HINDUSTAN UNIVERSITY

HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE

(Estd. u/s 3 of the UGC Act, 1956)

Padur, Kancheepuram District - 603 103.

DEPARTMENT OF
MECHANICAL ENGINEERING

Regulations Curriculum and Syllabus 2013

M.Tech.
THERMAL ENGINEERING

ACADEMIC REGULATIONS
(M.TECH./ M.B.A. / M.C.A.) (Full - Time / Part - Time)
(Effective 2013-14)

1. Vision, Mission and Objectives

1.1 The Vision of the Institute is "To make every man a success and no man a failure".

In order to progress towards the vision, the Institute has identified itself with a mission to provide every individual with a conducive environment suitable to achieve his / her career goals, with a strong emphasis on personality development, and to offer quality education in all spheres of engineering, technology, applied sciences and management, without compromising on the quality and code of ethics.

1.2 Further, the institute always strives

- To train our students with the latest and the best in the rapidly changing fields of Engineering, Technology, Management, Science & Humanities.
- To develop the students with a global outlook possessing, state of the art skills, capable of taking up challenging responsibilities in the respective fields.
- To mould our students as citizens with moral, ethical and social values so as to fulfill their obligations to the nation and the society.
- To promote research in the field of science, Humanities, Engineering, Technology and allied branches.

1.3 Our aims and objectives are focused on

- Providing world class education in engineering, technology, applied science and management.
- Keeping pace with the ever changing technological scenario to help our students to gain proper direction to emerge as competent professionals fully aware of their commitment to the society and nation.
- To inculcate a flair for research, development and entrepreneurship.

2. Admission

2.1 The admission policy and procedure shall be decided from time to time by the Board of Management (BOM) of the Institute, following guidelines issued by Ministry of Human Resource Development (MHRD), Government of India. The number of seats in each branch of the (M.TECH / M.B.A. / M.C.A.) programme will be decided by BOM as per the directives from Ministry of Human Resource Development (MHRD), Government of India and taking into account the market demands. Some seats for Non Resident Indians and a few seats for foreign nationals shall be made available.

2.2 The selected candidates will be admitted to the (M.TECH / M.B.A. / M.C.A.) programme after he/she fulfills all the admission requirements set by the Institute and after payment of the prescribed fees.

2.3 Candidates for admission to the first semester of the Master's Degree Programme shall be required to have passed an appropriate Degree Examination recognized by Hindustan University.

2.4 In all matters relating to admission to the (M.TECH / M.B.A. / M.C.A.). Programme, the decision of the Institute and its interpretation given by the Chancellor of the Institute shall be final.

2.5 If at any time after admission, it is found that a candidate has not fulfilled any of the requirements stipulated by the Institute, the Institute may revoke the admission of the candidate with information to the Academic Council.

3. Structure of the programme

3.1 The programme of instruction will have the following structure

i) Core courses of Engineering / Technology / Management.

ii) Elective courses for specialization in areas of student's choice

3.2 The minimum durations of the programmes are as given below:

Program	No. of Semesters
M.Tech.(Full-Time)	4
M.Tech.(Part -Time)	6
M.B.A. (Full - Time)	4
M.B.A. (Part - Time)	6
M.C.A.(Full - Time)	6
M.C.A.(Part -Time)	8

Every (M.TECH / M.B.A. / M.C.A.) programme will have a curriculum and syllabi for the courses approved by the Academic Council.

3.3 Each course is normally assigned certain number of credits. The following norms will generally be followed in assigning credits for courses.

- One credit for each lecture hour per week per semester
- One credit for each tutorial hour per week per semester
- One credit for each laboratory practical of three hours per week per semester.
- One credit for 4 weeks of industrial training and
- One credit for 2 hours of project per week per semester.

3.4 For the award of degree, a student has to earn certain minimum total number of credits specified in the curriculum of the relevant branch of study. The curriculum of the different programs shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below.

Program	Minimum prescribed credit range
M.Tech. (Full time / Part time)	75 - 85
M.B.A. (Full time / Part time)	85 - 95
M.C.A (Full time / Part time)	115 - 125

3.5 The medium of instruction, examination and the language of the project reports will be English.

4. Faculty Advisor

4.1 To help the students in planning their courses of study and for getting general advice on the academic programme, the concerned Department will assign a certain number of students to a Faculty member who will be called their Faculty Advisor.

