Gandhinagar Institute of Technology

Academic Regulation & Curriculum

for

M.Tech

in

Thermal Engineering

***w.e.f.* 2026-27**

Preamble

The Mechanical Engineering Department, Gandhinagar Institute of Technology, Gandhinagar University, is committed to fostering academic excellence, applied research, professional ethics, and industry-oriented learning across the disciplines of Mechanical Engineering, Robotics & Automation, Energy Engineering and Robotics and Artificial Intelligence. The programmes offered by this department are designed in alignment with AICTE guidelines, NEP 2020, Outcome-Based Education (OBE), and Choice-Based Credit System (CBCS) principles, with the goal of preparing skilled, adaptable, and innovation-driven engineers and technologists for India's rapidly evolving industrial and technological landscape.

Under the NEP 2020 framework, the department embraces a flexible, multidisciplinary, and learner-centric approach to engineering education. The Choice-Based Credit System (CBCS) enables students to exercise academic autonomy by selecting elective courses aligned with their interests, career goals, and emerging industry needs. The Outcome-Based Education (OBE) philosophy ensures that every course, every laboratory exercise, and every project activity is purposefully designed to achieve defined Programme Outcomes (POs), Programme Educational Objectives (PEOs), and Course Outcomes (COs), making the learning process transparent, measurable, and continuously improvable.

The department offers Ten programmes spanning undergraduate and postgraduate levels: D.Tech in Mechanical Engineering, D.Tech in Robotics & Automation, B.Tech in Mechanical Engineering, B.Tech in Robotics & Automation, B.Tech in Energy Engineering, B.Tech in Robotics and Artificial Intelligence, M.Tech in CAD/CAM, M.Tech in Thermal Engineering, and M.Tech in Energy Engineering, M.Tech in Robotics and Artificial Intelligence. Together, these programmes form a cohesive academic ecosystem that addresses the full spectrum of mechanical sciences — from classical thermodynamics and manufacturing to advanced robotics, intelligent automation, and sustainable energy systems.

The curriculum integrates core engineering domains including Thermal sciences, energy systems, heat transfer, fluid mechanics, refrigeration and air conditioning, renewable energy

technologies, and sustainable engineering practices that are shaping the future of engineering practice in India and globally. The curriculum encourages flexibility, multidisciplinary engagement, and experiential learning, enabling students to adapt to emerging technologies and evolving industry requirements. The programme ultimately aims to produce competent thermal engineers with strong technical foundations, ethical values, leadership qualities, and a commitment to continuous professional growth and societal welfare.

Through a balanced pedagogy of classroom instruction, laboratory experimentation, industry internships, live projects, design challenges, and research activities, the department aims to develop engineers who are not only technically proficient but also capable of critical thinking, independent problem-solving, and responsible innovation. The postgraduate programmes in CAD/CAM, Thermal Engineering, Energy Engineering and Robotics and Artificial Intelligence are designed to deepen specialization, advance research capability, and prepare graduates for leadership roles in industry and academia.

The department continuously reviews and updates its curriculum through feedback from industry partners, academic peers, alumni, and students, ensuring that its graduates remain relevant, competitive, and equipped to contribute meaningfully to India's manufacturing sector, energy future, and the global engineering community.

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1. Institutional Vision & Mission

1.1 Vision:

To create a flexible and learner-focused engineering ecosystem that builds strong technical skills, practical knowledge, and innovative thinking, preparing graduates to adapt, perform, and lead in a rapidly evolving technological and societal environment.

1.2 Mission:

To provide a holistic learning environment that develops technical skilled, innovative, and socially responsible engineers capable of addressing industrial, technological, and societal needs.

2. Departmental Vision Mission

2.1 Vision:

Impart outcome-based education to engrave mechanical engineers having a successful future with productive capabilities and progressive/innovative approach to meet the social and economical needs of society.

2.2 Mission:

To sensitize mechanical engineering students for a conquering profession/future with the subjective information of diverse technical components through vital mechanical engineering abilities with the superb mindset and fruitful teamwork with the aid of making them able to think out of the box using the state of the art laboratory facilities and resources.

3. Program Educational Objectives

PEO 1:
To develop graduates with advanced knowledge and technical expertise in thermal engineering, enabling them to analyze, design, optimize, and manage thermal and energy systems for industrial and societal applications.

PEO 2:
To equip graduates with research, innovation, and problem-solving skills for addressing complex engineering challenges related to heat transfer, fluid mechanics, energy conversion, refrigeration, air conditioning, and sustainable energy technologies.

PEO 3:
To prepare graduates for successful careers in industry, research organizations, academia, consultancy, and entrepreneurship through the effective application of modern engineering tools, computational techniques, and professional practices.

PEO 4:
To foster professional ethics, environmental responsibility, leadership qualities, teamwork, and effective communication skills for contributing to sustainable development and societal welfare.

PEO 5:
To encourage lifelong learning, continuous professional development, and adaptation to emerging technologies and interdisciplinary advancements in thermal engineering and energy systems.

4. Program Details

4.1 Program Structure & Duration

- Duration & Intake : 2 Years & 9 Seats
- Semesters: 4
- Mode: Full Time
- Credit Structure: As per NEP/University norms
- Medium of Instruction: English

4.2 Eligibility Criteria for Admission

Candidates who have passed B.E. / B.Tech in Mechanical / Production / Industrial / Automobile / Manufacturing / Mechatronics Engineering or an equivalent discipline from a recognised university, with a minimum of 50% aggregate marks (45% for reserved category candidates as per applicable norms), shall be eligible for admission to the programme. Candidates holding a valid GATE score in a relevant discipline shall be given preference as per prevailing admission rules.

4.3 Admission Procedure

Admission to the M.Tech Thermal programme may be granted either through the Admission Committee for Professional Courses (ACPC), Government of Gujarat, based on the prevailing postgraduate / GATE admission norms, or through the direct admission process conducted by the University as per applicable rules and eligibility criteria.

4.4. Credit Summary

Component	Credits	Sem I	Sem II	Sem III	Sem IV
Professional Core	23	12	11	0	0
Program Electives (I–IV)	14	4	10	0	0
MLC – Research Methodology & IPR	3	3	0	0	0
Audit Courses	0	0	0	0	0
Dissertation / Internal Review / Seminar	32	0	0	16	16
Total	**72**	**19**	**21**	**16**	**16**

Definition of Credit (as per UGC):

- 1 Hour Lecture (L) per Week = 1 Credit
- 1 Hour Tutorial (T) per Week = 1 Credit
- 2 Hours Practical / Lab / Fieldwork per Week = 1 Credit

5. Curriculum Structure

GANDHINAGAR UNIVERSITY

Gandhinagar Institute of Technology (01)

Program Name: Masters of Technology (02) | **Branch Name (Code): Thermal (09)**

Semester / Year : First Year / Semeter I | **Effective From Academic Year:2025-26**

NCrF LEVEL	Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
					L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
NCR - 6.5	10080109	Professional Core	Applied Mathematics for Engineers	4	4	0	0	4	60	40	0	0	100
	10090101	Professional Core	Advanced Therodynamics & Heat Transfer	4	3	0	2	5	60	40	30	20	150
	10090102	Professional Core	Advanced Fluid Mechanics	4	3	0	2	5	60	40	30	20	150
	10000152	Audit	Disaster Management	0	2	0	0	2	0	50	0	0	50
	10000151	MLC	Research Methodology and IPR	3	1	1	2	4	0	0	80	20	100
		Program Elective-I	Elective-I	4	3	0	2	5	60	40	30	20	150
				19	**16**	**1**	**8**	**25**					**700**

	Elective-I						
	10090111	Program Elective-I	Advanced Refrigeration				
	10090112	Program Elective-I	Combustion Engineering				
	10090113	Program Elective-I	Cryogenics Engineering				

Program Name: Masters of Technology (02) | **Branch Name (Code): Thermal (09)**

Semester / Year : First Year / Semeter II | **Effective From Academic Year:2025-26**

NCrF LEVEL	Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
					L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
NCR - 6.5	10000251	MLC	Technical Writing	0	2	0	0	2	0	50	0	0	50
	10090201	Professional Core	Design of Heat Exchanger	4	3	0	2	5	60	40	30	20	150
	10090209	Professional Core	Research Review and Seminar	3	0	0	6	6	0	0	100	0	100
	10090202	Professional Core	Energy Management in Thermal System	4	4	0	0	4	60	40	0	0	100
		Program Elective-II	Elective-II	4	3	0	2	5	60	40	30	20	150
		Program Elective-III	Elective-III	4	3	0	2	5	60	40	30	20	150
		Program Elective-IV	Elective-IV	2	2	0	0	2	60	40	0	0	100
			Total	**21**	**17**	**0**	**12**	**29**					**800**

Elective-II			Elective-III			Elective-IV		
10090211	Elective-II	Adavance Internal Combustion Engine	10090221	Program Elective-III	Advance Air-Conditioning	10080231	Program Elective-IV	Cost Management of Engineering Projects
10090212	Elective-II	Computational Fluid Dynamics	10090222	Program Elective-III	Solar Energy Engineering	10080232	Program Elective-IV	Industrial Safety
10090213	Elective-II	Design and Optimization of Thermal Systems	10090223	Program Elective-III	Advanced Thermal Turbo Machines	10080233	Program Elective-IV	Composite Materials

Gandhinagar Institute of Technology (01)

Institute Name (Code): Gandhinagar Institute of Technology (01)	**G U - 4th Batch - Year - 2025 - 26**
Program Name: Masters of Technology (02)	**Branch Name (Code): Thermal (09)**
Semester / Year : Second Year / Semeter III	**Effective in Academic Year - 2026 - 27 (July - Dec)**

NCrF LEVEL	Subject Code	Course Type	Subject Name	Credit	Blende With	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
						L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
NCF - 7.0	10090301	Internal Review	Internal Review - I	2		0	0	4	4	0	0	100	0	100
	10090302	Dissertation Phase	Dissertation Phase - I	14		0	0	28	28	0	0	100	0	100
			Total	**16**		**0**	**0**	**32**	**32**					**200**

Institute Name (Code): Gandhinagar Institute of Technology (01)	**G U - 4th Batch - Year - 2025 - 26**
Program Name: Masters of Technology (02)	**Branch Name (Code): Thermal (09)**
Semester / Year : Second Year / Semeter IV	**Effective in Academic Year - 2026 - 27 (July - Dec)**

NCrF LEVEL	Subject Code	Course Type	Subject Name	Credit	Blende With	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
						L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
NCF - 7.0	10090401	Internal Review	Internal Review - II	2		0	0	4	4	0	0	100	0	100
	10090402	Dissertation Phase	Dissertation Phase - II	14		0	0	28	28	0	0	100	0	100
			Total	**16**		**0**	**0**	**32**	**32**					**200**

1st Sem	700	**3rd Sem**	200
2nd Sem	800	**4th Sem**	200

Total Credit:	**72**
Total Marks:	**1900**

6. Teaching, Learning & Evaluation

6.1 Teaching Methodology

The M.Tech. Thermal Engineering programme adopts an outcome-based, student-centric, and research-oriented teaching methodology aligned with NEP 2020. The curriculum integrates interactive lectures, laboratory experiments, case studies, seminars, and project-based learning to strengthen conceptual understanding and practical skills. Advanced simulation tools such as CFD, ANSYS, and MATLAB are used for modeling and analysis of thermal systems. Research activities, dissertation work, and technical presentations foster innovation and critical thinking. Industry interaction through expert talks, internships, and industrial visits provides real-world exposure. Continuous assessment, blended learning, and interdisciplinary approaches ensure the development of competent and industry-ready thermal engineering professionals.

6.2 Attendance Rules

- Minimum 75% attendance shall be mandatory in each course.
- Students below prescribed attendance may not be permitted to appear in examination.
- Additional attendance requirements may apply for practicals, seminars, and dissertation work.

6.3 Examination and Evaluation System

6.3.1 Evaluation Components The evaluation may consist of Continuous Internal Evaluation (CIE) and End Semester Examination (ESE). CIE may include: Mid-Semester Examination · Assignments · Presentations · Software/Lab Work · Class Test · AI Quiz & Viva Voce · Seminar · Dissertation Review.

