide measures for energy conservation in thermal applications	2	S,Em
CO2	Students should be able to design suitable energy monitoring system to analyz and optimize the energy consumption in an organization.	3	S
CO3	Students should be able to improve the thermal efficieny by designing suitable systems for heat recovery and co-generation.	3	S
CO4	Students should be able to guide the employees of the organization about the need and the methods of energy conservation.	2	S
CO5	Students will be able to carry out the cost- benefit analysis of various investment alternatives for meeting the energy needs of the organization.	3	S,Em

CO-PO Mapping for ME4305

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	2	1	3	2	3	0	2	2	2	3	3	1	2	2	2
CO 2	3	2	1	2	0	2	0	0	1	2	0	2	3	1	1	2	3
CO 3	3	3	2	2	2	1	2	1	1	0	2	1	3	3	2	2	2
CO 4	3	2	3	3	2	2	1	1	1	1	2	1	3	2	2	1	3
CO 5	3	2	3	3	2	2	2	1	2	2	0	1	3	2	2	3	3
Avg	3	2.2	2.2	2.2	2.2	1.8	1.8	0.6	1.6	1.4	1.3	1.6	3	1.8	1.8	2	2.4

ME 4309	Title: Air-Conditioning System Design	L T P C 3 0 0 3
Version No.	1.0	
Course Prerequisites	Nil	
Objectives	To provide the concepts of thermal distribution technique through a air conditioning system and its various types and advantages	
Unit No.	Unit Title	No. of hours (per Unit)
Unit I	Estimation of Solar Radiation	6
Cooling And Heating Load Calculation – I: Introduction, solar radiation, constant and irradiation geometry and various related basic and derived angle ,angle of incident for horizontal, vertical and tilted surfaces, calculation of direct, diffuse and reflected radiation using ASHRAE solar radiation model including effect of clouds.		
Unit II	Solar Radiation fenestration, ventilation and infiltration	8
Cooling And Heating Load Calculation – II: Fenestration, need, effect on air conditioning systems, estimation, concepts, SHGF, shading coefficient, external shading, calculation of shaded area, windows with overhang, infiltration and ventilation, causes, estimation of heat transfer rate.		
Unit III	Heat Transfer through building, fabric heat gain/loss	8
Cooling And Heating Load Calculation – III: Heat transfer through buildings, 1-D, steady state and unsteady state heat transfer through homogeneous, non homogeneous walls, air spaces, composite walls, opaque walls, roofs. The analytical and in brief numerical methods used to solve the 1-D transient heat transfer problem, semi-emperical methods, physical significance of decrement and time lag factor, typical tables of CLTD for walls and roofs.		
Unit IV	Selection Of Air Conditioning Systems	6
Introduction to thermal distribution systems, there functions, selection criteria and there classification of air conditioning systems, working principal, advantages, disadvantages and its application for various air/water flow systems.		
Unit V	Transmission of Air in Air Conditioning Ducts	8
Describe an air handling unit(AHU) its functions, need for studying transmission , air flow through ducts, Bernoulli and modified Bernoulli equation, static, dynamic, datum and total head, fan total pressure(FTP) and power input to fan, estimation of pressure loss through ducts, estimation of dynamic pressure drop in various types of heatings.		
Text Books	1. Stoecker W.F ,Refrigeration and air conditioning, McGraw Hill 2. C.P. Arora ,Refrigeration and air conditioning, Tata McGraw Hill.	
Reference Books	1. Ahmad ul Ameen ,Refrigeration and air conditioning, PHI publication. 2. Shan K. Wang ,Handbook of air conditioning and Refrigeration,Tata McGraw Hill	
Mode of Evaluation	Internal and External Examinations	
Recommendation by Board of Studies on	06.06.2019	
Date of approval by the Academic Council	13.07.2019	

Course Outcome For ME4309

Unit-wise Course Outcome	Descriptions	BL Level	Employability (Em)/ Skill(S)/ Entrepreneurship (En)/ None (*Use , for more than One*)
CO1	Students should be able to estimate the solar radiation.	3	S
CO2	Students should be able to learn about the Solar Radiation fenestration, ventilation and infiltration.	2	S
CO3	Students should be able to learn about the Heat Transfer through building, fabric heat gain/loss.	3	S
CO4	Students should be able to sense about the Selection of Air Conditioning Systems	2	S
CO5	Students should be able to differentiate about the Transmission of Air in Air Conditioning Ducts	2	S,Em

CO-PO Mapping for ME4309

Course Outcomes	Program Outcomes (Course Articulation Matrix (Highly Mapped- 3, Moderate- 2, Low-1, Not related-0)												Program Specific Outcomes		Program Educational Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PEO 1	PEO 2	PE O 3
CO 1	3	2	2	1	3	0	3	0	2	2	2	2	3	0	1	2	2
CO 2	3	2	1	2	0	0	0	0	1	2	0	2	3	1	1	2	3
CO 3	3	3	2	2	2	0	2	0	1	0	2	1	3	3	1	2	2
CO 4	3	2	3	3	2	0	1	0	1	1	2	1	3	2	1	1	3
CO 5	3	2	3	3	2	0	2	0	2	2	0	1	3	2	2	3	3
Avg	3	2.2	2.2	2.2	2.2	0	1.8	0	1.6	1.4	1.3	1.4	3	2.2	1.2	2	2.6