ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

For

M.Tech. MECHANICAL BRANCH

Specialization :

THERMAL ENGINEERING

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

ACADEMIC REGULATIONS R13 FOR M. Tech (REGULAR) DEGREE COURSE

Applicable for the students of M. Tech (Regular) Course from the Academic Year 2013-14 onwards

The M. Tech Degree of Jawaharlal Nehru Technological University Kakinada shall be conferred on candidates who are admitted to the program and who fulfil all the requirements for the award of the Degree.

1.0 ELIGIBILITY FOR ADMISSIONS

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.

Admissions shall be made on the basis of merit/rank obtained by the candidates at the qualifying Entrance Test conducted by the University or on the basis of any other order of merit as approved by the University, subject to reservations as laid down by the Govt. from time to time.

2.0 AWARD OF M. Tech DEGREE

2.1 A student shall be declared eligible for the award of the M. Tech Degree, if he pursues a course of study in not less than two and not more than four academic years.

2.2 The student shall register for all 80 credits and secure all the 80 credits.

2.3 The minimum instruction days in each semester are 90.

3.0 A. COURSES OF STUDY

The following specializations are offered at present for the M. Tech course of study.

1. M.Tech- Structural Engineering
2. M.Tech- Transportation Engineering
3. M.Tech- Infrastructure Engineering & Management
4. ME- Soil Mechanics and Foundation Engineering
5. M.Tech- Environmental Engineering
6. M.Tech-Geo-Informatics
7. M.Tech-Spatial Information Technology

8. M.Tech- Civil Engineering
9. M.Tech -Geo-Technical Engineering
10. M.Tech- Remote Sensing
11. M.Tech- Power Electronics
12. M.Tech- Power & Industrial Drives
13. M.Tech- Power Electronics & Electrical Drives
14. M.Tech- Power System Control & Automation
15. M.Tech- Power Electronics & Drives
16. M.Tech- Power Systems
17. M.Tech- Power Systems Engineering
18. M.Tech- High Voltage Engineering
19. M.Tech- Power Electronics and Power Systems
20. M.Tech- Power System and Control
21. M.Tech- Power Electronics & Systems
22. M.Tech- Electrical Machines and Drives
23. M.Tech- Advanced Power Systems
24. M.Tech- Power Systems with Emphasis on High Voltage Engineering
25. M.Tech- Control Engineering
26. M.Tech- Control Systems
27. M.Tech- Electrical Power Engineering
28. M.Tech- Power Engineering & Energy System
29. M.Tech- Thermal Engineering
30. M.Tech- CAD/CAM
31. M.Tech- Machine Design
32. M.Tech- Computer Aided Design and Manufacture
33. M.Tech- Advanced Manufacturing Systems
34. M.Tech-Computer Aided Analysis & Design
35. M.Tech- Mechanical Engineering Design
36. M.Tech- Systems and Signal Processing
37. M.Tech- Digital Electronics and Communication Systems
38. M.Tech- Electronics & Communications Engineering
39. M.Tech- Communication Systems
40. M.Tech- Communication Engineering & Signal Processing
41. M.Tech- Microwave and Communication Engineering
42. M.Tech- Telematics

43. M.Tech- Digital Systems & Computer Electronics
44. M.Tech- Embedded System
45. M.Tech- VLSI
46. M.Tech- VLSI Design
47. M.Tech- VLSI System Design
48. M.Tech- Embedded System & VLSI Design
49. M.Tech- VLSI & Embedded System
50. M.Tech- VLSI Design & Embedded Systems
51. M.Tech- Image Processing
52. M.Tech- Digital Image Processing
53. M.Tech- Computers & Communication
54. M.Tech- Computers & Communication Engineering
55. M.Tech- Instrumentation & Control Systems
56. M.Tech – VLSI & Micro Electronics
57. M.Tech – Digital Electronics & Communication Engineering
58. M.Tech- Embedded System & VLSI
59. M.Tech- Computer Science & Engineering
60. M.Tech- Computer Science
61. M.Tech- Computer Science & Technology
62. M.Tech- Computer Networks
63. M.Tech- Computer Networks & Information Security
64. M.Tech- Information Technology
65. M.Tech- Software Engineering
66. M.Tech- Neural Networks
67. M.Tech- Chemical Engineering
68. M.Tech- Biotechnology
69. M.Tech- Nano Technology
70. M.Tech- Food Processing
71. M.Tech- Avionics

and any other course as approved by AICTE/ University from time to time.

3.0 B. Departments offering M. Tech Programmes with specializations are noted below:

Civil Engg.	1. M.Tech- Structural Engineering 2. M.Tech- Transportation Engineering 3. M.Tech- Infrastructure Engineering & Management 4. ME- Soil Mechanics and Foundation Engineering 5. M.Tech- Environmental Engineering 6. M.Tech-Geo-Informatics 7. M.Tech-Spatial Information Technology 8. M.Tech- Civil Engineering 9. M.Tech -Geo-Technical Engineering 10. M.Tech- Remote Sensing
EEE	1. M.Tech- Power Electronics 2. M.Tech- Power & Industrial Drives 3. M.Tech- Power Electronics & Electrical Drives 4. M.Tech- Power System Control & Automation 5. M.Tech- Power Electronics & Drives 6. M.Tech- Power Systems 7. M.Tech- Power Systems Engineering 8. M.Tech- High Voltage Engineering 9. M.Tech- Power Electronics and Power Systems 10. M.Tech- Power System and Control 11. M.Tech- Power Electronics & Systems 12. M.Tech- Electrical Machines and Drives 13. M.Tech- Advanced Power Systems 14. M.Tech- Power Systems with Emphasis on High Voltage Engineering 15. M.Tech- Control Engineering 16. M.Tech- Control Systems 17. M.Tech- Electrical Power Engineering 18. M.Tech- Power Engineering & Energy System
ME	1. M.Tech- Thermal Engineering 2. M.Tech- CAD/CAM 3. M.Tech- Machine Design 4. M.Tech- Computer Aided Design and Manufacture 5. M.Tech- Advanced Manufacturing Systems 6. M.Tech-Computer Aided Analysis & Design 7. M.Tech- Mechanical Engineering Design

ECE	1. M.Tech- Systems and Signal Processing 2. M.Tech- Digital Electronics and Communication Systems 3. M.Tech- Electronics & Communications Engineering 4. M.Tech- Communication Systems 5. M.Tech- Communication Engineering & Signal Processing 6. M.Tech- Microwave and Communication Engineering 7. M.Tech- Telematics 8. M.Tech- Digital Systems & Computer Electronics 9. M.Tech- Embedded System 10. M.Tech- VLSI 11. M.Tech- VLSI Design 12. M.Tech- VLSI System Design 13. M.Tech- Embedded System & VLSI Design 14. M.Tech- VLSI & Embedded System 15. M.Tech- VLSI Design & Embedded Systems 16. M.Tech- Image Processing 17. M.Tech- Digital Image Processing 18. M.Tech- Computers & Communication 19. M.Tech- Computers & Communication Engineering 20. M.Tech- Instrumentation & Control Systems 21. M.Tech – VLSI & Micro Electronics 22. M.Tech – Digital Electronics & Communication Engineering 23. M.Tech- Embedded System & VLSI
CSE	1. M.Tech- Computer Science & Engineering 2. M.Tech- Computer Science 3. M.Tech- Computer Science & Technology 4. M.Tech- Computer Networks 5. M.Tech- Computer Networks & Information Security 6. M.Tech- Information Technology 7. M.Tech- Software Engineering 8. M.Tech- Neural Networks
Others	1. M.Tech- Chemical Engineering 2. M.Tech- Biotechnology 3. M.Tech- Nano Technology 4. M.Tech- Food Processing 5. M.Tech- Avionics

4.0 ATTENDANCE

4.1 A student shall be eligible to write University examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

4.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester shall be granted by the College Academic Committee.

4.3 Shortage of Attendance below 65% in aggregate shall not be condoned.

4.4 Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class.

4.5 A prescribed fee shall be payable towards condonation of shortage of attendance.

4.6 A student shall not be promoted to the next semester unless he satisfies the attendance requirement of the present semester, as applicable. They may seek readmission into that semester when offered next. If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

5.0 EVALUATION

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practicals, on the basis of Internal Evaluation and End Semester Examination.