6.4 Weightage

- Continuous Internal Evaluation: 40%
- End Semester Examination: 60%

6.5 Passing Standards

A student shall be declared to have successfully passed a course subject to fulfilling the minimum passing criteria prescribed by the University from time to time. The passing criteria for the M.Tech Thermal programme shall generally include:

- Minimum 40% marks in the End Semester Examination (ESE) where applicable.
- Minimum 50% aggregate marks considering all evaluation components including continuous internal evaluation and end semester examination.
- Separate passing criteria may be applicable for theory, practical, laboratory, seminar, and dissertation components as prescribed by the University.

Students must fulfil all academic, practical, attendance, and evaluation requirements for successful completion of the course and the programme. The University reserves the right to revise the evaluation and passing criteria from time to time as per academic regulations and statutory guidelines.

6.6 Grading System

The program shall follow Gandhinagar University grading norms.

6.6.1 Grade Table

Grade	Grade Points	From Marks	To Marks
AA	10	80	100
AB	9	75	79
BB	8	70	74
BC	7	65	69
CC	6	60	64
CD	5	55	59
DD	4	50	54
FF	0	0	49

6.7 Dissertation / Project Work

The dissertation is the principal component of the M.Tech Thermal programme, spanning

Semesters III and IV through Internal Review and Dissertation Phases I and II. Requirements may include: Proposal Presentation · Periodic Review (Internal Review I & II) · Final Report Submission · Viva Voce Examination. The dissertation shall be evaluated by internal and external examiners. Students are encouraged to align their dissertation with current research problems, industry challenges, or publishable work in Thermal and allied computational design and manufacturing domains.

7. Rules and Regulations

7.1 Rules for Promotion

A student enrolled in the M.Tech Thermal programme shall be promoted to the subsequent semester in accordance with the academic regulations and promotion rules prescribed by the University from time to time, subject to fulfilment of minimum attendance requirements, academic performance criteria, and completion of prescribed credits.

7.2 Maximum Duration for Completion

The maximum duration for completion of the M.Tech Thermal programme shall be four academic years from the date of admission, or as prescribed by the University and applicable regulatory authorities from time to time.

7.3 Internship / Research Engagement Guidelines

Students are encouraged to undertake research internships, industry-oriented dissertation work, or experiential learning activities relevant to Thermal Engineering and Energy Systems. Such engagements may be carried out in:

- Power Generation Industries
- HVAC and Refrigeration Industries
- Renewable Energy Organizations
- Oil and Gas Industries
- Manufacturing and Process Industries
- Automobile and Aerospace Industries
- Energy Consulting and Energy Audit Organizations
- Research and Development Organizations

- Government and Public Sector Undertakings
- MSMEs and Industrial Plants
- Thermal Equipment and Energy Management Companies

Students may be required to submit:

- Internship / Research Report
- Work Diary / Logbook
- Completion Certificate
- Presentation / Viva Voce
- Project or Dissertation-Linked Report, wherever applicable

These activities provide practical exposure to industrial practices, thermal system design and analysis, energy management, sustainability initiatives, and emerging technologies. Such experiential learning enhances technical competence, research aptitude, problem-solving skills, professional ethics, and industry readiness, thereby strengthening career opportunities in Thermal Engineering, Energy Engineering, research organizations, and allied sectors.

7.4 Discipline Rules

Students shall maintain discipline, professional ethics, safety standards, and proper conduct within the institution, laboratories, industrial visits, internships, examinations, technical events, and all academic activities associated with the programme.

Students are expected to: attend classes, laboratories, and seminars regularly; follow institutional rules, regulations, and safety practices; respect faculty members, staff, fellow students, and institutional property; maintain academic honesty and integrity in assignments, projects, practical work, dissertation, and examinations; and properly use laboratory equipment, software, machines, and computing facilities.

Any form of misconduct, indiscipline, ragging, use of unfair means in examinations, plagiarism in dissertation work, damage to institutional property, harassment, or unsafe laboratory practices shall be treated seriously and may result in disciplinary action including warning, suspension, cancellation of examination, withholding of results, or expulsion from the programme as per University rules, AICTE norms, and UGC regulations.

7.5 Anti-Ragging Policy

The programme shall strictly comply with: UGC Anti-Ragging Regulations · AICTE Anti-Ragging Guidelines · Anti-Ragging Affidavit requirements · Institutional disciplinary procedures. Ragging in any form is strictly prohibited and shall invite strict disciplinary action as per applicable regulations.

7.6 Ethical Use of Technology and AI Tools

Students are encouraged to effectively utilize modern engineering software, simulation platforms, and AI-based technologies for thermal system design, analysis, research, and innovation. Students may use:

- CFD and Thermal Simulation Software
- Heat Transfer and Fluid Flow Analysis Tools
- ANSYS, MATLAB, and Engineering Computing Platforms
- Energy Modelling and Optimization Software
- Programming and Data Analysis Tools
- AI-Based Learning and Research Platforms
- Data Analytics and Visualization Tools
- Digital Energy Management Systems
- Virtual Laboratories and Online Learning Platforms
- Renewable Energy and HVAC Design Software

The use of AI tools and digital technologies shall be ethical, responsible, and aligned with academic integrity. Students shall not engage in plagiarism, unauthorized copying, fabrication or manipulation of data, or misuse of AI-generated content in academic submissions, laboratory work, projects, examinations, research publications, dissertations, or other scholarly activities. The department shall promote the responsible use of digital technologies to enhance learning, research quality, innovation, and professional competence while upholding the highest standards of academic and research ethics.

8. Student Support

8.1 Industry Collaboration

The department shall actively promote collaboration with power generation industries, HVAC and refrigeration industries, renewable energy companies, oil and gas industries, process and manufacturing industries, automobile and aerospace sectors, energy consulting firms, research institutions, MSMEs, public sector undertakings, and professional engineering bodies to enhance practical exposure and industry relevance of the M.Tech. Thermal Engineering programme. Such collaborations may include industrial internships, plant visits, energy audits, expert lectures, live industry projects, consultancy assignments, joint research and innovation activities, skill development programmes, entrepreneurship support, and placement initiatives.

The institution may establish MoUs with industries, energy organizations, and research institutions for collaborative research, technology transfer, sustainable energy solutions, thermal system optimization, and industry-oriented learning. These initiatives will strengthen students' technical competencies, research capabilities, and professional skills while ensuring alignment with emerging trends and requirements in thermal engineering and energy sectors.

8.2 Research and Consultancy

The department shall encourage faculty and students to engage in research, innovation, consultancy, and technology development related to thermal engineering, energy systems, heat transfer, fluid mechanics, refrigeration and air conditioning, power generation, renewable energy, combustion, and emerging sustainable energy technologies. Students may undertake research and innovation projects, thermal system design and optimization, energy audits, CFD simulation and modelling studies, experimental investigations, and industry-oriented technical problem-solving activities.

The institution may undertake consultancy in thermal system design, energy management, HVAC and refrigeration systems, power plant performance analysis, renewable energy applications, thermal equipment optimization, and energy efficiency improvement.

Participation in conferences, technical competitions, publications, funded research projects, patents, technology transfer activities, and incubation initiatives shall be encouraged to promote innovation, entrepreneurship, and professional excellence in the field of thermal engineering.

8.3 Library and Laboratory Facilities

Adequate library, laboratory, computing, and digital learning facilities shall be made available to support teaching, practical training, research, and skill development in Thermal Engineering. The department shall facilitate access to engineering textbooks and reference books, national and international journals, research publications and e-resources, standards and technical databases, digital learning platforms, and virtual laboratories related to thermal sciences and energy systems.

The department shall provide access to advanced thermal engineering laboratories, including heat transfer, fluid mechanics, refrigeration and air conditioning, thermal engineering, renewable energy, and energy management laboratories. Modern simulation and analysis tools such as CFD, ANSYS, MATLAB, thermal system modelling software, and energy analysis packages shall be made available for academic and research purposes. Necessary computing facilities, high-performance workstations, experimental test rigs, thermal measurement instruments, data acquisition systems, and software licenses required for project work, research activities, and dissertation-based learning shall be provided to support innovation, industry-oriented training, and advanced research in Thermal Engineering.

8.4 Student Support and Mentoring

A structured system for student support, academic mentoring, and professional guidance shall be implemented to facilitate the holistic development of students enrolled in the M.Tech. Thermal Engineering programme. The department shall provide academic counselling and mentoring, career and higher education guidance, technical skill development, research and innovation support, entrepreneurship guidance, and professional development initiatives related to thermal engineering and energy systems.

Students shall be encouraged to interact with industry experts, researchers, and academicians and participate in workshops, seminars, conferences, industrial visits, power plant visits, energy audit activities, technical competitions, and innovation challenges. Such activities will enhance their technical competence, research aptitude, problem-solving abilities, employability, leadership qualities, communication skills, teamwork, and professional ethics. The department shall also support students in pursuing research publications, patents, funded projects, internships, certifications, and entrepreneurial ventures, thereby preparing them for successful careers in industry, research organizations, academia, and emerging technology sectors.

8.5 Placement and Career Development

The department shall actively promote placement assistance and career development through industry interaction, internships, professional networking, and campus engagement. Efforts shall be made to establish linkages with power generation industries, HVAC and refrigeration companies, renewable energy organizations, manufacturing industries, automobile and aerospace sectors, oil and gas industries, energy consulting firms, research and development organizations, government and public sector undertakings, MSMEs, and startup ecosystems related to energy and thermal technologies.

Career development activities such as aptitude training, resume building, interview preparation, soft-skill development, technical certification programmes, and placement-oriented workshops shall be organized regularly. Students shall be encouraged to participate in industrial training, technical seminars, professional society activities, energy management programmes, and industry-sponsored projects to enhance their employability and professional competence. These initiatives will support successful career opportunities in industry, research organizations, consultancy, entrepreneurship, and higher education within the field of Thermal Engineering.

9. Program Credibility

9.1 Executive Summary

The M.Tech. Thermal Engineering programme is designed in alignment with NEP 2020 to provide advanced knowledge, research skills, and industry-oriented competencies in thermal sciences and energy systems. The curriculum integrates modern simulation tools, laboratory experimentation, industrial training, research projects, and multidisciplinary learning to ensure academic excellence and practical relevance. Strong industry interaction, expert guidance, and exposure to emerging technologies enhance employability and professional growth. The programme addresses current industry demands in energy, HVAC, manufacturing, renewable energy, and power sectors, preparing graduates for leadership roles in industry, research organizations, academia, consultancy, and doctoral studies.

9.2 Scope and Career Opportunities

M.Tech. Thermal Engineering offers excellent career opportunities in power generation, renewable energy, HVAC, refrigeration and air conditioning, manufacturing, automobile, aerospace, oil and gas, and process industries. Graduates can work as Thermal Engineers, Energy Engineers, HVAC Design Engineers, CFD Analysts, Research Engineers, Project Managers, Energy Auditors, and Consultants in public and private organizations. The increasing focus on energy efficiency, sustainability, renewable energy systems, and advanced thermal technologies has significantly enhanced the demand for skilled thermal engineering professionals. The programme also provides a strong foundation for research, entrepreneurship, higher education, and doctoral studies in specialized areas of thermal engineering.

9.3 Potential Job Roles

Graduates of M.Tech. Thermal Engineering can pursue diverse and rewarding career opportunities across industries and research organizations. Potential job roles include Thermal Engineer, Energy Engineer, HVAC Design Engineer, CFD Analyst, Heat Transfer Specialist, Refrigeration and Air Conditioning Engineer, Power Plant Engineer, Renewable Energy Engineer, Research and Development Engineer, Project Engineer, Energy Auditor, Maintenance Engineer, Process Engineer, and Technical Consultant. Opportunities are

available in power generation, manufacturing, automobile, aerospace, oil and gas, renewable energy, and process industries. Graduates may also work as faculty members, research associates, or pursue doctoral studies and advanced research in thermal engineering and energy systems.

9.4 Higher Study & Professional Opportunities

M.Tech. Thermal Engineering provides a strong foundation for higher studies, research, and professional advancement. Graduates can pursue Ph.D. programmes in Thermal Engineering, Energy Engineering, Mechanical Engineering, Renewable Energy, Computational Fluid Dynamics (CFD), and related interdisciplinary fields at reputed national and international institutions. Professional opportunities include careers in research and development organizations, academic institutions, government agencies, consultancy firms, and multinational companies. Graduates can also obtain professional certifications in energy management, HVAC design, CFD analysis, and project management. The programme enhances technical expertise, research capabilities, innovation skills, and leadership potential, supporting long-term career growth in engineering and technology sectors.