5. Class Committee

5.1 A Class Committee consisting of the following will be constituted by the Head of the Department for each class:

(i) A Chairman, who is not teaching the class.

(ii) All subject teachers of the class.

(iii) Two students nominated by the department in consultation with the class.

The Class Committee will meet as often as necessary, but not less than three times during a semester.

The functions of the Class Committee will include:

(i) Addressing problems experienced by students in the classroom and the laboratories.

(ii) Analyzing the performance of the students of the class after each test and finding ways and means of addressing problems, if any.

(iii) During the meetings, the student members shall express the opinions and suggestions of the class students to improve the teaching / learning process.

6. Grading

6.1 A grading system as below will be adhered to.

Range of Marks	Letter Grade	Grade points
95-100	S	10
85 - 94	A	09
75- 84	B	08
65-74	C	07
55-64	D	06
50-54	E	05
< 50	U	00
	I (Incomplete)	–

6.2 GPA & CGPA

GPA is the ratio of the sum of the product of the number of credits C_i of course "i " and the grade points P_i earned for that course taken over all courses "i" registered by the student to the sum of Ci for all "i ". That is,

$$GPA = \frac{\sum_i C_i P_i}{\sum_i C_i}$$

CGPA will be calculated in a similar manner, at any semester, considering all the courses enrolled from first semester onwards.

6.3 For the students with letter grade I in certain subjects, the same will not be included in the computation of GPA and CGPA until after those grades are converted to the regular grades.

6.4 Raw marks will be moderated by a moderation board appointed by the Vice-Chancellor of the University. The final marks will be graded using an absolute grading system. The Constitution and composition of the moderation board will be dealt with separately.

7. Registration and Enrollment

7.1 Except for the first semester, registration and enrollment will be done in the beginning of the semester as per the schedule announced by the University.

7.2 A student will be eligible for enrollment only if he/she satisfies regulation 10 (maximum duration of the programme) and will be permitted to enroll if (i) he/she has cleared all dues in the Institute, Hostel & Library up to the end of the previous semester and (ii) he/she is not

debarred from enrollment by a disciplinary action of the University.

7.3 Students are required to submit registration form duly filled in.

8. Registration requirement

8.1 **(i)** A Full time student shall not register for less than 16 credits or more than 26 credits in any given semester.

8.1 **(ii)** A part time student shall not register for less than 10 credits or more than 20 credits in any given semester.

8.2 If a student finds his/her load heavy in any semester, or for any other valid reason, he/she may withdraw from the courses within three weeks of the commencement of the semester with the written approval of his/her Faculty Advisor and HOD. However the student should ensure that the total number of credits registered for in any semester should enable him/her to earn the minimum number of credits per semester for the completed semesters.

9. Minimum requirement to continue the programme

9.1 For those students who have not earned the minimum required credit prescribed for that particular semester examination, a warning letter to the concerned student and also to his parents regarding the shortage of his credit will be sent by the HOD after the announcement of the results of the university examinations.

10. Maximum duration of the programme

The minimum and maximum period for the completion of various programs are given below.

Program	Min. No. of Semesters	Max. No. of Semesters
M.Tech (Full - time)	4	8
M.Tech (Part - time)	6	10
M.B.A. (Full Time)	4	8
M.B.A. (Part Time)	6	10
M.C.A. (Full - Time)	6	12
M.C.A (Part -Time)	8	14

11. Temporary discontinuation

11.1 A student may be permitted by the Director(academic) to discontinue temporarily from the programme for a semester or a longer period for reasons of ill health or other valid reasons. Normally a student will be permitted to discontinue from the programme only for a maximum duration of two semesters.

12. Discipline

12.1 Every student is required to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which will tend to bring down the prestige of the University.

12.2 Any act of indiscipline of a student reported to the Director (Academic) will be referred to a Discipline Committee so constituted. The Committee will enquire into the charges and decide on suitable punishment if the charges are substantiated. The committee will also authorize the Director(Academic) to recommend to the Vice-Chancellor the implementation of the decision. The student concerned may appeal to the Vice-Chancellor whose decision will be final. The Director (Academic) will report the action taken at the next meeting of the Council.