5.1 For the theory subjects 60 marks shall be awarded based on the performance in the End Semester Examination and 40 marks shall be awarded based on the Internal Evaluation. The internal evaluation shall be made based on the **average** of the marks secured in the two Mid Term-Examinations conducted-one in the middle of the Semester and the other immediately after the completion of instruction. Each mid term examination shall be conducted for a total duration of 120 minutes with 4 questions (without choice) each question for 10 marks. End semester examination is conducted for 60 marks for 5 questions to be answered out of 8 questions.

5.2 For practical subjects, 60 marks shall be awarded based on the performance in the End Semester Examinations and 40 marks shall be awarded based on the day-to-day performance as Internal Marks.

5.3 There shall be two seminar presentations during III semester and IV semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee consisting of Head of the Department, Supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

5.4 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End semester Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

5.5 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.4) he has to reappear for the End semester Examination in that subject. A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and has failed in the end examination. In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate's attendance in the re-registered subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks obtained in the previous attempt stand cancelled. For re-registration the candidates have to apply to the University through the college by paying the requisite fees and get approval from the University before the start of the semester in which re-registration is required.

5.6 In case the candidate secures less than the required attendance in any re registered subject (s), he shall not be permitted to write the End Examination in that subject. He shall again re-register the subject when next offered.

5.7 Laboratory examination for M. Tech. courses must be conducted with two Examiners, one of them being the Laboratory Class Teacher or teacher of the respective college and the second examiner shall be appointed by the university from the panel of examiners submitted by the respective college.

6.0 EVALUATION OF PROJECT/DISSERTATION WORK

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

6.1 A Project Review Committee (PRC) shall be constituted with Head of the Department and two other senior faculty members.

6.2 Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects, both theory and practical.

6.3 After satisfying 6.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work for approval. The student can initiate the Project work, only after obtaining the approval from the Project Review Committee (PRC).

6.4 If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the Project Review Committee (PRC). However, the Project Review Committee (PRC) shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

6.5 A candidate shall submit his status report in two stages at least with a gap of 3 months between them.

6.6 The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after

successful completion of theory and practical course with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. The candidate has to pass all the theory and practical subjects before submission of the Thesis.

6.7 Three copies of the Project Thesis certified by the supervisor shall be submitted to the College/School/Institute.

6.8 The thesis shall be adjudicated by one examiner selected by the University. For this, the Principal of the College shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned and head of the department.

6.9 If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is unfavorable again, the thesis shall be summarily rejected. The candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the University.

6.10 If the report of the examiner is favourable, Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the Thesis. The Board shall jointly report the candidate's work as one of the following:

A. Excellent
B. Good
C. Satisfactory
D. Unsatisfactory

The Head of the Department shall coordinate and make arrangements for the conduct of Viva-Voce examination.

6.11 If the report of the Viva-Voce is unsatisfactory, the candidate shall retake the Viva-Voce examination only after three months. If he fails to get a satisfactory report at the second Viva-Voce examination, the candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the University.

7.0 AWARD OF DEGREE AND CLASS

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree he shall be placed in one of the following four classes:

Class Awarded	**% of marks to be secured**
First Class with Distinction	70% and above (Without any Supplementary Appearance)
First Class	Below 70% but not less than 60% 70% and above (With any Supplementary Appearance)
Second Class	Below 60% but not less than 50%

The marks in internal evaluation and end examination shall be shown separately in the memorandum of marks.

8.0 WITHHOLDING OF RESULTS

If the student has not paid the dues, if any, to the university or if any case of indiscipline is pending against him, the result of the student will be withheld. His degree will be withheld in such cases.

4.0 TRANSITORY REGULATIONS (for R09)

9.1 Discontinued or detained candidates are eligible for re-admission into same or equivalent subjects at a time as and when offered.

9.2 The candidate who fails in any subject will be given two chances to pass the same subject; otherwise, he has to identify an equivalent subject as per R13 academic regulations.

10. GENERAL

10.1 Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

10.2 The academic regulation should be read as a whole for the purpose of any interpretation.

10.3 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

10.4 The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/ Improper conduct	Punishment
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project

	(theory or practical) in which the candidate is appearing.	work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and

	the examination.	shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/ Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.

	outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining

		examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/ year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the candidates as per the above guidelines.
2. Punishment for institutions : (if the squad reports that the college is also involved in encouraging malpractices)
   - (i) A show cause notice shall be issued to the college.
   - (ii) Impose a suitable fine on the college.
   - (iii) Shifting the examination centre from the college to another college for a specific period of not less than one year.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

KAKINADA-533003, Andhra Pradesh (India)
For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

Prohibition of ragging in educational institutions Act 26 of 1997

Salient Features

- ⇨ Ragging within or outside any educational institution is prohibited.
- ⇨ Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student

	Imprisonment upto		Fine Upto
Teasing, Embarrassing and Humiliation	6 Months	+	Rs. 1,000/-
Assaulting or Using Criminal force or Criminal intimidation	1 Year	+	Rs. 2,000/-
Wrongfully restraining or confining or causing hurt	2 Years	+	Rs. 5,000/-
Causing grievous hurt, kidnapping or Abducts or rape or committing unnatural offence	5 Years	+	Rs.10,000/-
Causing death or abetting suicide	10 Months	+	Rs. 50,000/-

In Case of Emergency CALL TOLL FREE NO. : 1800 - 425 - 1288

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

KAKINADA-533003, Andhra Pradesh (India)
For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

ABSOLUTELY NO TO RAGGING

1. Ragging is prohibited as per Act 26 of A.P. Legislative Assembly, 1997.
2. Ragging entails heavy fines and/or imprisonment.
3. Ragging invokes suspension and dismissal from the College.
4. Outsiders are prohibited from entering the College and Hostel without permission.
5. Girl students must be in their hostel rooms by 7.00 p.m.
6. All the students must carry their Identity Card and show them when demanded
7. The Principal and the Wardens may visit the Hostels and inspect the rooms any time.

Jawaharlal Nehru Technological University Kakinada
For Constituent Colleges and Affiliated Colleges of JNTUK

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LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech Specialization : THERMAL ENGINEERING

I SEMESTER

S.NO	SUBJECT	L	P	C
1	OPTIMIZATION TECHNIQUES & APPLICATIONS	4	0	3
2	ADVANCED THERMODYNAMICS	4	0	3
3	ADVANCED HEAT & MASS TRANSFER	4	0	3
4	ADVANCED FLUID MECHANICS	4	0	3
5	ELECTIVE – I GAS DYNAMICS REFRIGERATION & AIR CONDITIONING RENEWABLE ENERGY TECHNOLOGIES THEORY AND TECHNOLOGIES OF FUEL CELLS	4	0	3
6	ELECTIVE – II	4	0	3
	ADVANCED IC ENGINES SOLAR ENERGY TECHNOLOGY			
	TURBO MACHINES ALTERNATIVE FUELS TECHNOLOGIES			
7	THERMAL ENGINEERING LAB	0	4	2
	TOTAL			**20**

II SEMESTER

S.NO.	SUBJECT	L	P	CREDITS
1	FUELS, COMBUSTION & ENVIRONMENT	4	0	3
2	ENERGY MANAGEMENT	4	0	3
3	FINITE ELEMENT METHOD	4	0	3
4	COMPUTATIONAL FLUID DYNAMICS	4	0	3
5	ELECTIVE– III MATERIALS FOR THERMAL ENGG CONVECTIVE HEAT TRANSFER THERMAL AND NUCLEAR POWER PLANTS	4	0	3

	ADVANCED AUTOMOBILE ENGG			
6	ELECTIVE– IV THERMAL MEASUREMENTS AND PROCESS CONTROLS CRYOGENIC ENGINEERING JET PROPULSION AND ROCKETRY EQUIPMENT DESIGN FOR THERMAL SYSTEMS	4	0	3
7	THERMAL SYSTEMS DESIGN LAB	0	6	4
	TOTAL			**22**

III SEMESTER

1	SEMINAR - I	0	3	2
2	COMPREHENSIVE VIVA VOCE			2
3	PROJECT - PART I			14
	TOTAL			**18**

IV SEMESTER

1	SEMINAR -II	0	3	2
2	PROJECT PART II & VIVA VOCE			18
	TOTAL			**20**

SYLLABUS

I – I	L	P	Credits
	4	-	3
OPTMIZATION TECHNIQUES & APPLICATIONS			

UNIT- I Introduction

Optimization levels, mathematical representation, optimization procedures, search methods. Constrained and unconstrained optimization using lagrange multiplier equations. Sensitivity coefficients and inequality constraints and related exercises.