10. Collaborative Field Work / Experimental Work

The M.Tech. Thermal Engineering programme emphasizes collaborative field work and experimental learning to bridge the gap between theoretical knowledge and industrial practice. Students work in teams to conduct laboratory experiments, industrial case studies, field investigations, and research projects related to heat transfer, fluid flow, thermal system design, refrigeration and air conditioning, power generation, renewable energy systems, and energy management.

Field work includes industrial visits, energy audits, performance evaluation of thermal equipment, HVAC system assessment, and interaction with industry experts. Experimental work involves the use of advanced laboratories and software tools for thermal analysis, CFD simulations, combustion studies, heat exchanger performance testing, and renewable energy applications. Collaborative projects encourage interdisciplinary learning, teamwork, problem-solving, and innovation while addressing real-world engineering challenges.

These activities enhance technical competence, research aptitude, communication skills, and practical understanding of modern thermal engineering systems. The experience gained through collaborative field and experimental work prepares students for professional practice, research, consultancy, and leadership roles in industry and academia.

11. Market Survey

11.1 Executive Summary

The M.Tech. in Thermal Engineering is a specialized postgraduate programme designed to develop advanced knowledge and research capabilities in thermal sciences, heat transfer, fluid mechanics, energy systems, refrigeration and air conditioning, and renewable energy technologies. Aligned with the vision of NEP 2020, the programme emphasizes outcome-based education, multidisciplinary learning, innovation, sustainability, and industry relevance.

The curriculum integrates advanced theoretical concepts with practical laboratory work, computational modeling, simulation tools, research projects, and industrial exposure. It aims to equip students with the technical expertise required to address contemporary challenges in energy efficiency, thermal system optimization, sustainable energy utilization, and environmental conservation.

The programme responds to the growing demand for skilled thermal engineers in sectors such as power generation, renewable energy, HVAC, manufacturing, automobile, aerospace, oil and gas, and process industries. Industry feedback highlights the need for competencies in advanced simulation tools, data analysis, energy management, research, and problem-solving, which are effectively addressed through the curriculum.

Graduates are prepared for careers in industry, research and development organizations, consultancy, academia, and doctoral studies. Through a combination of advanced technical education, research orientation, industry collaboration, and professional skill development, the programme aims to produce competent, innovative, and socially responsible thermal engineering professionals capable of contributing to technological advancement and sustainable development.

11.2 Market Demand & Industry Trends

The demand for Thermal Engineering professionals is growing due to rapid industrialization, increasing energy requirements, and the global emphasis on energy efficiency and

sustainability. Industries such as power generation, renewable energy, HVAC, refrigeration and air conditioning, oil and gas, manufacturing, automobile, aerospace, and process engineering require skilled thermal engineers for design, analysis, optimization, and maintenance of thermal systems.

Current industry trends include the adoption of renewable energy technologies, waste heat recovery systems, energy conservation practices, green building solutions, smart HVAC systems, and decarbonization initiatives. The increasing use of computational tools such as CFD, digital twins, artificial intelligence, and data-driven optimization in thermal system design and operation is creating new opportunities for thermal engineering professionals.

There is also a growing demand for expertise in sustainable energy systems, hydrogen energy technologies, electric vehicle thermal management, advanced refrigeration systems, and Industry 4.0-enabled energy management solutions. Consequently, graduates with advanced technical knowledge, simulation skills, research capabilities, and an understanding of emerging technologies are highly valued by industry, research organizations, and academic institutions.

11.3 Skill Gap Identified by Industry

Industry feedback indicates that while graduates possess strong theoretical knowledge, there is a need for enhanced practical and interdisciplinary skills. Key skill gaps identified include proficiency in advanced simulation and modeling tools such as CFD, ANSYS, MATLAB, and thermal system design software; data analysis and optimization techniques; and application of Industry 4.0 concepts in energy and thermal systems. Industries also emphasize the need for stronger research and innovation capabilities, problem-solving skills, project management, and the ability to work on multidisciplinary engineering challenges.

Additionally, employers seek improved communication, technical report writing, presentation, teamwork, and leadership skills. Knowledge of renewable energy technologies, energy management, sustainability practices, and emerging thermal technologies is increasingly important. The M.Tech. Thermal Engineering programme addresses these gaps through industry-oriented projects, laboratory training, internships, research activities, expert lectures, and exposure to modern engineering tools and practices, ensuring graduates are well

prepared for professional and research careers.

11.4 Employment Opportunities & Industry Support

The M.Tech Thermal Engineering programme prepares graduates for diverse career opportunities in industries related to energy, power generation, manufacturing, HVAC, refrigeration and air conditioning, oil and gas, renewable energy, automobile, aerospace, and process engineering. Graduates can work as Thermal Engineers, Energy Analysts, HVAC Design Engineers, CFD Analysts, Research Engineers, Project Engineers, Energy Auditors, and Consultants in public and private sector organizations. They can also pursue careers in research and development, higher education, and doctoral studies.

The programme is strengthened through industry support in the form of expert lectures, industrial visits, internships, collaborative projects, and consultancy activities. Partnerships with industries provide exposure to emerging technologies, real-world engineering challenges, and current industrial practices. Training in advanced simulation and design tools, along with industry-oriented projects, enhances employability and professional competence. Continuous interaction with industry experts ensures that the curriculum remains relevant to evolving technological advancements and workforce requirements, enabling graduates to contribute effectively to sustainable energy solutions and thermal system innovations.

12. Review and Revision of Regulation

The University reserves the right to interpret, modify, revise, amend, or update any provision, rule, regulation, curriculum structure, evaluation pattern, academic requirement, or operational guideline related to the M.Tech Thermal programme from time to time in accordance with University regulations, statutory requirements, technological advancements, industry needs, and academic developments.

In case of any ambiguity or dispute regarding interpretation of any provision of this manual, the decision of the University or Competent Authority shall be final and binding on all stakeholders. Any amendments, additions, or revisions approved by the appropriate academic or statutory bodies of the University shall automatically become applicable to the programme.

Annexure I: Detail Syllabus

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M. TECH. 1st SEMESTER

COMPUTER ENGINEERING (SOFTWARE ENGINEERING)
MECHANICAL ENGINEERING (THERMAL ENGINEERING/CAD-CAM)

DOC NO: 4061

Subject Code: 10000151	**Subject Title:** Research Methodology and IPR
Pre-requisite: Nil	

Course Objective:

- To give an overview of the research methodology and explain the technique of defining a research problem.
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
1	1	2	3	0	0	80	20	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	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	5	17
2	Effective literature studies approaches, analysis Plagiarism, Research ethics,	4	15
3	Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	5	17
4	Nature of Intellectual Property: 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.	5	17


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5	Nature of Intellectual Property: 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.	5	17
6	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	5	17

Course Outcome: After completion of this course, student will be able to

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

List of References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2 nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall , "Industrial Design", McGraw Hill, 1992.
6. Niebel , "Product Design", McGraw Hill, 1974
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Open e-Resource:

1. NPTEL: https://onlinecourses.nptel.ac.in/noc19_ge21/preview
2. NPTEL: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 1st SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING / CAD-CAM)

DOC NO: 4061

Subject Code: 10000152	Subject Title: Disaster Management (Audit Course)
Pre-requisite: Zeal to learn	

Course Objective:

- To provide basic conceptual understanding of disasters.
- To understand approaches of Disaster Management.
- To build skills to respond to disasters.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
2	0	0	0	00	50	00	00	50

Subject Contents			
Sr. No	Topic	Total Hours	Weight (%)
1	**Introduction** Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude	4	17
2	**Repercussions Of Disasters and Hazards**: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts	5	17
3	**Disaster Prone Areas in India Study of Seismic Zones**; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post Disaster Diseases and Epidemics	5	17
4	**Disaster Preparedness and Management Preparedness**: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application	5	17

	of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness		
5	**Risk Assessment Disaster Risk**: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.	5	16
6	**Disaster Mitigation:** Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Nonstructural Mitigation, Programs of Disaster Mitigation in India.	4	16

Course Outcome: After completion of this course, student will be able to

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

List of References:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Open e-Resource:

1. https://nptel.ac.in/courses/105104183

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 1st SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING / CAD-CAM)

DOC NO: 4061

Subject Code: 10080109	Subject Title: Applied Mathematics for Engineers (Core-1)
Pre-requisite:- Basic Mathematics	

Course Objective:

- Enrich the knowledge in various advanced mathematical techniques.
- Fundamental concepts for model the engineering problems.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
4	0	0	4	60	40	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1.	**Matrix Theory:** The Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization - Least squares method - Singular value decomposition.	13	25
2.	**Calculus of Variations:** Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functional dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz and Kantorovich methods.	12	23
3.	**Probability and Random Variables:** Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.	13	25
4.	**Laplace Transform Techniques for Partial Differential Equations:** Laplace transform - Definitions - Properties – Transform error function - Bessel's function - Dirac delta function - Unit step functions – Convolution	14	27

	theorem – Inverse Laplace transform: Complex inversion formula – Solutions to partial differential equations: Heat equation - Wave equation.		

Course Outcome: After completion of this course, student will be able to

- Apply various methods in matrix theory to solve systems of linear equations.
- Maximizing and minimizing the functional that occur in various branches of engineering disciplines.
- Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable.
- Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.

List of References:

1. Andrews L.C. and Shivamoggi, B. "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Bronson, R. “Matrix Operations”, Schaum’s outline series, 2nd Edition, McGraw Hill, 2011.
3. James, G., “Advanced Modern Engineering Mathematics ", 3rd Edition, Pearson Education, 2004.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
5. O'Neil, P.V., "Advanced Engineering Mathematics ", Thomson Asia Pvt. Ltd., Singapore, 2003.
6. Sankara Rao, K., “Introduction to Partial Differential Equations”, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

Open e-Resource:

1. https://nptel.ac.in/courses/111102133

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 1st SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090101	**Subject Title: Advance Thermodynamics and Heat Transfer (Core-2)**
Pre-requisite: - Basic Thermodynamics and Het Transfer	

Course Objective:

- Enhance the understanding of thermodynamics principles.
- Experience in applying thermodynamic principles to predict physical phenomena.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Entropy: A Measure of Disorder:** Increases of entropy principle and its application, Tds relation, entropy change of solid, liquid and ideal gas, entropy transfer with heat transfer, entropy generation in open and closed system, entropy balance **Exergy: A Measure of Work Potential:** Exergy transfer by heat, work & mass, decrease of exergy principle and exergy destruction, applications of Gouy–Stodola theorem, exergy balance for steady flow and closed processes, second law efficiency Law of Corresponding States	11	25
2	**Conduction:** Conduction Rate Equation, Heat Diffusion Equation, Boundary and Initial Conditions, General conduction Equation, Conduction with Heat Generation, Extended Surfaces with Uniform and Non-Uniform Cross Sections, Two-Dimensional Steady State Conduction: Mathematical, Graphical and Numerical Analysis of Two-Dimensional Heat Conduction Unsteady State Conduction: Lumped Parameter Analysis, Numerical Solutions, Heisler and Semi Analytical Analysis	12	28

3	**Convection:** Different Types of Flow and Boundary Layers, Flow Through Tubes, Flow Over Flat Plates, Cylinders, Spheres and Tube Blanks, Free Convection on Flat Surfaces, Cylinders, Spheres and Enclosed Spaces **Heat Transfer during Phase Transformation:** Boiling: Pool Boiling and its Correlations, Forced Convection Boiling, Condensation: Laminar and Turbulent Film Condensation, Film Condensation in Radial Surfaces and Horizontal Tubes, Heat Pipe	12	28
4	**Radiation:** Radiation Intensity, Blackbody Radiation, Emission from Real Surfaces Radiation Combine with Conduction and Convection, Radiation Exchange with Participating Media, Radiative exchange and overall heat transfer in furnaces	**7**	19

Course Outcome: After completion of this course, student will be able to

- Apply entropy principle to various thermal engineering applications
- Apply the concept of second law efficiency and exergy principle to various thermal engineering applications
- Analyze steady state and transient heat conduction problems of real-life thermal systems
- Analyze extended surface heat transfer problems and problems of phase change heat transfer like boiling and condensation
- Analyze radiation heat transfer problems of various thermal systems
- Use of software (like EES) for solving thermodynamic and heat transfer problems

List of References:

1. Thermodynamics – An Engineering Approach by Yunus Cengel & Boles, McGraw-Hill Publication, New Delhi
2. Fundamentals of Thermodynamics by Sonntag, Borgnakke & Van Wylen, John Wiley & Sons (Asia) Pvt. Ltd
3. Engineering Thermodynamics by P.K. Nag, McGraw-Hill , New Delhi
4. Fundamentals of Heat and Mass Transfer, by Incropera, Dewitt, John Wiley & Sons (Asia) Pvt. Ltd
5. Heat Transfer by J P Holman, McGraw-Hill Publication, New Delhi
6. A Heat Transfer Textbook by J H Lienhard, Phlogiston Press

Open e-Resource:

1. https://nptel.ac.in/courses/112103313

List of Suggested Tutorials:

1. Conduction heat transfer in composite wall.
2. Conduction heat transfer in metal rod.
3. Conduction heat transfer in through insulating powder.
4. Conduction heat transfer from a Pin fin.
5. Convection heat transfer in forced convection.
6. To study unsteady state heat transfer by the lumped capacitance
7. To study of heat transfer in the process of condensation.
8. To determine the value of Stefan Boltzmann constant for radiation heat transfer.
9. To measure the emissivity of test plate.
10. To study the pool boiling phenomena and measure the critical heat flux.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 1st SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090102	**Subject Title: Advanced Fluid Mechanics (Core-3)**
Pre-requisite: - Fluid Mechanics and Heat Transfer	

Course Objective:

- To understand fluid properties.
- To identify governing equations of fluid flow in differential form.
- To understand dynamics of ideal fluid motion.
- To apply Reynolds number approximation of Navier – stokes equation in practical application.
- To understand high Reynolds number approximation.
- To understand one dimensional isentropic flow.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Review of Basic Concepts and Fluid Properties:** Basic law of Fluid Motion, Internal stresses and external forces on fluid elements, Review of Concepts of Kinematics of fluid motion, Vorticity, Circulation, Velocity potential and stream function, Irrotational flow.	4	10
2	**Governing Equations of Fluid Flow in Differential Form:** Navier – Stokes Equation and exact solutions, Energy equation and solution of fluid flow with thermal effects.	3	6
3	**Dynamics of Ideal Fluid Motion:** Applications, Integrations of Euler's Equation of Motion, Generalized form of Bernoulli Equation, Potential flows, Principle of Superposition.	4	10
4	**Low Reynolds number Approximation of Navier – Stokes Equation:**	3	6

	Creeping flow over sphere, Stokes and Oseen approximation, Hydrodynamic Theory of Lubrication.		
5	**High Reynolds number Approximation:** Prandtl's Boundary Layer Equations, Laminar Boundary Layer over a flat plat, Blausius solution, Falkner – Skan solution, Approximation method for solution of Boundary Layer Equation, Momentum Integral methods, Holstein and Bohlen method, Thermal Boundary Layer, Reynolds Analogy.	5	12
6	**Transition to Turbulence:** Introduction to Theory of Hydrodynamic Stability, Orr-Sommerfeld equation, Results from transition studies, Factor affecting transition and its control.	4	10
7	**Fundamental of Turbulent flows:** Reynolds stress tensor, Phenomenological theories of turbulence, Prandtl's mixing length and Eddy viscosity concepts, Universal velocity distribution, Laws of the wall and the wake.	5	12
8	**One Dimensional Isentropic Flow:** General features, Working equations, Choking in isentropic flow, Operation of nozzle, Diffuser under varying pressure ratio, Performance of real nozzles, Applications of isentropic flow.	5	12
9	**Normal Shocks:** Introductory remarks, Governing equations, Rankine Hugoniot, Prandtl and other relations, Weak shocks, Thickness of shocks, Normal shocks in ducts, Performance of convergent divergent nozzle with shocks, Moving shock waves, Shocks problems in one dimensional supersonic diffuser, Supersonic pilot tube.	5	12
10	**Flow in constant area duct with friction:** Governing equations, Working formulas and tables, Choking due to friction, Performance of long duct, Isothermal flow in long duct and flow in constant area duct with heating and cooling.	4	10

Course Outcome: After completion of this course, student will be able to

- Apply the fundamentals of kinematics and conservation laws of fluid flow systems.
- Apply the principles of high and low Reynolds number flows to fluid flow systems.
- Review the concepts of boundary layer and flow in transition.
- Analyse and apply the fundamentals of turbulent flow to various fluid flow systems.
- Apply the fundamentals of one-dimensional isentropic flow to variable area duct.
- Analyse the principles of normal shock formation and its effects.
- Apply the principles of compressible flow to constant area duct subjected to friction or heat transfer.

List of References:

1. Yunus Cengel and John Cimbala, Fluid Mechanics, McGraw Hill Publishing Co. Ltd.
2. F M White, Viscous Fluid Flow, McGraw Hill Publishing Co. Ltd.
3. H Schlichting, Boundary Layer Theory, McGraw Hill Publishing Co. Ltd.
4. Yunus Cengel and John Cimbala, Fluid Mechanics, McGraw Hill Publishing Co. Ltd.
5. F M White, Viscous Fluid Flow, McGraw Hill Publishing Co. Ltd.
6. H Schlichting, Boundary Layer Theory, McGraw Hill Publishing Co. Ltd.
7. F M White, Fluid Mechanics, McGraw Hill Publishing Co. Ltd.
8. Fox, Pritchard and McDonald, Introduction to Fluid Mechanics, John Wiley & Sons.
9. Zucker & Biblarz, Fundamentals of Gas Dynamics, John Wiley & Sons, Inc.
10. James John and Theo Keith, Gas Dynamics, Pearson Prentice Hall.
11. S M Yahya, Fundamentals of Compressible Flow, New Age International Publishers.
12. J D Anderson, Computational Fluid Dynamics, McGraw Hill Publishing Co. Ltd.

Open e-Resource:

1. https://nptel.ac.in/courses/112105218
2. https://onlinecourses.nptel.ac.in/noc22_me102/preview
3. https://onlinecourses.nptel.ac.in/noc22_me127/preview

List of Suggested Experiments:

1. To study the effect of angle of attack on Lift and Drag force
2. To study the loss of energy in wake region behind various models (car, jeep, bus etc.) in the wind tunnel.
3. To draw profile of NACA Aerofoils.
4. To Investigate on Recent development and advances in rarefied gas dynamics.
5. To visualize and plot the pattern of flow around an object in a fluid stream using Hale-Shaw apparatus
6. To develop temperature distribution in thermal boundary layer for the flow over a flat plate.
7. To develop a Gas Table (Isentropic flow, Normal shocks, Fanno flow, Rayleigh flow) for different γ values.
8. A case study: Performance of real nozzle.
9. Derive the solution u (y, z) for flow through an elliptical duct, by solving equation.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 1st SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090111	**Subject Title: Advanced Refrigeration (Program Elective-1)**
Pre-requisite: - Fluid Mechanics, Heat Transfer and Refrigeration	

Course Objective:

- To understand the principle of refrigeration and different types of refrigerants.
- To analyse air and vapour compression refrigeration (VCR) systems.
- To analyse Vapor absorption refrigeration systems.
- To understand the factors to be considered for cooling load calculations.
- To study various components of the refrigeration system.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Refrigerants:** Eco-friendly refrigerants & their properties, secondary Refrigerants, mixture of refrigerants, azeotropic, salient characteristics of various refrigerants, CFC/HCFC phase-out regulations, Montreal and Kyoto Protocols, synthetic lubricating oil & their properties.	4	10
2	**Air Cycle Refrigeration:** Aircraft refrigeration systems – simple, boot-strap, regenerative and reduced ambient, analysis of an aircraft refrigeration cycles and their applications, calculations of COP of the systems.	6	14
3	**Vapour Compression Refrigeration:** Balancing of vapour compression refrigeration system, dual pressure vapour compression system and its analysis, compound compression with flash cooler and flash intercooler, multiple expansions, parallel operation,	12	28

	sectionalizing, booster operations, various types of cascade systems and their analysis.		
4	**Vapour Absorption refrigeration:** Properties of LiBr-H2O and NH3-H2O solutions, analysis of vapour absorption refrigeration systems, heat balance, COP comparison with vapour compression refrigeration systems, two stage vapour absorption refrigeration system, solar driven sorption systems, heat sources for absorption systems	12	28
5	**Load estimation:** Sources of heat generation, insulating materials, design principles of cold storage, milk tankers and blood plasma storage. **Refrigeration Applications:** Refrigeration for preservation of food, refrigerating systems for transport by trucks and containers, Refrigerated railway cars, Marine refrigeration.	4	10
6	**Control Devices:** Thermostatic and automatic expansion valve, side glass, filter dryer etc. **Refrigeration Tubing:** Cutting, flaring, pinching, savaging, soldering etc	4	10

Course Outcome: After completion of this course, student will be able to

- Appraise refrigerants, their properties and applications.
- Discuss different air and vapour compression refrigeration systems and analyze them
- Analyze vapour absorption cycles
- Estimate the refrigeration load and appraise applications of refrigeration
- Discuss various control devices and tubing operations used in refrigeration.

List of References:

1. Refrigeration and air conditioning, C. P. Arora, McGraw Hill
2. ASHRAE Hand Book, (1) Fundamentals (2) Refrigeration
3. 40 Lessons on Refrigeration and Air Conditioning IIT KGP
4. Principles of Refrigeration, R J Dossat, Pearson Education Asia
5. Refrigeration and air conditioning, Stocker, McGraw Hill
6. Refrigeration and air conditioning, Jordan and Priester, McGraw Hill
7. Industrial Refrigeration Handbook, Stoecker, McGraw Hill

Open e-Resource:

1. https://onlinecourses.nptel.ac.in/noc22_me135/preview
2. https://nptel.ac.in/courses/112105128

List of Suggested Experiments:

1. To compare and analyse advanced refrigeration cycles for different refrigerants.
2. Performance and analysis on heat pump system with different working conditions.
3. Performance analysis of VCR system using capillary tube as a throttling device.
4. Performance analysis of VCR system using thermostatic expansion valve as a throttling device.
5. Performance evaluation of cascade refrigeration system.
6. Design of a NH3-H2O vapour absorption refrigeration system for a particular application.
7. Design of a LiBr-H2O vapour absorption refrigeration system for a particular application.
8. To estimate the cooling load of a cold storage.
9. To estimate cooling load and star rating (energy efficiency rating) for any refrigeration application like, domestic refrigerator, deep freezer, water cooler etc.
10. To determine the percentage running time of a domestic refrigerator on a particular thermostat setting.
11. To understand construction and working of an Ice Plant and determine COP of it.
12. To understand various tools used for refrigeration tubing and to perform various operations like flaring, swaging, bending, brazing

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 1st SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090112	**Subject Title: Combustion Engineering (Program Elective-1)**
Pre-requisite: - IC Engine	

Course Objective:

- To understand combustion and thermochemistry.
- To understand the concept of chemical kinetics.
- To understand chemical and thermal systems.
- To apply conservative equations in practical application.
- To understand laminar and turbulent flames.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Combustion and Thermochemistry:** Introduction, Heat of reaction and formation, Free energy and the equilibrium constants, Flame temperature calculations – Analysis & Practical considerations, Sub and supersonic combustion thermodynamics – Comparisons & Stagnation pressure considerations	4	10
2	**Chemical Kinetics:** Introduction, Rates of reactions and their temperature dependence - The Arrhenius rate expression & Transition state and recombination rate theories, Simultaneous interdependent reactions, Chain reactions, Pseudo-first-order reactions and the "fall-off" range, The partial equilibrium assumption, Pressure effect in fractional conversion, Chemical kinetics of large reaction mechanisms – Sensitivity analysis, Rate of production analysis, Coupled thermal and chemical reacting systems & Mechanism simplification	9	21

3	**Chemical and Thermal Systems:** Constant pressure fixed mass reactor, constant volume reactor, well stirred reactor, plug flow reactor, application to combustion system modelling	6	14
4	**Conservative Equations:** Mass conservation, Species mass conservation, Multi component diffusion, momentum conservation, Energy conservation, Conserved Scalar concept	6	14
5	**Laminar Flames:** Laminar premixed flames - Physical description, Simplified analysis, Detailed analysis factors influencing flame velocity and thickness, flame stabilization, ignition Laminar diffusion flames – non reacting constant density laminar jet, jet flame, flame lengths, soot formation and destruction, counter flow flames	9	21
6	**Turbulent Flames:** Applications of turbulent flames, Definition of turbulent flame speed, structure of turbulent premixed flames, wrinkled flame regime, flamelets, flame stabilization, Jet Flames	8	20

Course Outcome: After completion of this course, student will be able to

- To comprehend combustion, types of flames and effect and control of combustion
- To apply the theories of chemical equilibrium
- To mass, momentum and energy conservation to combustion process and make calculations of various reactors
- To apply concepts of laminar premixed and diffusion flames to appropriate reactive systems
- To apply concepts of turbulent flames to appropriate reactive systems.