UNIT- II Search methods

Overview: Single variable, constrained and unconstrained multi variable methods. Dichotomous search, Fibonacci search, Lattice search, univariate search, steepest – ascent method. Penalty functions. Hemstitching method and exercises.

UNIT-III

Dynamic and Geometric programming

Description characteristics, efficiency and solution pattern of dynamic programming

Objective function, constraints, solution mechanism for constrained and unconstrained single and multivariable optimization of geometric programming.

UNIT –IV

Mathematical modeling of thermal systems.

Need for mathematical modeling. Non linear regression analysis. Newton – Rapson technique, Quasi-Newton method and related exercises.

UNIT- V

Dynamic behavior of Thermal systems.

Scope and approach. Laplace Transforms. Stability analysis using frequency response and loop transfer function. Proportional control, P.I. control and P.I.D control

TEXT BOOK:

1. Design of Thermal Systems by W.F.Stoecker, 3rd ed, TMH.

REFERENCES:

1. Engineering Optimization: Theory and Practice by Singiresu S. Rao. New Age International.
2. Optimization Techniques / Belagundu & Chandraputala / Pearson Asia

I – I	L	P	Credits
	4	-	3
ADVANCED THERMODYNAMICS			

UNIT -I

REVIEW OF THERMODYNAMIC LAWS AND COROLLARIES: Transient flow analysis, Second law of thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation. Evaluation of thermodynamic properties of working substance

UNIT-II

P.V.T SURFACE: Equation of state. Real gas behavior, Vander Waal's equation, Generalized compressibility factor. Energy properties of real gases. Vapour pressure, Clausius - Clapeyro equation. Throttling, Joule - Thompson coefficient. Non reactive mixtures of perfect gases. Governing laws, Evaluation of properties, Psychometric mixture properties and psychometric chart, Air conditioning processes, cooling towers. Real gas mixture.

UNIT-III

COMBUSTION: Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat of reaction, Adiabatic flame temperature generated product, Enthalpies, Equilibrium. Chemical equilibrium of ideal gases, Effect of non reacting gases equilibrium in multiple reactions, The vent hoff's equation. The chemical potential and phase equilibrium. The Gibbs phase rule.

UNIT-IV

POWER CYCLES: Review of binary vapour cycle, co generation and combined cycles, Second law analysis of cycles. Refrigeration cycles. Thermodynamics of irreversible processes. Introduction, Phenomenological laws, Onsaga Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits.

UNIT-V

DIRECT ENERGY CONVERSION Introduction: Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices, magneto hydronamic generations, Photovoltaic cells.

TEXT BOOKS:

1. Basic and Applied Thermodynamics/ P.K.Nag/ TMH
2. Thermodynamics/Holman/ Me Graw Hill.

REFERENCES

1. Engg. Thermodynamics/PL.Dhar / Elsevier
2. Thermodynamics/Sonnatag & Van Wylen / John Wiley & Sons
3. Thermodynamics for Engineers/Doolittle-Messe / John Wiley & Sons
4. Irreversible thermodynamics/HR De Groff.
5. Thermal Engineering / Soman / PHI
6. Thermal Engineering / Rathore / TMH
7. Engineering Thermodynamics/Chatopadyaya/

I – I	L	P	Credits
	4	-	3
ADVANCED HEAT AND MASS TRANSFER			

UNIT-I

BRIEF INTRODUCTION TO DIFFERENT MODES OF HEAT TRANSFER: Conduction: General heat Conduction equation-initial and boundary conditions.

Transient heat conduction: Lumped system analysis-Heisler charts-semi infinite solid-use of shape factors in conduction-2D transient heat conduction-product solutions.

UNIT-II

FINITE DIFFERENCE METHODS FOR CONDUCTION: ID & 2D steady state and simple transient heat conduction problems-implicit and explicit methods.

Forced Convection: Equations of fluid flow-concepts of continuity, momentum equations-derivation of energy equation-methods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept of exact solution. Approximate method-integral analysis.

UNIT-III

EXTERNAL FLOWS: Flow over a flat plate: integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to various geometries for laminar and turbulent flows.

Internal flows: Fully developed flow: integral analysis for laminar heat transfer coefficient-types of flow-constant wall temperature and constant heat flux boundary conditions-hydrodynamic & thermal entry lengths; use of empirical correlations.

UNIT-IV

FREE CONVECTION: Approximate analysis of laminar free convective heat transfer-boussinesque approximation-different geometries-combined free and forced convection.

Boiling and condensation: Boiling curve-correlations-Nusselts theory of film condensation on a vertical plate-assumptions & correlations of film condensation for different geometries.

UNIT-V

RADIATION HEAT TRANSFER: Radiant heat exchange in grey, non-grey bodies, with transmitting, Reflecting and absorbing media, specular surfaces, gas radiation-radiation from flames.

Mass Transfer: Concepts of mass transfer-diffusion & convective mass transfer analogies-significance of non-dimensional numbers.

TEXT BOOKS:

1. Principals of Heat Transfer/Frank Kreith/Cengage Learning
2. Heat Transfer / Necati Ozisik / TMH

REFERENCES:

1. Fundamentals of Heat and Mass Transfer-5th Ed. / Frank P. Incropera/ John Wiley
2. Elements of Heat Transfer/E. Radha Krishna/CRC Press/2012
3. Introduction to Heat Transfer/SK Som/PHI
4. Heat Transfer / Nellis & Klein / Cambridge University Press / 2012.
5. Heat Transfer/ P.S. Ghoshdastidar/ Oxford Press
6. Engg. Heat & Mass Transfer/ Sarit K. Das/Dhanpat Rai
7. Heat Transfer/ P.K.Nag /TMH
8. Heat Transfer / J.P Holman/MGH

I – I	L	P	Credits
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ADVANCED FLUID MECHANICS

UNIT-I

INVISCID FLOW OF INCOMPRESSIBLE FLUIDS: Lagrangian and Eulerain Descriptions of fluid motion- Path lines, Stream lines, Streak lines, stream tubes – velocity of a fluid particle, types of flows, Equations of three dimensional continuity equation- Stream and Velocity potential functions.

Basic Laws of fluid Flow: Condition for irrotationality, circulation & vorticity Accelerations in Cartesystems normal and tangential accelerations, Euler's, Bernouli equations in 3D– Continuity and Momentum Equations

UNIT-II

Viscous Flow: Derivation of Navier-Stoke's Equations for viscous compressible flow – Exact solutions to certain simple cases : Plain Poisoulle flow - Coutte flow with and without pressure gradient - Hagen Poisoulle flow - Blasius solution.

UNIT-III

Boundary Layer Concepts : Prandtl's contribution to real fluid flows – Prandtl's boundary layer theory - Boundary layer thickness for flow over a flat plate – Approximate solutions – Creeping motion (Stokes) – Oseen's approximation - Von-Karman momentum integral equation for laminar boundary layer –– Expressions for local and mean drag coefficients for different velocity profiles.

UNIT-IV

Introduction to Turbulent Flow: Fundamental concept of turbulence – Time Averaged Equations – Boundary Layer Equations - Prandtl Mixing Length Model - Universal Velocity Distribution Law: Van Driest Model –Approximate solutions for drag coefficients – More Refined Turbulence Models – k-epsilon model - boundary layer separation and form drag – Karman Vortex Trail, Boundary layer control, lift on circular cylinders

Internal Flow: Smooth and rough boundaries – Equations for Velocity Distribution and frictional Resistance in smooth rough Pipes – Roughness of Commercial Pipes – Moody's diagram.

UNIT- V

Compressible Fluid Flow – I: Thermodynamic basics – Equations of continuity, Momentum and Energy - Acoustic Velocity Derivation of Equation for Mach Number – Flow Regimes – Mach Angle – Mach Cone – Stagnation State

Compressible Fluid Flow – II: Area Variation, Property Relationships in terms of Mach number, Nozzles, Diffusers – Fanno and Releigh Lines, Property Relations – Isothermal Flow in Long Ducts – Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks – Supersonic Wave Drag.

TEXT BOOKS:

1. Fluid Mechanics / L.Victor Steeter / TMH
2. Fluid Mechanics / Frank M.White / MGH

REFERENCES:

1. Fluid Mechanics and Machines/Modi and Seth/Standard Book House
2. Fluid Mechanics/Cohen and Kundu/Elsevier/5th edition
3. Fluid Mechanics/Potter/Cengage Learning
4. Fluid Mechanics/William S Janna/CRC Press
5. Fluid Mechanics / Y.A Cengel and J.M Cimbala/MGH
6. Boundary Layer Theory/ Schlichting H /Springer Publications
7. Dynamics & Theory and Dynamics of Compressible Fluid Flow/ Shapiro.
8. Fluid Dynamics/ William F. Hughes & John A. Brighton/TMH

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(ELECTIVE I)
GAS DYNAMICS

UNIT-I

Basic concepts : Introduction to compressible flow, A brief review of thermodynamics and fluid mechanics, Integral forms of conservation equations, Differential conservation equations, Continuum Postulates, Acoustic speed and Mach number, Governing equations for compressible flows

UNIT-II

One-dimensional compressible flow: One dimensional flow concept, Isentropic flows, Stagnation/Total conditions, Characteristics speeds of gas dynamics, Dynamic pressure and pressure coefficients, Normal shock waves, Rankine-Hugonoit equations, Rayleigh flow, Fanno flow, Crocco's theorem.

UNIT-III

Two-dimensional flows: Oblique shock wave and its governing equations, è-B-M relations, The Hodograph and Shock Polar, Supersonic flow over wedges and cones, Mach line, Attached and Detached shock, Reflections and interaction of oblique shock waves, Expansion waves, Prandtl-Meyer flow and its governing equations, Supersonic flow over convex and concave corners, Approximation of continuous expansion waves by discrete waves.

UNIT-IV

Quasi-one dimensional flows: Governing equations, Areavelocity relations, Isentropic flow through variable-area ducts, Convergent-divergent (or De Laval) nozzles, Over-expanded and under-expanded nozzles, Diffusers.

UNIT-V

Unsteady wave motions: Moving normal shock waves, Reflected shock waves, Physical features of wave propagation, Elements of acoustic

theory, Incident and reflected waves, Shock tube relations, Piston analogy, Incident and reflected expansion waves, Finite compression waves, Shock tube relations.

Introduction to experimental facilities: Subsonic wind tunnels, Supersonic wind tunnels, Shock tunnels, Free-piston shock tunnel, Detonation-driven shock tunnels, and Expansion tubes.

TEXT BOOKS:-

1. Gas Dynamics by S.M Yahya
2. Gas Dynamics by Radha Krishnan

REFERENCES:

1. Gas Dyanamics by Zucker
2. Dynamics and Thermodynamics of compressible fluid flow (Vol. I, II) by Ascher H.Shapiro
3. Elements of Gas Dynamics by H.W. Liepmann and A. Roshko
4. Fundamentals of Gas Dynamics by V. Babu
5. Modern Compressible Flow by John D. Anderson,Jr.

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(ELECTIVE I)
REFRIGERATION AND AIR CONDITIONING

UNIT – I

VAPOUR COMPRESSION REFRIGERATION: Performance of Complete vapor compression system. **Components of Vapor Compression System:** The condensing unit – Evaporators – Expansion valve – Refrigerants – Properties – ODP & GWP - Load balancing of vapor compression Unit.

Compound Compression: Flash inter-cooling – flash chamber – Multi-evaporator & Multistage systems.

UNIT – II

PRODUCTION OF LOW TEMPERATURE: Liquefaction system; Cascade System – Applications.– Dry ice system.

Vapor absorption system – Simple and modified aqua – ammonia system – Representation on Enthalpy –Concentration diagram. Lithium – Bromide system Three fluid system – HCOP.

UNIT – III

AIR REFRIGERATION: Applications – Air Craft Refrigeration -Simple, Bootstrap, Regenerative and Reduced ambient systems – Problems based on different systems.

Steam Jet refrigeration system: Representation on T-s and h-s diagrams – limitations and applications.

Unconventional Refrigeration system – Thermo-electric – Vortex tube & Pulse tube – working principles.

UNIT – IV

AIR –CONDITIONING: Psychrometric properties and processes – Construction of Psychrometric chart. Requirements of Comfort Air – conditioning – Thermodynamics of human body – Effective temperature and Comfort chart – Parameters influencing the Effective

Temperature. Summer , Winter and year round air – conditioning systems.

Cooling load Estimation: Occupants, equipments, infiltration, duet heat gain fan load, Fresh air load.

UNIT – V

AIR –CONDITIONING SYSTEMS: All Fresh air , Re-circulated air with and without bypass, with reheat systems – Calculation of Bypass Factor, ADP,RSHF, ESHF and GSHF for different systems. **Components:**Humidification and dehumidification equipment – Systems of Air cleaning – Grills and diffusers – Fans and blowers – Measurement and control of Temperature and Humidity.

TEXT BOOKS:

1. Refrigeration & Air Conditioning /C.P. Arora/TMH
2. Refrigeration and Air Conditioning/Dossat /Mc Graw Hill

REFERENCES:

1. Refrigeration & Air Conditioning /Arora & Domkundwar/ Dhanpat Rai
2. Refrigeration and Air Conditioning /Manohar Prasad/
3. Refrigeration and Air Conditioning /Stoecker /Mc Graw Hill
4. Refrigeration and Air Conditioning /Jordan& Preister /Prentice Hall

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(ELECTIVE I)
RENEWABLE ENERGY TECHNOLOGIES

UNIT-I

Introduction, Energy Scenario, Survey of energy resources. Classification and need for conventional energy resources.

Solar Energy: The Sun, Sun Earth relationship, Basic matter to waste heat energy circuit, Solar Radiation, Attenuation, Radiation measuring instruments.

Solar Energy Applications: Solar water heating. Space heating, Active and passive heating. Energy storage. Selective surface. Solar stills and ponds, solar refrigeration, Photovoltaic generation.

UNIT-II

GEOTHERMAL ENERGY: Structure of earth, Geothermal Regions, Hot springs. Hot Rocks, Hot Aquifers. Analytical methods to estimate thermal potential. Harnessing techniques, Electricity generating systems.

UNIT-III

DIRECT ENERGY CONVERSION: Nuclear Fusion: Fusion, Fusion reaction, P-P cycle, Carbon cycle, Deuterium cycle, Condition for controlled fusion, Fuel cells and photovoltaic. Thermionic & thermoelectric generation, MHD generator.

Hydrogen Gas as Fuel: Production methods, Properties, I.C. Engines applications, Utilization strategy, Performances.

UNIT-IV

BIO-ENERGY: Biomass energy sources. Plant productivity, Biomass wastes, aerobic and Anaerobic bioconversion processes, Raw metrical and properties of bio-gas, Bio-gas plant technology and status, the energetics and economics of biomass systems, Biomass gasification

UNIT-V

WIND ENERGY: Wind, Beaufort number, Characteristics, Wind energy conversion systems, Types, Betz model. Interference factor. Power coefficient, Torque coefficient and Thrust coefficient, Lift machines and Drag machines. Matching, Electricity generation.

Energy from Oceans: Tidal energy. Tides. Diurnal and semi-diurnal nature, Power from tides, Wave Energy, Waves, Theoretical energy available. Calculation of period and phase velocity of waves, Wave power systems, Submerged devices. Ocean thermal Energy, Principles, Heat exchangers, Pumping requirements, Practical considerations.

TEXT BOOK:

1. Renewable Energy Resources/ John Twidell & Tony Weir/Taylor & Francis/2nd edition

REFERENCES:

1. Renewable Energy Resources- Basic Principles and Applications/ G.N.Tiwari and M.K.Ghosal/ Narosa Publications
2. Biological Energy Resources/ Malcolm Fleischer & Chris Lawis/E&FN Spon

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(ELECTIVE I)
THEORY AND TECHNOLOGIES OF FUEL CELLS

UNIT-I

INTRODUCTION

Relevance, Principle, various configurations (Alkaline, Acid, Proton Exchange Membrane, direct methanol, molten carbonate and solid oxide fuel cells) fuel cell applications.

Basic theory of electrochemistry, electrochemical energy conversion, electrochemical techniques. Thermodynamics of fuel cells. Heat and mass transfer in fuel cells. Single cell characteristics.