List of References:

1. An Introduction to Combustion, Concepts and Applications, Stephen R. Turns, McGraw-Hill Education
2. Combustion, Irvin Glassman, Academic Press
3. Combustion Theory, Forman A Williams, Addison-Wesley
4. Combustion Physics, C.K. Law, Cambridge University Press
5. Combustion, Flames and Explosions of Gases, Bernard Lewis and Guenther von Elbe, Academic Press
6. Chemical Kinetics, Keith Laidler, Harper and Row.

Open e-Resource:

1. https://nptel.ac.in/courses/112106290
2. https://onlinecourses.nptel.ac.in/noc21_me47/preview

List of Suggested Experiments:

1. Find the smoke point of different fuels.
2. Find the pour point and cloud point of various lubricants.
3. Test the performance of fuel pump with fuel pump test rig.
4. Study of various spray characteristics of fuel.
5. Study of flame stabilization at different equivalence ratio.
6. Study of laminar premixed flames.
7. Study of turbulent flames.
8. Model different H2/O2 mechanism and find equilibrium temperatures at different equivalence ratios.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 1st SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090113	**Subject Title: Cryogenics Engineering (Program Elective-1)**
Pre-requisite: Basic of Refrigeration	

Course Objective:

- To understand the properties of cryogenic fluids
- To identify best cryogenic insulation as per different working condition.
- To understand the application of cryogenics in various field.
- To understand the different refrigeration cycle used in cryogenic
- To understand the concept of various cryocooler
- To understand the concept of liquification

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Cryogenic:** Properties of engineering materials at cryogenic temperatures, mechanical properties, thermal properties, electric & magnetic properties, super conducting materials, thermo electric materials, composite materials, cryo metallurgy, properties of cryogenic fluids, super fluidity of He3 & He4.	7	16
2	**Cryogenic Insulation:** expanded foams, gas filled & fibrous insulation, vacuum insulation, evacuated powder & fibrous insulation, opacified powder insulation, multilayer insulation, comparison of performance of various insulations	5	14
3	**Applications of Cryogenic Systems**: Super conductive devices such as bearings, motors, cryotrons, magnets, D.C. transformers, tunnel diodes, space technology, space simulation, cryogenics in biology and medicine, food	6	15

	preservation and industrial applications, nuclear propulsions, chemical propulsions		
4	**Cryogenic Refrigeration System**: Ideal isothermal and reversible isobaric source refrigeration cycles, Joule Thomson system, cascade or pre-cooled Joule–Thomson refrigeration systems, expansion engine and cold gas refrigeration systems	7	16
5	**Advanced Cryo coolers**: Philips refrigerators, Importance of regenerator effectiveness for the Philips refrigerators, Gifford single volume refrigerator, Gifford double volume refrigerators analysis, COP, FOM, regenerators, pulse tube refrigerators, various types of pulse tube refrigerator	10	21
6	**Gas Liquefaction Systems:** Introduction, thermodynamically ideal systems, Joule Thomson effect, liquefaction systems such as Linde Hampton, Pre-cooled Linde Hampson, Linde dual pressure, cascade, claude, kapitza, heyland systems using expanders, comparison of liquefaction systems, introduction to cryogenics vessels	7	18

Course Outcome: After completion of this course, student will be able to

- Understand the concept of cryogenic fundamental.
- Learn the requirement and use of proper insulation.
- Understand about the concept of cryocooler and application in various fields.
- Select the proper cryogenic fluid for particular applications like, cryo metallurgy, medical applications etc.
- Learn about the cryogenic refrigerators for different applications

List of References:

1. Cryogenic process engineering, Thomas M Flynn, Informa Health Care
2. Miniature refrigerators for cryogenic sensors and cold electronics, Graham Walker, Clarendon Press
3. Cryogenic technology & applications, A R Jha, Butterworth-Heinemann
4. Cryocooler, Fundamentals Part I &II, Graham Walker, Plenum Press, New York
5. Cryogenic Regenerative Heat Exchangers, R.A. Ackermann, Springer
6. Cryogenic systems, R F Barron, Oxford University Press
7. Cryogenic heat transfer, R F Barron, Taylor & Francis Group

Open e-Resource:

1. https://nptel.ac.in/courses/112101004
2. https://nptel.ac.in/courses/112105128

List of Suggested Experiments:

1. Study of cryogenic properties of hydrogen and helium
2. Study of low temperature measurement instrument
3. Study of flow measurement and quality measurement instrument
4. Study of liquid level measurement
5. Study of insulation used in cryogenic equipment
6. Study of cryogenic application (superconductivity)
7. Study of cryogenic application in space technology
8. Study of cryogenic application in bio medical and food preservation
9. Study of safety while handling fluid
10. Study of ideal liquefaction system

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M. TECH. 2nd SEMESTER

COMPUTER ENGINEERING (SOFTWARE ENGINEERING)

MECHANICAL ENGINEERING (THERMAL ENGINEERING/CAD-CAM)

DOC NO: 4061

Subject Code: 10000251	**Subject Title: Technical Writing (Audit Course)**
Pre-requisite: Basic Language Skills	

Course Objective:

- Technical Writing focuses on planning and preparation of word choices and sentences and focuses on vocabulary building and helps them to be an effective communicator.
- Students will be able to produce a set of documents related to writing in the workplace and will be able to improve their ability to write clearly and accurately.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
2	0	0	0	0	50	0	0	50

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring	4	10
2	Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4	10
3	Sections of a paper – Title, abstract, introduction, etc. review of the literature, writing - methods, results, discussion, conclusions and final check	6	20
4	Organization of technical report: Title, Authors, Affiliation, Abstract,	4	20
5	Three pass reading. Effective communication– Teacher/Student perspective. Listening – Hearing Vs. Listening. Notes Taking. Elevator Pitch. Technical writing.	4	20
6	Useful phrases and punctuation, in-text citation and bibliography– MLA/APA styles	4	20

Course Outcome: After completion of this course, student will be able to

- Understand how to improve your writing skills and level of readability.
- Learn about what to write in each section.

- learn various skills necessary that are necessary for doing research.
- Ensure the good quality of paper at very first-time submission.

List of References:

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press ,2006
3. Raman, Meenakshi and Sangeeta Sharma, "Technical Communication: Principle and Practice", Oxford University Press.
4. Goldbort R. Writing for Science, Yale University Press, 2006

Open e-Resource:

1. https://nptel.ac.in/courses/109107172

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING / CAD-CAM)

DOC NO: 4061

Subject Code: 10080231	**Subject Title: Cost Management of Engineering Projects (Program Elective-4)**
Pre-requisite: Zeal to learn	

Course Objective:

- Establish systems to help streamline the transactions between corporate support departments and the operating units.
- Devise transfer pricing systems to coordinate the buyer-supplier interactions between decentralized organizational operating units.
- Use pseudo profit centers to create profit maximizing behavior in what were formerly cost centers.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
2	0	0	2	60	40	0	0	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	Introduction and Overview of the Strategic Cost Management Process	4	14
2	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making	6	22
3	Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Roleof each member. Importance Project site: Data required with significance.	6	22

	Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process		
4	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraint Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	6	21
5	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	6	21

Course Outcome: After completion of this course, student will be able to

- To understand the cost-volume-profit analysis.
- To understand the project commissioning: mechanical and process.
- To understand quantitative techniques for cost management.

List of References:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd

Open e-Resource:

1. https://nptel.ac.in/courses/105104161/

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING / CAD-CAM)

DOC NO: 4061

Subject Code: 10080232	**Subject Title: : Industrial Safety (Program Elective-4)**
Pre-requisite: Zeal to learn	

Course Objective:

- To provide awareness about safety helps students from any major accidents.
- To provide knowledge of maintenance, its type and application gives better work environments.
- To understand Different maintenance tools and techniques

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
2	0	0	2	60	40	0	0	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Industrial safety:** Accident, causes, types, results and control, mechanical andelectrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment, and methods.	06	19
2	**Fundamentals of maintenance engineering:** Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment	05	16
3	**Wear and Corrosion and their prevention:** Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, generalsketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun,	07	23

	iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods		
4	**Fault tracing:** Fault tracing-concept and importance, decision tree concept, need andapplications, sequence of fault finding activities, show as decision tree, drawdecision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes	06	19
5	**Periodic and preventive maintenance:** Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantagesof preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repaircycle concept and importance	07	23

Course Outcome: After completion of this course, student will be able to

- Understand Importance of Safety and Important related Acts.
- Apply Maintenance techniques as per requirements and able to
- compare for with different technique for better performance.
- Understand wear and corrosion, its causes and remedial actions for
- preventions.
- Demonstrate fault tracing, its methods and application.

List of References:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services
2. Maintenance Engineering, H. P. Garg, S. Chand and Company
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London

Open e-Resource:

1. https://archive.nptel.ac.in/courses/110/105/110105094/
2. https://archive.nptel.ac.in/courses/112/105/112105232/

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING / CAD-CAM)

DOC NO: 4061

Subject Code: 10080233	Subject Title: Composite Materials (Program Elective-4)
Pre-requisite: Zeal to learn	

Course Objective:

- To provide knowledge of classification and characteristics of composite materials.
- To understand manufacturing of metal matrix composites.
- To understand manufacturing of polymer matrix composites.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
2	0	0	2	60	40	0	0	100

Subject Contents			
Sr. No	Topic	Total Hours	Weight (%)
1	**Introduction:** Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance	02	08
2	**Reinforcements:** Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions	06	21
3	**Manufacturing Of Metal Matrix Composites:** Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications.Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, eaving. Properties and applications	06	21
4	**Manufacturing of Polymer Matrix Composites:** Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction	07	25

	injection moulding. Propertiesand applications		
5	**Strength:** Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations	07	25

Course Outcome: After completion of this course, student will be able to

- Understand the laminar failure criteria-strength ratio.
- Understand the compression molding.
- Understand the concept of manufacturing of metal matrix composites.

List of References:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition,
3. Hand Book of Composite Materials-ed-Lubin
4. Composite Materials – K.K.Chawla
5. Composite Materials Science and Applications – Deborah D.L. Chung
6. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi

Open e-Resource:

1. https://nptel.ac.in/courses/112104168

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090201	Subject Title: Design of Heat Exchanger (Core-4)
Pre-requisite: - Fluid Mechanics and Heat Transfer	

Course Objective:

- To familiarity with various types of heat exchangers, their construction, and applications.
- Conventional methods of heat exchanger analysis.
- Synthesis of heat exchanger network.
- To provide in depth knowledge of Design of Heat Exchange equipment.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	Topic	Total Hours	Weight (%)
1	**Basic design methodologies:** Classification of heat exchanger, selection of heat exchanger, Thermal-Hydraulic fundamentals, Overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multipass and cross flow heat exchanger, e-NTU method for heat exchanger analysis, Fouling, Rating and sizing problems, heat exchanger design methodology	6	14
2	**Fouling of heat exchangers:** Basic consideration, effect of fouling on heat transfer and pressure drop, cost of fouling, design of heat exchangers subject to fouling, fouling resistance, cleanliness factor, techniques to control fouling	4	10
3	**Design of double pipe heat exchangers:** Thermal and Hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop	6	14
4	**Design of Shell & tube heat exchangers:** Basic components, basic design procedure of heat exchanger, TEMA code, J-factors, conventional design methods, Bell-Delaware method.	8	20

5	**Design of compact heat exchangers:** Heat transfer enhancement, plate fin heat exchanger, tube fin heat exchanger, heat transfer and pressure drop	6	14
6	**Condensers and evaporators** **Condenser:** Shell and tube condenser, plate condenser, air cooled condenser, direct contact condenser, condenser for refrigeration and air-conditioning, thermal design of shell and tube condenser **Evaporator:** Evaporator for refrigeration and air-conditioning, thermal analysis of evaporator, standards for evaporators and condensers	6	14
7	**Heat transfer enhancement and performance e valuation:** Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique. Introduction to pinch analysis	6	14

Course Outcome: After completion of this course, student will be able to

- Learn how to design common types of heat exchangers; namely shell-and-tube, tube and tube.
- Learn to select appropriate Heat Exchanger for the given application.
- Become aware of single and multiphase heat transfer and friction coefficient correlations, and they will know how to select the appropriate ones for the case in hand
- Understand the effect of Corrosion on performance of heat exchanger.