UNIT-II

MODELLING

Electrochemical model. Heat and mass transfer model. System thermodynamic model.

UNIT-III

LOW AND HIGH TEMPERATURE FUEL CELLS

Proton exchange membrane fuel cell (PEMFC) and direct methanol fuel cell (DMFC): their special features and characteristics.

Molten carbonate fuel cell (MCFC) and solid oxide fuel cell (SOFC) for power generation, their special features and characteristics.

UNIT-IV

FUELS AND FUEL PROCESSING

Availability, production and characteristics of Hydrogen , fossil fuel – diverted fuels and biomass- diverted fuels. Principles of design of PEMFC, DMFC and SOFC.

UNIT-V

FUEL CELL SYSTEM

Materials, component, stack, interconnects, internal and external reforming, system layout, operation and performance.

TEXT BOOKS:

1. Basu, S. (Ed) Fuel Cell Science and Technology, Springer, N.Y. (2007).
2. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY (2006).

REFERENCES:

1. J., Dick A., Fuel Cell Systems Explained, 2nd Ed. Wiley, 2003.
2. Liu, H., Principles of fuel cells, Taylor & Francis, N.Y. (2006).
3. Bard, A. J. , L. R., Faulkner, Electrochemical Methods, Wiley, N.Y. (2004) Ref Book.
4. M.T.M. Koper (ed.), Fuel Cell Catalysis, Wiley, Larminie 2009.
5. J.O'M. Bockris, A.K.N. Reddy, Modern Electrochemistry, Springer 1998.

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(ELECTIVE II)
ADVANCED I.C. ENGINES

UNIT - I

Introduction – Historical Review – Engine Types – Design and operating Parameters.

Cycle Analysis: Thermo-chemistry of Fuel – Air mixtures, properties – Ideal Models of Engine cycles – Real Engine cycles - differences and Factors responsible for – Computer Modeling.

UNIT - II

GAS EXCHANGE PROCESSES: Volumetric Efficiency – Flow through ports – Supercharging and Turbo charging.

Charge Motion: Mean velocity and Turbulent characteristics – Swirl, Squish – Pre-chamber Engine flows.

UNIT - III

ENGINE COMBUSTION IN S.I ENGINES: Combustion and Speed – Cyclic Variations – Ignition – Abnormal combustion Fuel factors, MPFI, SI engine testing.

Combustion in CI engines: Essential Features – Types off Cycle. Pr. Data – Fuel

Spray Behavior – Ignition Delay – Mixing Formation and control, Common rail fuel injection system.

UNIT - IV

POLLUTANT FORMATION AND CONTROL: Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, unburnt Hydrocarbon and particulate – Emissions – Measurement – Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps, Lean, NOx, Catalysts.

UNIT - V

ENGINE HEAT TRANSFER: Importance of heat transfer, heat transfer and engine energy balance, Convective heat transfer , radiation heat transfer, Engine operating characteristics.

Fuel supply systems for S.I. and C.I engines to use gaseous fuels like LPG, CNG and Hydrogen.

Modern Trends in IC Engines: Lean Burning and Adiabatic concepts, Rotary Engines, Modification in I.C engines to suit Bio – fuels, HCCI and GDI concepts.

TEXT BOOK:

1. I.C. Engines Fundamentals/J.B Heywood/TMH

REFERENCES:

1. I.C. Engines / V.Ganesan/TMH
2. I.C. Engines/G.K. Pathak & DK Chevan/ Standerd Publications
3. Computer Simulation of C.I. Engine Process/ V.Ganesan/University Press
4. Fundamentals of IC Engines/HN Gupta/PHI/2nd edition
5. I.C. Engines/Ferguson/Wiley
6. The I.C. Engine in theory and Practice Vol.I / Teylor / IT Prof. And Vol.II

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(ELECTIVE II)
SOLAR ENERGY TECHNOLOGY

UNIT - I

Introduction – Solar energy option, specialty and potential – Sun – Earth – Solar radiation, beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications.

Capturing solar radiation – physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collectors – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking – Performance Analysis.

UNIT - II

DESIGN OF SOLAR WATER HEATING SYSTEM AND LAYOUT

Power generation – solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers, concentration ratio.

UNIT - III

THERMAL ENERGY STORAGE: Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction – application and limitations.

Other solar devices – stills, air heaters, dryers, Solar Ponds & Solar Refrigeration, active and passive heating systems.

UNIT - IV

DIRECT ENERGY CONVERSION: solid-state principles – semiconductors – solar cells – performance – modular construction – applications. conversion efficiencies calculations.

UNIT - V

ECONOMICS: Principles of Economic Analysis – Discounted cash flow – Solar system – life cycle costs – cost benefit analysis and optimization – cost based analysis of water heating and photo voltaic applications.

TEXT BOOK:

1. Principles of solar engineering/ Kreith and Kerider/Taylor and Franscis/ 2nd edition

REFERENCES:

1. Solar energy thermal processes/ Duffie and Beckman/John Wiley & Sons
2. Solar energy: Principles of Thermal Collection and Storage/ Sukhatme/ TMH/2nd edition
3. Solar energy/ Garg/TMH
4. Solar energy/ Magal/Mc Graw Hill
5. Solar Thermal Engineering Systems / Tiwari and Suneja/Narosa
6. Power plant Technology/ El Wakil/TMH

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(ELECTIVE II)
TURBO MACHINES

UNIT-I

FUNDAMENTALS OF TURBO MACHINES: Classifications, Applications, Thermodynamic analysis, Isentropic flow. Energy transfer. Efficiencies, Static and Stagnation conditions, Continuity equations, Euler's flow through variable cross sectional areas, Unsteady flow in turbo machines

UNIT-II

STEAM NOZZLES: Convergent and Convergent-Divergent nozzles, Energy Balance, Effect of back pressure of analysis. Designs of nozzles.

Steam Turbines: Impulse turbines, Compounding, Work done and Velocity triangle, Efficiencies, Constant reactions, Blading, Design of blade passages, Angle and height, Secondary flow. Leakage losses, Thermodynamic analysis of steam turbines.

UNIT-III

GAS DYNAMICS: Fundamental thermodynamic concepts, isentropic conditions, mach numbers and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Super sonic flow, oblique shock waves. Normal shock recoveries, Detached shocks, Aerofoil theory.

Centrifugal compressor: Types, Velocity triangles and efficiencies, Blade passage design, Diffuserand pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

UNIT-IV

AXIAL FLOW COMPRESSORS: Flow Analysis, Work and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Drgree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance

Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

UNIT-V

AXIAL FLOW GAS TURBINES: Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifels relation, Design cascade analysis, Soderberg, Hawthrone, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, Off design performance.

TEXTBOOK:

1. Principles of Turbo Machines/DG Shepherd / Macmillan

REFERENCES:

1. Fundamentals of Turbomachinery/William W Perg/John Wiley & Sons
2. Element of Gas Dynamics/Yahya/TMH
3. Principles of Jet Propulsion and Gas Turbine/NJ Zucrow/John Wiley & Sons/Newyork
4. Turbines, Pumps, Compressors/Yahya/TMH
5. Theory and practice of Steam Turbines/ WJ Kearton/ELBS Pitman/ London
6. Element of Gas Dynamics/Liepeman and Roshkow/ Dover Publications

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(ELECTIVE II)
ALTERNATIVE FUELS TECHNOLOGIES

UNIT I

Fossil fuels and their limitations; Engine requirements; Potential alternative liquid and gaseous fuels.

UNIT II

Methods of production; Properties, safety aspects, handling and distribution of various liquid alternative fuels like alcohols, vegetable oils, Di-methyl and Di-ethyl ether etc.

UNIT III

Different ways of using alternative liquid fuels in engines, performance and emission characteristics; Conversion of vegetable oils to their esters and effect on engine performance.

UNIT IV

Use of gaseous fuels like biogas, LPG, hydrogen, natural gas, producer gas etc. in SI/CI engines; Production, storage, distribution and safety aspects of gaseous fuels.

UNIT V

Different approaches like duel fuel combustion and surface ignition to use alternative fuels in engines; Use of additives to improve the performance with alternative fuels; Hybrid power plants and fuel cell.

TEXT BOOK:

1. Alternative Fuels: The Future of Hydrogen, Second Edition**,** Michael Frank Hordeski, CRC Press

REFERENCES

1. Alternative Fuels for Transportation, A S Ramadhas, CRC Press
2. Alternative Fuels & Advanced Technology Vehicles: Incentives & Considerations, Thomas Huber, Jack Spera, Nova Science Publishers

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THERMAL ENGINEERING LABORATORY

1. Compressibility factor measurement of different real gases.
2. Dryness fraction estimation of steam.
3. Flame propagation analysis of gaseous fuels.
4. Performance test and analysis of exhaust gases of an I.C. Engine.
5. Heat Balance sheet, Volumetric Efficiency and air fuel ratio estimation of an I.C. Engine.
6. COP estimation of vapour compression refrigeration test.
7. Performance analysis of Air conditioning unit.
8. Performance analysis of heat pipe.
9. Performance evaluation of Solar Flat Plate Collector
10. Performance evaluation of Shell and Tube heat exchanger.
11. Performance evaluation of combined steam and gas power generation cycle.
12. Measurement of boundary layer thickness over an object using wind tunnel.

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FUELS, COMBUSTION AND ENVIRONMENT

UNIT – I

FUELS: Detailed classification – Conventional and Unconventional Solid, Liquid, gaseous fuels and nuclear fuels – Origin of Coal – Analysis of coal.

Coal – Carborisation, Gasification and liquification – Lignite: petroleum based fuels – problems associated with very low calorific value gases: Coal Gas – Blast Furnace Gas Alcohols and Biogas.

UNIT – II

PRINCIPLES OF COMBUSTION: Chemical composition – Flue gas analysis – dew point of products – Combustion stoichiometry.

Chemical kinetics – Rate of reaction – Reaction order – Molecularity – Zeroth, first, second and third order reactions - complex reactions – chain reactions. Theories of reaction Kinetics – General oxidation behavior of HC's.

UNIT – III

THERMODYNAMICS OF COMBUSTION: Enthalpy of formation – Heating value of fuel - Adiabatic flame Temperature – Equilibrium composition of gaseous mixtures.

UNIT – IV

LAMINAR AND TURBULENT FLAMES PROPAGATION AND STRUCTURE: Flame stability – Burning velocity of fuels – Measurement of burning velocity – factors affecting the burning velocity. Combustion of fuel, droplets and sprays – Combustion systems – Pulverized fuel furnaces – fixed, Entrained and Fluidised Bed Systems.

UNIT – V

ENVIRONMENTAL CONSIDERATIONS: Air pollution – Effects on Environment, Human Health etc. Principal pollutants – Legislative Measures – Methods of Emission control.

TEXT BOOK:

1. Fuels and combustion / Sharma and Chander Mohan/ Tata Mc Graw Hill

REFERENCES:

1. Combustion Fundamentals / Roger A strehlow / Mc Graw Hill
2. Combustion Engineering and Fuel Technology / Shaha A.K./ Oxford and IBH.
3. Principles of Combustion / Kanneth K.Kuo/ Wiley and Sons.
4. Combustion / Sarkar / Mc. Graw Hill.
5. An Introduction to Combustion / Stephen R. Turns/ Mc. Graw Hill International Edition.
6. Combustion Engineering / Gary L. Berman & Kenneth W. Ragland/ Mc. Graw Hill International Edition.

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ENERGY MANAGEMENT

UNIT-I

INTRODUCTION: Principles of energy management. Managerial organization, Functional areas for i) manufacturing industry, ii) Process industry, iii) Commerce, iv) Government, Role of Energy manager in each of these organizations. Initiating, Organizing and managing energy management programs

UNIT -II

ENERGY AUDIT: Definition and concepts. Types of energy audits, Basic energy concepts, Resources for plant energy studies. Data gathering, Analytical techniques. Energy Conservation: Technologies for energy conservation, Design for conservation of energy materials, Energy flow networks. Critical assessment of energy usage. Formulation of objectives and constrains, Synthesis of alternative options and technical analysis of options. Process integration.

UNIT-III

ECONOMIC ANALYSIS: Scope, Characterization of an investment project. Types of depreciation, Time value of money. Budget considerations, Risk analysis.

UNIT-IV

METHODS OF EVALUATION OF PROJECTS: Payback, Annualized costs, Investor's rate of return, Present worth, Internal rate of return, Pros and cons of the common method of analysis, Replacement analysis.

UNIT-V

ALTERNATIVE ENERGY SOURCES: SOLAR ENERGY: Types of devices for solar energy collections, Thermal storage system, Control systems. Wind Energy, Availability, Wind Devices, Wind Characteristics, performance of turbines and systems.

TEXT BOOK:

1. Energy Management Principles / CB Smith/ Pergamon Press

REFERENCES:

1. Energy Management Hand Book / W.C. Turner (Ed)
2. Energy Management / W.R.Murthy and G.Mc.Kay / BS Publication
3. Management / H.Koontz and Cyrill Donnel / McGraw Hill
4. Financial Management / S.C.Kuchhal / Chaitanya Publishing House

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FINITE ELEMENT METHOD

UNIT - I

Formulation Techniques: Methodology, Engineering problems and governing differential equations, finite elements., Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT – II

One-dimensional elements: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT – III

Two dimensional problems: CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

UNIT – IV

Isoparametric formulation: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle, Patch test.

UNIT – V

Finite elements in Structural Analysis: Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages.

TEXT BOOK:

1. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill,1983.

REFERENCES:

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994
2. Finite element methods by Chandrubatla & Belagondu.
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996
4. Concepts And Applications Of Finite Element Analysis, by Witt Plesha Malkus, Robert D Cook 4Th Ed Wiley India Pvt Ltd

I – II	L	P	Credits
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COMPUTATIONAL FLUID DYNAMICS

UNIT – I

Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations.

Solution methods: Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination.

Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

UNIT – II

Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations.

Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

UNIT – III

Formulations of incompressible viscous flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

Treatment of compressible flows: potential equation, Eluer equations, Navier-stokes system of equations, flowfield-dependent variation methods, boundary conditions, example problems.

UNIT – IV

Finite volume method: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

UNIT – V

Standard variational methods: Linear fluid flow problems, steady state problems, Transient problems.

TEXT BOOK:

1. Computational fluid dynamics, T. J.Chung, Cambridge University press,2002.
2. Computational Fluid Dynamics by John D. Anderson /TMH

REFERENCE:

1. Text book of fluid dynamics, Frank Chorlton, CBS Publishers &distributors, 1985.
2. Computational Techniques for Fluid Dynamics, Volume 1& 2 By C. A. J. Fletcher/ Springer

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(ELECTIVE III)
MATERIALS FOR THERMAL ENGINEERING

UNIT – I

Fundamentals of material science: Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening.

Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non crystalline material.

UNIT – II

Motivation of selection, cost basis and service requirements, selection for mechanical properties, strength, toughness, fatigue and creep, corrosion resistant materials and methods for controlling corrosion, use of material property charts for material selection.

UNIT – III

Modern metallic Materials: Dual phase steels, micro alloyed, high strength low alloy (HSLA) Steel, maraging steel, intermetalics, Ni and Ti aluminides, super alloys.

UNIT – IV

Non metallic materials: Polymeric materials and their molecular structures, production techniques for fibers, foams, adhesives and coatings, structure, properties and applications of engineering polymers. composites; Introduction, reinforcement, types of composite materials, - properties, processing and application of composite materials.

UNIT – V

Smart materials, shape memory alloys, metallic glass, quasi crystal and nano crystalline materials.

TEXT BOOKS:

1. Mechanical behavior of materials/Thomas H.Courtney/2nd Edition, McGraw-Hill, 2000
2. Mechanical Metallurgy/George E.Dieter/McGraw Hill, 1998
3. Material selction in mechanical design by M.F Ashby. Bott

REFERENCES:

1. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
2. ASM Hand book, Vol. 13 A, Corrosion Fundamentals, Testing and Protection.
3. Engineering mechanics of composite materials by Isaac M. Daniel, Ori Ishai/ Oxford university press

I – II	L	P	Credits
	4	-	3

(ELECTIVE III)
CONVECTIVE HEAT TRANSFER

UNIT-I

Introduction to Forced, free & combined convection – convective heat transfer coefficient – Application of dimensional analysis to convection – Physical interpretation of dimensionless numbers.