List of References:

1. Heat Exchanger Selection, Rating and Thermal Design by Sadik, Kakac, CRC Press
2. Fundamentals of Heat Exchanger Design by Ramesh K Shah, Wiley Publication
3. Compact Heat Exchangers by Kays, V.A. and London, A.L., McGraw Hill
4. Heat Exchanger Design Handbook by Kuppan, T, Macel Dekker, CRC Press
5. Heat Exchanger Design Hand Book by Schunder E.U., Hemisphere Pub.
6. Process Heat transfer by Donald Q Kern, McGraw Hill

Open e-Resource:

1. https://nptel.ac.in/courses/112105248

List of Suggested Experiments:

1. Design of heat exchange equipment by using LMTD method.
2. Design of heat exchange equipment by using effectiveness– NTU method.
3. Design and analysis of double pipe heat exchanger with parallel and counter flow arrangement.
4. Design and analysis of shell and tube type heat exchanger.
5. Design and analysis of plate type heat exchanger.

6. Design of evaporator for refrigeration system.
7. Design of condenser for refrigeration system.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090202	**Subject Title: Energy Management in Thermal Systems (Core-5)**
Pre-requisite: Basic of Energy	

Course Objective:

- Basic understanding of energy audit and management Conventional methods of heat exchanger analysis.
- To provide theoretical and practical knowledge of energy conservation, energy management.
- Different approaches of energy conservation in industries, economic aspects of energy conservation project and energy audit.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	1	0	4	60	40	0	0	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Fuel Analysis:** Proximate Analysis, Ultimate Analysis, Calorific Value. Combustion: Theoretical Air Requirement, Efficiency Estimates, Combustion Control, Stability in Flames. **Furnaces:** Classification, Excess Air and Heat Distribution Losses, Temperature Control, Draft Control. **Insulation and Refractory:** Insulation Type and Application, Refractory-Types, Selection and Application of Refractory	10	24
2	**Boilers:** Types, Analysis of Losses, Performance Evaluation, Feed Water Treatment, Blow Down, Energy Conservation Opportunities, AFBC, CFBC, PFBC Boilers, Condensing Boilers, Saving Potential. **Steam System:** Properties of Steam, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System.	12	28

	Cogeneration: Need, Applications, Advantages, Topping Cycles, Bottoming Cycles, Combined Cycles, Steam Tracking Mode, Electricity Tracking Mode, Saving Potential, Case Studies.		
3	**Waste Heat Recovery:** Commercially Viable Heat Recovery Devices, Saving Potential, Case Studies, HVAC and Refrigeration System, Vapor compression Refrigeration Cycle, Refrigerants, Factors Affecting Refrigeration and Air Conditioning System Performance and Savings Opportunities. **Cooling Towers:** Types and Performance Evaluation, Efficient System Operation, Flow Control Strategies and Energy Saving Opportunities, Case Studies.	10	24
4	**Motors:** Energy Saving Opportunities in Motors, Motor Selection, Energy Efficient Motors, Speed Control of AC Induction Motors, Soft starter with energy savers, Variable Speed Drives (VFD). **Compressed Air Systems:** Types of air compressors, compressor efficiency, efficient compressor operation, compressed air systems components, capacity assessment, and leakage test, factors affecting the performance and Efficiency, energy savings opportunities. Energy Saving Opportunities in Fans & Blowers, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities	10	24

Course Outcome: After completion of this course, student will be able to

- Learn how to calculate heat distribution losses.
- Learn to analyze the losses, performance evaluation, feed water treatment, blow down, energy conservation opportunities.
- Become aware of different opportunity of waste heat recovery.
- Understand the compressed air systems.

List of References:

1. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
2. Carig,B. Saith, Energy Management Principles, Applications, Bnefit and Saving, Per Press, New York
3. F. W. Pyne, P gm Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
4. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.

5. Davida , Fuels Of Opportunity , Characteristics and Uses In Combustion Systems, Edition-2004 Publisher- ELSEVIER LTD. UK
6. O.P. Gupta, Element Of Fuel Furnaces And Refractories, Edition-Second
7. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
8. Electrical Power Distribution in Industrial Plants by M.D. Parmar.
9. Energy Conservation in Electrical Systems, a reading material prepared by D. Buddhi. Smalensky , Electrical Machines , Vol-3, MIR Publishers MOSCOW
10. Igor J. Karassik , Pump Hand Book , Third Edition 2001 , Mcgrawn-Hill
11. B.R. Gupta, Generation of Electrical Energy Edition 2005, Eurasia Publishing House (PVT.) LTD. Ram Nagar
12. National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
13. Energy Auditing, The Fairmont Press Inc. Published by Atlanta, Georgia
14. Albert Thumann, P.E., C.E.M. , Plant engineers & Managers Guide To Energy Conservation 8th edition-2002, Published By The Fairmont Press , Inc 700 Indian Trail Liburn, GA30047
15. BEE VolumeI –Second Edition 2005
16. G.G. Ranjan: Optimizing Energy Efficiencies in Industry, Edition-2003 McGraw Hill

Open e-Resource:

1. https://nptel.ac.in/courses/108106022

List of Suggested Tutorials:

1. To study analysis of fuel properties.
2. To study different types of furnace and insulations.
3. To study the different types of boilers and cogeneration method.
4. Design and analysis of waste heat recovery system.
5. Design and analysis of cooling tower.
6. To study and perform compressed air system and their efficiency.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090209	Subject Title: Research Review & Seminar
Pre-requisite: Zeal to learn	

Course Objective:

- To Learn and present the research in public to a general audience.
- Students would receive regular feedback and advice on their research projects in specific field.
- The progress of our students would be regularly monitored and they would receive formal, regular feedback.
- A high rate of participation in such a visible research-oriented activity could help build the intellectual "atmosphere" of the department.
- Increased knowledge of one another's research would facilitate intergroup interactions.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
0	0	6	3	0	0	0	100	100

Content:

This course will help the scholars for their dissertation phase by motivation and encouraging in quality research. Research review will help them to boost their skills and widen their horizon of thinking for the domain. Research review and seminar is a hands-on course designed to impart soft skills by the foundational methods and techniques for academic research in THERMAL engineering. Scholars will examine to the main components of a research framework i.e., problem definition, research design, data collection, ethical issues in research, report writing, and presentation. Once equipped with this knowledge, scholars would be well-placed to conduct disciplined research in field of THERMAL engineering. In addition to their application in an academic setting, many of the methodologies discussed in this course would be similar to those deployed in professional research environments. The details of course includes sampling techniques, research designs and techniques of analysis which will be helpful in designing of components and performing experiments in areas of THERMAL engineering Students will have a semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the latest literature available. End semester presentation should be done along with the report and the

methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution

Course Outcome:
At the end of the course, the student will be able to:

1. To develop understanding of the basic framework of research review process and able to write technical report.
2. To identify various sources of information for literature review and data collection.
3. Study and develop elicit, analyze, and document skills in the form of a requirements specification.
4. Evaluate traceability between requirements, design, and implementation artefacts for the research work.
5. Develop skills to present and defend their work in front of a technically qualified audience.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090211	**Subject Title: Advanced Internal Combustion Engine (Program Elective-2)**
Pre-requisite: - IC Engine, Heat Transfer	

Course Objective:

- To give an overview of Internal Combustion Engines, their classification, applications, operation and processes.
- To give complete knowledge of type of fuels used in IC engines and the fuel supply systems
- To describe combustion phenomena in IC engines
- To explain the different performance analysis of IC engines
- To explain the effects of exhaust emission on human health and various pollution norms

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Engine Design and Operating Parameters:** Engine operating cycles, spark ignition engine operation, compression ignition engine operation, geometrical properties of reciprocating engine, brake torque and power, mechanical efficiency, mean effective pressure, specific fuel consumption, air/fuel and fuel/air ratio, specific emission and emission index, engine design and performance data	4	6
2	**Reactive Systems:** Stoichiometric equation for fuel air reaction, equivalence ratio, enthalpy of formation, first law analysis for steady state reacting system, enthalpy of combustion, internal energy of combustion and heating values, adiabatic combustion temperature, dissociation, chemically reacting gas mixture	5	12
3	**Ideal Models of Engine Cycles:**	4	10

	Ideal models of engine processes, thermodynamic relations for engine processes, constant volume cycle, constant pressure cycle, basics of simulation in SI and CI Engine cycles, real engine cycles		
4	**Gas Exchange Processes:** Flow through valves, phase of the flow, scavenging in two stroke cycle engines, turbulence, swirl, squish, flow in intake manifolds, analysis of suction and exhaust processes, fuel injection systems, supercharging, turbocharging.	4	10
5	**Combustion:** Combustion in SI engine with homogeneous air –fuel mixture, ignition and flame development, flame propagation and termination in SI engines, octane number, MPFI, combustion in CI engines, ignition delay, cetane number, cold weather problems, fuel spray structure, spray penetration and evaporation	5	12
6	**Emission from IC Engines and its Control:** Formation of nitrogen oxides, carbon monoxide, hydrocarbon emission in petrol and diesel engines, SI and CI engine particulates, soot formation and control, exhaust gas temperature, catalytic convertor, Indian emission standards for SI and CI engines	4	10
7	**Alternate Fuels for IC Engines:** Fuels and their properties : hydrogen, bio gas, alcohols, producer gas, LPG, CNG, non edible vegetable oils, nonedible wild oil, NH3 as substitute fuel for SI and CI engine, fuel additives, pros and cons of alternate fuels, biodiesel processing and production, fuels rating, coal gasification & liquefaction	4	8
8	**Heat Transfer, Friction and Lubrication in IC Engines:** Convective and radiative heat transfer, thermal loading on components, friction fundamentals, engine friction components, lubricant requirement, lubrication system	4	10
9	**Measurements and Testing of IC Engines:** Measurement of friction power, indicated power, brake power, fuel consumption, air consumption, emission, noise, endurance test of IC engines as per Indian standards	4	10
10	**Recent Developments in IC Engines:** PIV in turbulence measurement, optical methods for flame velocity measurement, new materials for engine components, improved two stroke engines, hybrid engines and vehicles, lean burn engines, stratified charge engines, HCCI engines	4	12

Course Outcome: After completion of this course, student will be able to

- Understand the operating characteristics of IC engines
- Perform a thermodynamic analysis of IC engine cycles
- Perform a combustion analysis of IC engines.
- Understand the generation of undesirable exhaust emissions and ways to reduce them

- Understand the various heat transfer mechanisms in the engine.

List of References:

1. Internal Combustion Engine Fundamentals by John B. Heywood, McGraw Hill Education Pvt Ltd.
2. Fundamentals of Internal Combustion Engines by H N Gupta, PHI Learning
3. Internal Combustion Engine by V Ganeshan, McGraw Hill Education Pvt Ltd.
4. Internal Combustion Engine by M L Mathur and R P Sharma, DhanpatRai Publications (P) Ltd.
5. Internal Combustion Engines: Applied Thermo-sciences, Colin R Ferguson, John Wiley and Sons.