Equations of Convective Heat Transfer: Continuity, Navier-Strokes equation & energy equation for steady state flows – similarity – Equations for turbulent convective heat transfer – Boundary layer equations for laminar, turbulent flows – Boundary layer integral equations.

UNIT-II

EXTERNAL LAMINAR FORCED CONVECTION: Similarity solution for flow over an isothermal plate – integral equation solutions – Numerical solutions – Viscous dissipation effects on flow over a flat plate.

External Turbulent Flows: Analogy solutions for boundary layer flows – Integral equation solutions – Effects of dissipation on flow over a flat plate.

Internal Laminar Flows: Fully developed laminar flow in pipe, plane duct & ducts with other cross-sectional shapes - Pipe flows & plane duct flow with developing velocity & temperature fields.

Internal Turbulent Flows: Analogy solutions for fully developed pipe flow –Thermally developing pipe & plane duct flow.

UNIT – III

NATURAL CONVECTION: Boussineq approximation – Governing equations – Similarity – Boundary layer equations for free convective laminar flows – Numerical solution of boundary layer equations.

Free Convective flows through a vertical channel across a rectangular enclosure – Horizontal enclosure – Turbulent natural convection.

UNIT – IV

COMBINED CONVECTION: Governing parameters & equations – laminar boundary layer flow over an isothermal vertical plate – combined convection over a horizontal plate – correlations for mixed convection – effect of boundary forces on turbulent flows – internal flows - internal mixed convective flows – Fully developed mixed convective flow in a vertical plane channel & in a horizontal duct.

UNIT - V

CONVECTIVE HEAT TRANSFER THROUGH POROUS MEDIA: Area weighted velocity – Darcy flow model – energy equation – boundary layer solutions for 2-D forced convection – Fully developed duct flow – Natural convection in porous media – filled enclosures – stability of horizontal porous layers.

TEXT BOOK:

1. Convective Heat & Mass Transfer /Kays & Crawford/TMH

REFERENCE:

1. Introduction to Convective Heat Transfer Analysis/ Patrick H. Oosthuigen & David Naylor, MGH

I – II	L	P	Credits
	4	-	3

(ELECTIVE III)
THERMAL AND NUCLEAR POWER PLANTS

UNIT-I

INTRODUCTION: Sources of energy, Type of Power plants. Direct energy conversion system, Energy sources in India, Recent developments in power generation, Combustion of coal, Volumetric analysis, Gravimetric analysis. Flue gas analysis.

Steam power plant: Introduction. General layout of steam power plant, Modern coal. Fired Steam, Steam power plant-Power plant cycle, Fuel Handling, Combustion equipment, Ash handling, Dust collectors.

Steam Generators: Types, Accessories. Feed water heaters, Performance of boiling, Water treatment, Cooling towers. Steam turbines. Compounding of turbines, Steam condensers, Jet and surface condensers.

UNIT-II

GAS TURBINE POWER PLANT: Cogeneration. Combined cycle power plant, Analysis, Waste heat recovery, IGCC power plant, Fluidized bed, Combustion, Advantages, Disadvantages

UNIT-III

NUCLEAR POWER PLANT: Nuclear physics, Nuclear Reactor, Classification, Types of reactors, Site selection. Method of enriching uranium. Application of nuclear power plant. Nuclear Power Plant Safety: Bi-Product of nuclear power generation, Economics of nuclear power plant, Nuclear power plant in India, Future of nuclear power.

UNIT-IV

ECONOMICS OF POWER GENERATION: Factors affecting the economics, Loading factors, Utilization factor, Performance and operating characteristics of power plant, Point economic load sharing, Depreciation. Energy rate, Criteria for optimum loading. Specific economic energy problem

UNIT-V

POWER PLANT INSTRUMENTATIONS: Classification, Pressure measuring instrument, Temperature measurement and Flow Measurement, Analysis of combustion gases, Pollution types, Methods of control.

TEXT BOOKS:

1. Nuclear Power Plant Engineering/ James H. Rust/Haralson Publishing Company.
2. Powr Plant Technology / Mohamed Mohamed El-Wakil /Tata McGraw Hill
3. Thermal Engineering in Power Systems/R.S Amano, B. Sunden/WIT Press

REFERENCES:

1. Power Plant Engineering / P.K.Nag / TMH
2. Power Plant Engineering / R.K.Rajput/ Lakshmi Publications.
3. Power Plant Engineering / P.C.Sharma/ Kotearia Publications.

I – II	L	P	Credits
	4	-	3

(ELECTIVE III)
ADVANCED AUTOMOBILE ENGINEERING

UNIT -I Transmission systems

Clutch, gearbox, propeller shaft, differential, axle and wheels

UNIT- II Breaking systems

Mechanical, hydraulic & pneumatic breaking systems. Antilock breaking systems. Safety and security

UNIT- III Steering & Suspension systems

Mechanical and power steering. Mechanical, electronic and adaptive suspension systems.

UNIT- IV Electrical & Electronic systems

Wiring circuits, Trouble diagnosis & Trouble shooting, charging, starting and lighting system.

UNIT- V Hybrid vehicles & Motor vehicle act

Components of hybrid vehicles, Motor vehicle act.

TEXT BOOKS:

1. Automobile Engineering – by – Sudhir Kumar Saxena – University science press
2. Automotive Mechanics – by – S. Srinivasan – 2nd ed Mc GrawHill

REFERENCES:

1. Automobile Engineering – by – Kirpal Singh, Vol.I & II
2. Automobile Engineering – by – Hitner
3. Automotive Mechanics – by – Crouse, W.H & D.L. Anlin, 1oth Edition, McGrawHill

I – II	L	P	Credits
	4	-	3

(ELECTIVE-IV)
THERMAL MEASUREMENTS AND PROCESS CONTROLS

UNIT-I

GENERAL CONCEPTS: Fundamental elements of a measuring instrument. Static and dynamic characteristics – errors in instruments – Different methods of measurement and their analysis – Sensing elements and transducers.

Measurement of pressure – principles of pressure measurement, static and dynamic pressure, vacuum and high pressure measuring – Measurement of low pressure, Manometers, Calibration methods, Dynamic characteristics- design principles.

UNIT-II

MEASUREMENT OF FLOW: Obstruction meters, variable area meters. Pressure probes, compressible fluid flow measurement, Thermal anemometers, calibration of flow measuring instruments. Introduction to design of flow measuring instruments.

UNIT-III

TEMPERATURE MEASUREMENT: Different principles of Temperature Measurement, use of bimetallic thermometers – Mercury thermometers, Vapor Pressure thermometers,

Thermo positive elements, thermocouples in series & parallel, pyrometry, measurement of heat flux, calibration of temperature measuring instruments. Design of temperature measuring instruments.

UNIT-IV

Level Measurement: Direct & indirect methods, manometric methods, float level meters, electrical conductivity, Capacitive, Ultrasonic, and Nucleonic Methods.

Measurement of density – Hydrometer, continuous weight method, Gamma rays, Gas impulse wheel.

Velocity Measurement – Coefficient of viscosity, Ostesld method, free fall of piston under gravity, torque method.

Measurement of moisture content and humidity.

Measurement of thermal conductivity of solids, liquids and gases.

UNIT-V

PROCESS CONTROL: Introduction and need for process control principles, transfer functions, block diagrams, signal flow graphs, open and closed loop control systems – Analysis of First & Second order systems with examples of mechanical and thermal systems.

Control System Evaluation – Stability, steady state regulations, transient regulations.

TEXT BOOK:

1. Measurement System, Application & Design – E.O. Doeblin, MGH

REFERENCES:

1. Mechanical and Industrial Measurements – R.K. Jain – Khanna Publishers.
2. Mechanical Measurements – Buck & Beckwith – Pearson.
3. Control Systems, Principles & Design, 2nd Edition – M. Gopal – TMH.

I – II	L	P	Credits
	4	-	3

(ELECTIVE-IV)
CRYOGENIC ENGINEERING

UNIT-I

INTRODUCTION TO CRYOGENIC SYSTEMS: Mechanical Properties at low temperatures. Properties of Cryogenic Fluids.

Gas Liquefaction: Minimum work for liquefaction. Methods to protect low temperature. Liquefaction systems for gages other than Neon. Hydrogen and Helium.

UNIT II

LIQUEFACTION SYSTEMS FOR NEON, HYDROGEN AND HELIUM: Components of Liquefaction systems. Heat exchangers. Compressors and expanders. Expansion valve, Losses in real machines.

UNIT-III

GAS SEPARATION AND PURIFICATION SYSTEMS: Properties of mixtures, Principles of mixtures, Principles of gas separation, Air separation systems.

UNIT-IV

CRYOGENIC REFRIGERATION SYSTEMS: Working Medium, Solids, Liquids, Gases, Cryogenic fluid storage & transfer, Cryogenic storage systems, Insulation, Fluid transfer mechanisms, Cryostat, Cryo Coolers

UNIT-V

APPLICATIONS: Space technology, In-Flight air separation and collection of LOX, Gas industry, Biology, Medicine, Electronics.

TEXT BOOK:

1. Cryogenic Systems/ R.F.Barren/ Oxford University Press

REFERENCES:

2. Cryogenic Research and Applications: Marshal Sitting/ Von Nostrand/ Inc. New Jersey

3. Cryogenic Heat Transfer/ R.F.Baron

4. Cryogenic Engineering Edit / B.A. Hands/ Academic Press, 1986

5. Cryogenic Engineering/ R.B.Scottm Vin Nostrand/ Inc. New Jersey, 1959

6. Experimental Techniques in Low Temperature Physics- O.K. White, Oxford Press, 1968

7. Cryogenic Process Engineering/ K.D. Timmerhaus & TM Flynn/ Plenum Press, 1998

8. Hand Book of Cryogenic Engineering – J.G.Weisend –II, Taylor and Francis, 1998

I – II	L	P	Credits
	4	-	3

(ELECTIVE-IV)
JET PROPULSION AND ROCKETRY

UNIT - I

PRINCIPLES OF JET PROPULSION AND ROCKETRY: Fundamentals of jet propulsion, Rockets and air breathing jet engines – Classification – turbo jet , turbo fan, turbo prop, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

Nozzle Theory and Characteristics Parameters: Theory of one dimensional convergent – divergent nozzles – aerodynamic choking of nozzles and mass flow through a nozzle – nozzle exhaust velocity – thrust, thrust coefficient, A_c / A_t of a nozzle, Supersonic nozzle shape, non-adapted nozzles, summer field criteria, departure from simple analysis – characteristic parameters – 1) characteristic velocity, 2) specific impulse 3) total impulse 4) relationship between the characteristic parameters 5) nozzle efficiency, combustion efficiency and overall efficiency.

UNIT - II

AERO THERMO CHEMISTRY OF THE COMBUSTION PRODUCTS: Review of properties of mixture of gases – Gibbs – Dalton laws – Equivalent ratio, enthalpy changes in reactions, heat of reaction and heat of formation – calculation of adiabatic flame temperature and specific impulse – frozen and equilibrium flows.

Solid Propulsion System: Solid propellants – classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods. Composite propellant oxidizers and binders. Effect of binder on propellant properties. Burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates.

UNIT - III

Solid propellant rocket engine – internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters. Transient and pseudo equilibrium operation, end burning and burning grains, grain design. Rocket motor hard ware design. Heat transfer

considerations in solid rocket motor design. Ignition system, simple pyro devices.

Liquid Rocket Propulsion System: Liquid propellants – classification, Mono and Bi propellants, Cryogenic and storage propellants, ignition delay of hypergolic propellants, physical and chemical characteristics of liquid propellant. Liquid propellant rocket engine – system layout, pump and pressure feed systems, feed system components. Design of combustion chamber, characteristic length, constructional features, and chamber wall stresses. Heat transfer and cooling aspects. Uncooled engines, injectors – various types, injection patterns, injector characteristics, and atomization and drop size distribution, propellant tank design.

UNIT - IV

TURBO JET PROPULSION SYSTEM: Gas turbine cycle analysis – layout of turbo jet engine. Turbo machinery- compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis.

Flight Performance: Forces acting on vehicle – Basic relations of motion – multi stage vehicles

UNIT - V:

RAMJET AND INTEGRAL ROCKET RAMJET PROPULSION SYSTEM: Fuel rich solid propellants, gross thrust, gross thrust coefficient, combustion efficiency of ramjet engine, air intakes and their classification – critical, super critical and sub-critical operation of air intakes, engine intake matching, classification and comparison of IIRR propulsion systems.

TEXT BOOKS:

1. Mechanics and Dynamics of Propulsion/ Hill and Peterson/John Wiley & Sons
2. Rocket propulsion elements/Sutton/John Wiley & Sons/8th Edition

REFERENCES:

1. Gas Turbines/Ganesan /TMH
2. Gas Turbines & Propulsive Systems/Khajuria & Dubey/Dhanpat Rai & Sons
3. Rocket propulsion/Bevere/
4. Jet propulsion /Nicholas Cumpsty/

I – II	L	P	Credits
	4	-	3

(ELECTIVE-IV)
EQUIPMENT DESIGN FOR THERMAL SYSTEMS

UNIT-I

CLASSIFICATION OF HEAT EXCHANGERS: Introduction, Recuperation & regeneration, Tubular heat exchangers, Double pipe, shell & tube heat exchanger, Plate heat Exchangers, Gasketed plate heat exchanger. Spiral plate heat exchanger, Lamella heat exchanger, Extended surface heat exchanger, Plate fin and Tubular fin.

Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient, LMTD method for heat exchanger analysis, Parallel flow, Counter flow. Multipass, cross flow heat exchanger design calculations:

UNIT-II

DOUBLE PIPE HEAT EXCHANGER: Film coefficient for fluids in annulus, fouling factors, Calorific temperature, Average fluid temperature, The calculation of double pipe exchanger, Double pipe exchangers in series parallel arrangements.

Shell & Tube Heat Exchangers: Tube layouts for exchangers, Baffle heat exchangers, Calculation of shell and tube heat exchangers, Shell side film coefficients, Shell side equivalent diameter, The true temperature difference in a 1-2 heat exchanger. Influence of approach temperature on correction factor. Shell side pressure drop, Tube side pressure drop, Analysis of performance of 1-2 heat exchanger and design of shell & tube heat exchangers, Flow arrangements for increased heat recovery, the calculation of 2-4 exchangers.

UNIT-III

CONDENSATION OF SINGLE VAPOURS: Calculation of horizontal condenser, Vertical condenser, De-Super heater condenser, Vertical condenser-sub-Cooler, Horizontal Condenser-Sub cooler, Vertical reflux type condenser. Condensation of steam.

UNIT-IV

VAPORIZERS, EVAPORATORS AND REBOILERS: Vaporizing processes, Forced circulation vaporizing exchanger, Natural circulation vaporizing exchangers, Calculations of a reboiler. Extended Surfaces: Longitudinal fins. Weighted fin efficiency curve, Calculation of a Double pipe fin efficiency curve. Calculation of a double pipe finned exchanger, Calculation of a longitudinal fin shell and tube exchanger.

UNIT-V

DIRECT CONTACT HEAT EXCHANGER: Cooling towers, relation between wet bulb & dew point temperatures, The Lewis number and Classification of cooling towers, Cooling tower internals and the roll of fill, Heat Balance. Heat Transfer by simultaneous diffusion and convection, Analysis of cooling tower requirements, Deign of cooling towers, Determination of the number of diffusion units, Calculation of cooling tower performance.

TEXT BOOK:

1. Process Heat Transfer/D.Q.Kern/ TMH

REFERENCES:

1. Heat Exchanger Design/ A.P.Fraas and M.N.Ozisicj/ John Wiely & sons, New York.
2. Cooling Towers / J.D.Gurney and I.A. Cotter/ Maclaren

I – II	L	P	Credits
	-	6	4

(ELECTIVE-IV)
THERMAL SYSTEMS DESIGN LAB

Using software packages such as T K Solver, ANSYS, CATIA, PRO-E, HYPER MESH, NASTRAN, CFX, STARCD, MATLAB, FLUENT, GAMBIT etc., should design, model, analyze and optimize

(a) Various mechanical components of Steam, Nuclear, gas turbine and Solar power plants.

(b) Heat Exchangers.

(c) Cryogenic systems

(d) Propulsion systems

(e) Refrigeration & Air conditioning systems.

(f) Internal Combustion Engine systems

(g) Internal flows & External flows over stream lined bodies.

(h) Nano-fluid characteristics.

(i) Bio-fuel characteristics.

(j) Wind Energy systems.