Open e-Resource:

1. https://archive.nptel.ac.in/courses/112/103/112103262/
2. https://nptel.ac.in/courses/112104033

List of Suggested Experiments:

1. To perform variable speed test of a multi / single cylinder petrol / diesel engine as per IS standard and prepare the curves of (i) BP, IP, FP Vs Speed (ii) Indicated specific fuel consumption Vs Speed
2. To find the indicated power on multi cylinder diesel engine / petrol engine by Morse test.
3. To find friction power of multi cylinder diesel engine / petrol engine by Willian's line method or motoring method.
4. To evaluate comparative performance of CI engine operated with Diesel and Diesel/Biodiesel blend.
5. To study about first law analysis for steady state reacting system and combustion stoichiometric.
6. To prepare heat balance sheet on multi cylinder diesel engine / petrol engine.
7. To study the effect of A/F ratio on the performance of the two stroke single cylinder petrol engine.
8. To analyze the exhaust gases emission from single / multi cylinder petrol engine.
9. To study and draw the valve timing diagram four stroke petrol and diesel engine.
10. To prepare a report on Indian emission norms.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090212	**Subject Title: Computational Fluid Dynamics (Program Elective-2)**
Pre-requisite: - Fluid Mechanics & Heat Transfer	

Course Objective:

- To impart detailed study of computational techniques in field of fluid flow.
- To impart detailed study of computational techniques in field of heat transfer.
- To learn the software associated with real life simulation problems.
- To prepare a user defined code to solve the computational problems.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction:** What is Computational fluid dynamics (CFD) and how it works, CFD as design and research tool, impact of CFD in Engineering, governing equations of fluid dynamics: Models flow, time rate of change (of moving fluid element), divergence of velocity and its physical meaning, continuity, momentum and energy equations, mathematical behaviour of partial differential equations	4	9
2	**Basic Concept of Discretization:** Introduction to discretization technique, introduction to finite differences: Taylor's series expansion, difference equations: explicit and implicit approach, errors and stability analysis, CFL condition	5	12
3	**Grid Transformation:** Introduction, general transformation equations, matrices and Jacobean, transformed version of governing equation particularly suited for CFD, compressed grids, elliptic grid generation, adaptive grids.	5	12
4	**Simple CFD Technique:**	8	19

	Lax Wandroff technique, Mac-Cormack's technique, relaxation technique and its use with low speed, alternating direction implicit technique (ADI), pressure correction technique: need for staggered grid and its formula, boundary condition for pressure correction method		
5	**Heat Conduction and Convection:** Conduction: 1D conduction equation, grid layout discretisation, stability and convergence, dealing with non-linearity, methods of solution, 2D conduction. Convection: 1D convection, exact solution and its discretisation, upwind difference scheme, comparison of central difference scheme, upwind difference scheme and exact solution, numerical false diffusion, hybrid and power-law schemes, total variation diminishing scheme, 2D Convection: cartesian and complex domain, Unsteady conduction and convection, Stability of the unsteady flow.	10	24
6	**Finite Volume Method:** Introduction to finite volume method (FVM), FVM for diffusion and convection–diffusion problems, discretization of equation for two- dimension, false diffusion, computation of the flow field using stream function and vorticity formulation, solution procedure for unsteady flow calculations: SIMPLE, SIMPLEC, PISO, and MAC algorithms, Solution algorithms for pressure–velocity coupling in steady flows	10	24

Course Outcome: After completion of this course, student will be able to

- Develop perception of major theories, approaches and methodologies used in CFD.
- Analyse and apply CFD analysis to solve major engineering design problems involving fluid flow and heat transfer.
- Build up the skills in the implementation of CFD methods (e.g. boundary conditions.) in actual engineering using commercial CFD codes.

List of References:

1. Computational Fluid Dynamics the Basics with Applications, John D Anderson, Jr., McGraw Hill Book Company.
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, H K Versteeg, W Malalasekera, Pearson Education Ltd.
3. Introduction to Computational Fluid Dynamics, Anil W Date, Cambridge University Press.
4. Numerical Heat Transfer and Fluid Flow, Suhas V Patankar, Hemisphere Publishing Co.
5. Computational Fluid Dynamics: A Practical Approach, JiyuanTu, Guan HengYeoh, Chaoqun Liu, Elsevier.
6. Principles of Computational Fluid dynamics, Pieter Wesseling, Springer International Edition
7. Fundamentals of Computational Fluid Dynamics, Tapan K. Sengupta, Universities Press.

8. Introduction to Fluid Mechanics, Edward J Shaughnessy,Jr., Ira M Katz, Oxford University press

Open e-Resource:

1. https://nptel.ac.in/courses/112105045
2. http://www.cfd-online.com

List of suggested Experiments:

1. Perform Analytical and Numerical analysis on Pin-Fin to calculate temperature distribution.
2. Perform Analytical and Numerical analysis on 1-D steady state heat conduction to calculate temperature distribution along wall thickness.
3. Perform Analytical and Numerical analysis on 2-D steady state heat conduction to calculate temperature distribution along wall thickness.
4. Perform Analytical and Numerical analysis on 1-D unsteady state heat conduction along the wall thickness.
5. Perform Analytical and Numerical analysis on 2-D unsteady state heat conduction along the wall thickness.
6. Perform Analytical and Numerical analysis on unsteady state heat transfer by convection.
7. Perform Numerical analysis on flow through pipe with varying Reynold's number.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090213	Subject Title: Design and Optimization of Thermal Systems (Program Elective-2)
Pre-requisite: - Fluid Mechanics & Heat Transfer	

Course Objective:

- To understand engineering design of thermal systems.
- To study different models used in modelling of thermal systems.
- To study various optimization techniques and apply them.
- To estimate costing of thermal systems.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	Topic	Total Hours	Weight (%)
1	**Introduction:** Engineering Design, Design as Part of Engineering Enterprise, Design versus analysis, need for optimization, basic characteristics of thermal system, Formulation of the Design Problem, Steps in the Design Process, Computer-Aided Design	8	18
2	**Modelling & Simulation of thermal systems:** Basic considerations in design, importance of modelling in design, types of models, mathematical modelling, physical modelling and dimensional analysis, solution procedure, merging of different models, accuracy and validation, system simulation, curve fitting, methods of numerical simulation, numerical simulation versus real systems	12	30
3	**Optimization:** Introduction, Formulation of optimization problems, Calculus techniques: Lagrange multiplier method, Search methods, Concept of interval of	16	38

	uncertainty, reduction ratio, reduction ratios of simple search techniques like exhaustive search, dichotomous search, Fibonacci search and Golden section search, numerical examples. Method of steepest ascent/steepest descent, conjugate gradient method: examples, New generation optimization techniques: Genetic algorithm and simulated annealing, Introduction to Bayesian framework for optimization		
4	**Economic Considerations:** Calculation of Interest, Worth of Money as a Function of Time, Series of Payments, Raising Capital, Taxes, Economic Factor in Design, Application to Thermal Systems, Carbon Credit Calculation	6	14

Course Outcome: After completion of this course, student will be able to

- Explain engineering design of thermal systems.
- Discuss different models used in modelling of thermal systems.
- Appraise various optimization techniques and apply the same to thermal system design.
- Determine costing of thermal systems.

List of References:

1. Design and optimization of thermal systems, Y Jaluria, McGraw Hill.
2. Elements of thermal fluid system design, L C Burmeister, Prentice Hall
3. Essentials of Thermal System Design and Optimization, C Balaji, Ane Books/CRC Press
4. Design of thermal systems, W F Stoecker, McGraw Hill
5. Introduction to optimum design, J S Arora, McGraw Hill

Open e-Resource:

1. https://archive.nptel.ac.in/courses/112/106/112106064/

List of suggested Experiments:

1. To evaluate need for optimization in engineering enterprise.
2. Exercise on mathematical modelling and problem formulation for optimization of various thermal system.
3. Write a program to implement single variable optimization technique.
4. Write a program to implement multivariable optimization techniques.
5. Write program to implement genetic algorithm.
6. To discuss different economics considerations used for design and optimization of thermal systems.

7. To apply various methods of numerical simulation for thermal systems optimization.
8. To apply reduction ratios of simple search techniques used for optimization.
9. To calculate carbon credit for specific case study.
10. To appraise different types of modelling techniques.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090221	**Subject Title: Advanced Air Conditioning (Program Elective-3)**
Pre-requisite: - Fluid Mechanics, Heat Transfer and Basic of Refrigeration & Air-conditioning	

Course Objective:

- To understand the different psychometric process and its importance to maintain human comfort
- To identify best design condition for commercial and residential application of HVAC
- To understand the basics of air distribution through duct
- To understand constant and variable volume systems.
- To know air system: components and to gain knowledge about ventilation for control of work environment.
- To gain knowledge about ventilation for control of work environment.
- To acquire knowledge on Air controls.
- To select drive and transmission element as per working condition.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Applied psychometric:** Different psychrometric charts, combinations of different processes and their representation on psychrometric charts, psychrometric calculations for cooling and dehumidification, high latent heat load, dehumidified air quantities based on total and effective room loads, GSHF and RSHF, effective surface temperature, effect of bypass factor on GSHF, analysis for using all outside air, psychrometric of partial load control	5	14

2	**Design conditions and Heat load calculation:** Selection of inside design conditions for different applications, Thermal comfort, Different equations governing thermal exchanges, environmental indices, AQ and its importance, Basic terminology for heat load calculation, heat transfer through walls and roofs, heat gain through glass, solar heat gain factor, shading of glass, shading devices and its selection, load due to other sources, stack effect, brief idea about other ASHRAE methods of calculating cooling load.	10	21
3	**Distribution of Air:** Terminology, outlet performance, types of outlets, location of outlets, factors affecting grill performance, selection of outlets using nomographs and tables, room air diffusions performance index (ADPI) and its use in outlet selection, types of ducts, duct materials and their accessories, duct construction, factors affecting duct construction, friction charts and other correction factors, losses, design velocity and its selection, duct heat gain or loss, duct insulation, duct layouts, duct sizing methods, noise and their isolation	10	21
4	**Air conditioning systems:** Factors affecting the selection of the systems, classification, design procedure, system features, controls of all air, air water, all water, DX, VAV and dual duct systems, basic idea of cold air distributions systems	5	14
5	**Evaporative cooling equipment:** Cooling tower: Types, construction, working and performance; Evaporative air cooler: Types, construction, working and performance, testing of evaporative air coolers as per IS standards, indirect evaporative cooling; Air washer: Types, construction, working, performance	5	14
6	**Air handling systems:** Types, construction and performance characteristics of fans, fan laws, testing as per IS and AMCA standards, fan selection with the help of tables, charts and curves, fan drive arrangements and discharge from fans.	4	10
7	**Advances in Air Conditioning:** Chilled beam, clean room concept, filtration of suspended particles, PPM control and methods, types of filters	3	6

Course Outcome: After completion of this course, student will be able to

- To make calculation of various Psychrometric processes
- To estimate the cooling load requirements of residential and commercial building and design the system components accordingly
- To make use of tables and nomographs to design air distribution systems
- To develop the skills to analyse the domestic and industrial requirement of air conditioning systems and evaporative cooling equipment
- To select fan for particular air conditioning system and discuss recent developments in air conditioning

List of References:

1. Air Conditioning Engineering by W P Jones, Butterworth-Heinemann, Boston, Oxford
2. Refrigeration and Air conditioning by C P Arora, McGraw-Hill Publication
3. Hand book of Air conditioning Systems Design by Carrier Corporation
4. Air conditioning Principles and Systems by Edward G. Pita, John Wiley& Sons Australia Limited
5. HVAC Testing Adjusting and Balancing Manual by John Gladstone 3rd, McGraw-Hill Publication
6. ASHRAE Handbook of HVAC Systems and Equipment
7. ASHRAE Handbook of HVAC Applications
8. Fan Handbook by Frank P Bleier, McGraw-Hill Professional

Open e-Resource:

1. https://nptel.ac.in/courses/112105128
2. https://nptel.ac.in/courses/112105129
3. https://nptel.ac.in/courses/112107208

List of suggested Experiments:

1. To study various instruments used in air conditioning.
2. Study of advanced air conditioning systems.
3. Study of air conditioning test rig.
4. Performance evaluation of air conditioning system with different psychrometric conditions.
5. To carry out cooling load calculation of a residential/commercial building
6. Design of duct system for above selected building.
7. Understand the salient features of a water chilling plant.
8. To determine the capacity of the window or split air conditioner.
9. To determine evaporative cooling capacity of cooling tower.
10. To determine the humidifying efficiency of an air cooler.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090222	**Subject Title Solar Energy Engineering (Program Elective-3)**
Pre-requisite: - Renewable Energy	

Course Objective:

- To educate students about Solar Energy Engineering
- To educate students about Solar applications

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Solar Radiation**: Source of radiation, solar radiation geometry, solar radiation measuring instruments, solar constant, solar radiation on tilted surface, solar charts	5	12
2	**Solar Concentrating Collectors:** Optical and thermal analysis of compound parabolic collectors, optical and thermal analysis of parabolic through collectors, second law analysis, minimum entropy generation rate, optimum collector temperature, non-isothermal collector, solar non-concentrating collectors, design considerations	7	16
3	**Performance of Solar Collectors:** Collector thermal efficiency, collector energy losses, collector incident angle modifier, concentrating collector acceptance angle, collector time constant, dynamic system test method, collector test results and preliminary collector selection, quality test methods, analysis of concentric tube collector	8	20
4	**Solar Thermal Applications:** Selection criteria of storage materials for heating and cooling applications, selection of heat transfer fluid for heating and cooling applications, active and passive solar water heating system, solar space heating, solar cooling with absorption and adsorption refrigeration,	8	20

	solar desalination systems, solar powered absorption air conditioning system, solar irrigation system, solar chimney, drier, dehumidifier, solar still		
5	**Solar Thermal Power System:** Parabolic through collector system, power tower system, dish systems, thermal analysis of solar thermal power plants, solar ponds, f-chart and utilizability methods	7	16
6	**Solar Economic Analysis:** Life cycle analysis, time value of money, description of the life cycle analysis method, the P1, P2 method, uncertainties in economic analysis, construction concepts, energy storage -sensible, latent heat and thermochemical storage - pebble bed etc. Materials for phase change - glauber's salt - organic compounds, solar ponds	7	16

Course Outcome: After completion of this course, student will be able to

- To know the concept of solar radiation and principle of measuring instruments.
- To understand the thermal analysis, thermal efficiency, energy losses of concentrating and non-concentrating collectors of solar radiation system.
- To know the various applications of solar thermal energy
- To understand the life cycle analysis method and uncertainties in solar economic analysis.

List of References:

1. Solar Engineering of Thermal Processes, Duffie J A, Beckman W A, Wiley
2. Solar Energy Engineering – Process and Systems, Soteris A Kalogirou, Academic Press
3. Solar Energy – Principles of Thermal Collection and Storage, S P Sukhatme, McGraw Hill
4. Principles of Solar Engineering, D Y Goswami, F Kreith and J F Kreider, Taylor and Francis
5. Solar Energy: Fundamentals and Applications, H P Garg & Jai Prakash, McGraw Hill
6. Engineering Thermodynamics of Thermal Radiation for Solar Power Utilization, Petela R, McGrawHill
7. Fundamentals for solar energy conversion, Edward E Anderson, Addison Wesley Publ. Co.
8. Thermal Energy Storage, Dincer I, Rosen M, Wiley

Open e-Resource:

1. https://nptel.ac.in/courses/115103123
2. http://nptel.ac.in/downloads/112105051/

List of suggested Experiments:

1. Measurement of solar radiation using pyranometer and other solar radiation measuring instruments.

2. Performance evaluation of solar flat plate collector.
3. To study the effect of solar flat plate collector in parallel combination.
4. Performance evaluation of concentrating solar collector.
5. To study the effect of concentrating solar collector in series arrangements.
6. Performance evaluation of solar cooker.
7. Performance evaluation of solar air dryer.
8. Performance evaluation of solar still.
9. To compare of solar thermal power systems.
10. Performance evaluation of solar funnel.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

M.TECH 2nd SEMESTER

MECHANICAL ENGINEERING (THERMAL ENGINEERING)

DOC NO: 4061

Subject Code: 10090223	**Subject Title: Advanced Thermal Turbo Machines (Program Elective-3)**
Pre-requisite: - Fluid Mechanics and Fluid Power Engineering	

Course Objective:

- To understand turbomachinery.
- To understand the working of axial and radial flow turbines.
- To understand axial flow compressor.
- To understand the concept of nature of impeller flow, slip factor, diffuser, volute casing.
- To understand working of fans and blowers.
- To understand use of CFD for turbo machineries.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Turbomachinery:** Turbines, pumps and compressors, fans and blowers, compressible flow machines, incompressible flow machines, Energy transfer between fluid and rotor-classification of fluid machinery, dimensionless parameters-specific speed-applications-stage velocity triangles-work and efficiency.	7	15
2	**Axial Flow Turbines:** Introduction, Stage velocity triangle, Single impulse stage, Multistage velocity compounded impulse and Multistage pressure compounded impulse, Reaction stages, Blade to gas speed ratio, Losses and efficiencies, Performance charts, Low hub-tip ration stage. **Radial Flow Turbines:** Elements of radial turbine stage, Stage velocity triangles, H-S diagram, Stage losses, Outward flow radial stage and Performance characteristics.	11	26

3	**Axial Flow Compressor:** Introduction. Geometry and working principle, Stage velocity triangles, H-S diagram. Flow through blade row, Stage losses and efficiency, Work done factor, Low hub-tip ratio, Supersonic and transonic stages, Performance characteristics	8	18
4	**Centrifugal Compressor:** Introduction and different parts of centrifugal compressor, Principles of operation. H-S diagram. Nature of impeller flow, Slip factor, Diffuser, Volute casing, Performance characteristics and losses in centrifugal compressor.	8	18
5	**Fans and Blowers:** Fan and Blowers types-stage and design parameters-flow analysis in impeller blades-volute and diffusers, losses, characteristic curves and selection, drives and noise. Noise problems in fans and Blowers	6	16
6	Use of CFD for Turbo machineries analysis and design.	2	7

Course Outcome: After completion of this course, student will be able to

- Understand to apply physics of flow through turbomachines.
- Understand the analysis of radial and axial flow turbines, its losses and performance
- Understand the analysis of centrifugal and axial flow compressors, its losses and performance
- Understand the fan and blowers machines their need and it's applications.

List of References:

1. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, reprint 2008.
2. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., latest edition.
3. Principals of Turbomachines, D. G. Shepherd, The Macmillan Company (1964)
4. Fluid Mechanics & Thermodynamics of Turbomachines, S. L. Dixon, Elsevier (2005)
5. Textbook of Turbomachines, M. S. Govindgouda and A. M. Nagaraj, M. M. Publications, 4Th Ed, 2008.
6. Turbomachine, B.K.Venkanna PHI, New Delhi 2009.

Open e-Resource:

1. https://nptel.ac.in/courses/101/101/101101058/
2. https://nptel.ac.in/courses/112106303

List of suggested Experiments:

1. Study or performance of axial flow turbines performance and its efficiency.
2. Study or performance of Radial flow turbines performance and its efficiency.
3. Study or performance of axial flow Compressors performance and its efficiency.
4. Study or performance of centrifugal compressors performance and its efficiency.
5. Performance study of axial fan.
6. Study of centrifugal air blower.

GANDHINAGAR INSTITUTE OF TECHNOLOGY

Master of Technology

Thermal Engineering

Subject Code: 10090301	**Subject Title:** Internal Review-1
Pre-requisite: --	

Course Objective:

1. Initiate independent research through systematic literature review.
2. Identify research problems and formulate a relevant dissertation topic.
3. Align topics with emerging research trends in the respective field.
4. Conduct in-depth analysis and review of existing methods.
5. Establish a structured research foundation for further dissertation development.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
0	0	4	2	0	0	0	100	100

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

1. Understand the chosen research topic and define its relevance and associated challenges.
2. Identify and interpret quality literature from reputed journals to validate the problem statement.
3. Conduct a comparative review of existing methods and highlight research gaps or scope for improvement.
4. Evaluate previous approaches using relevant datasets and appropriate performance metrics.
5. Propose a hypothesis or research direction with suitable algorithms, methods, or modeling approaches.

Course Structure and Work Plan

- Week 1–2: Finalization of research domain and title approval in consultation with guide.
- Week 3–5: Extensive literature survey (minimum 20 papers, including 10 recent journal articles).
- Week 6–8: Identification of research gaps and statement of problem.
- Week 9–11: Comparative analysis of existing methodologies.
- Week 12–14: Initial data collection, feasibility study or conceptual framework.
- Week 15–16: Preparation of draft report and internal presentation.

Deliverables:

1. Synopsis/Concept note approved by faculty guide
2. Literature review summary with annotated bibliography
3. Problem statement and research objectives

4. Comparative analysis table or benchmarking matrix
5. Internal presentation before a departmental review panel
6. Progress report (typed and signed by guide)

Evaluation Components:

Component	Weightage (Marks)
Literature Review Quality	15
Clarity of Problem Statement	10
Identification of Research Gap	10
Comparative Analysis / Review Matrix	10
Presentation and Communication	15
Viva by Panel / Review Committee	40
Total	**100**

GANDHINAGAR UNIVERSITY

GANDHINAGAR INSTITUTE OF TECHNOLOGY

Master of Technology

Thermal Engineering

Subject Code: 10090302	**Subject Title:** Dissertation Phase-1
Pre-requisite: --	

Course Objective:

1. To enable students to independently identify, analyze, and define a research problem in their chosen engineering domain, applying relevant analytical and/or experimental methodologies.
2. To conduct a comprehensive literature review, establish research objectives, define the scope, and outline the preliminary work for the dissertation project.
3. To facilitate the development of a structured research report, documenting the findings, methodology, and analysis, while proposing solutions and future work based on the project's results.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
0	0	28	14	0	0	100	0	100

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

1. Choose a domain of project work related to their engineering specialization.
2. Discover appropriate literature and define the objectives & scope of the project work.
3. Solve the designated problem through analysis, design, and/or experimentation.
4. Create and discuss the project report.

Syllabus:

The Dissertation Phase-1 is designed to train students in independently analyzing and addressing problems in their engineering field. The project may involve analytical and/or experimental work, focusing on the latest advancements in the chosen engineering domain.

The project report should include:

- Objective of study and scope of work.
- Critical literature review related to the project.
- Preliminary work conducted in the domain, including analytical and/or experimental components.

GANDHINAGAR UNIVERSITY

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Master of Technology

Thermal Engineering

Subject Code: 10090401	**Subject Title:** Internal Review-2
Pre-requisite: --	

Course Objective:

1. Initiate students into independent research with a focus on data collection, evaluation, and hypothesis testing.
2. Guide students in applying methodologies, validating solutions, and evaluating performance.
3. Enable students to communicate research outcomes effectively.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
0	0	4	2	0	0	0	100	100

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

1. Apply ethical standards in data collection and analysis.
2. Test and validate hypotheses using qualitative/quantitative methods.
3. Evaluate methodologies and solutions using performance metrics.
4. Analyze experimental data and derive meaningful conclusions.
5. Present and communicate research outcomes clearly.

Course Structure and Work Plan

- Week 1–2: Complete data collection and hypothesis testing.
- Week 3–6: Validate methodology and perform comparative analysis.
- Week 7–9: Analyze experimental data and finalize conclusions.
- Week 10–12: Prepare final report and presentation.

Deliverables:

1. Final Research Report: Document methodology, analysis, results.
2. Presentation Slides: Showcase research findings and methodology.
3. Experimental Data: Include experiments, analysis, and performance evaluation.
4. Internal Presentation: Final presentation for internal review.

Evaluation Components:

Component	Weightage (Marks)
Literature Review & Problem Statement	20
Hypothesis & Methodology Validation	25
Experimental Work & Data Analysis	30

Final Report & Presentation	25
Total	**100**

GANDHINAGAR UNIVERSITY

GANDHINAGAR INSTITUTE OF TECHNOLOGY

Master of Technology

Thermal Engineering

Subject Code: 10090402	**Subject Title:** Dissertation Phase-2
Pre-requisite: --	

Course Objective:

1. Independently execute the identified research problem, applying advanced analytical and experimental methodologies.
2. Design a comprehensive experimental or simulation setup to validate the research hypothesis.
3. Complete a detailed analysis of the results, interpret the findings, and propose future work based on the outcomes.
4. Prepare a final dissertation report summarizing the work conducted, methodologies used, and outcomes achieved.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
0	0	28	14	0	0	100	0	100

Course Outcomes (COs):

At the end of this course, students will be able to:

1. Select and define a research problem relevant to their field of specialization.
2. Conduct a thorough literature review and establish clear research objectives and scope.
3. Apply suitable analytical, design, or experimental methods to solve the research problem.
4. Compile a comprehensive project report detailing methodology, analysis, conclusions, and recommendations.

Syllabus:

This phase of the dissertation is a continuation of Dissertation Phase-1, where students will:

- Carry forward the preliminary work from Phase-1, refining the problem statement, objectives, and scope.
- Implement advanced methodologies for research, including data collection, modeling, simulation, or experimental setup.
- Analyze data from experiments or simulations and interpret the results within the context of the research problem.
- Propose solutions based on the findings, along with future work recommendations.
- Document the entire research process in a structured dissertation report.