12.3 Ragging and harassment of women are strictly prohibited in the University campus and hostels.

13. Attendance

13.1 A student whose attendance is less than 75% is not eligible to appear for the end semester examination for that semester. The details of all students who have attendance less than 75% will be announced by the teacher in the class. These details will be sent to the concerned HODs and Director (Academic).

13.2 Those who have less than 75% attendance will be considered for condonation of shortage of attendance. However a condonation of 10% in attendance will be given on medical reasons. Application for condonation recommended by the Faculty Advisor, concerned faculty member and the HOD is to be submitted to the Director (Academic) who, depending on the merits of the case, may permit the student to appear for the end semester examination. A student will be eligible for this concession at most in two semesters during the entire degree programme. Application for medical leave, supported by medical certificate with endorsement by a Registered Medical Officer, should reach the HOD within seven days after returning from leave or, on or before the last instructional day of the semester, whichever is earlier.

13.3 As an incentive to those students who are involved in extra curricular activities such as representing the University in Sports and Games, Cultural Festivals, and Technical Festivals, NCC/ NSS events, a relaxation of up to 10% attendance will be given subject to the condition that these students take prior approval from the officer-in-charge. All such applications should be recommended by the concerned HOD and forwarded to Director (Academic) within seven instructional days after the programme/activity.

14. Assessment Procedure

14.1 The Academic Council will decide from time to time the system of tests and examinations in each subject in each semester.

14.2 For each theory course, the assessment will be done on a continuous basis as follows:

Test / Exam	Weightage	Duration of Test Exam
First Periodical Test*	10%	2 Periods
Second Periodical Test*	10%	2 Periods
Model exam	20%	3 hours
Seminar/ Assignments/Quiz	20%	
End - semester examination	50%	3 Hours

*** Best out of the two tests will be considered.**

14.3 For practical courses, the assessment will be done by the subject teachers as below:

(i) Weekly assignment/Observation note book / lab records - weightage 60%.

(ii) End semester examination of 3 hours duration including viva - weightage 40%

15. Make up Examination/model examination

15.1 Students who miss the end-semester examinations / model examination for valid reasons are eligible for make-up examination /model examination. Those

who miss the end-semester examination / model examination should apply to the Head of the Department concerned within five days after he / she missed examination, giving reasons for absence.

15.2 Permission to appear for make-up examination / model exam will be given under exceptional circumstances such as admission to a hospital due to illness. Students should produce a medical certificate issued by a Registered Medical Practitioner certifying that he/she was admitted to hospital during the period of examination / model exam and the same should be duly endorsed by parent / guardian and also by a medical officer of the University within 5 days.

16. Project evaluation

16.1 For Project work, the assessment will be done on a continuous basis as follows:

Review / Examination	Weightage
First Review	10%
Second Review	20%
Third Review	20%
End semester Examination	50%

For end semester exam, the student will submit a Project Report in a format specified by the Director (Academic). The first three reviews will be conducted by a Committee constituted by the Head of the Department. The end - semester examination will be conducted by a Committee constituted by the Controller of Examinations. This will include an external expert.

17. Declaration of results

17.1 A candidate who secures not less than 50% of total marks prescribed for a course with a minimum of 50% of the marks prescribed for the end semester examination shall be declared to have passed the course and earned the specified credits for the course.

17.2 After the valuation of the answer scripts, the tabulated results are to be scrutinized by the Result Passing Boards of PG programmes constituted by the Vice-Chancellor. The recommendations of the Result Passing Boards will be placed before the Standing Sub Committee of the Academic Council constituted by the Chancellor for scrutiny. The minutes of the Standing Sub Committee along with the results are to be placed before the Vice-Chancellor for approval. After getting the approval of the Vice-Chancellor, the results will be published by the Controller of Examination/ Registrar.

17.3 If a candidate fails to secure a pass in a course due to not satisfying the minimum requirement in the end semester examination, he/she shall register and re-appear for the end semester examination during the following semester. However, the sessional marks secured by the candidate will be retained for all such attempts.

17.4 If a candidate fails to secure a pass in a course due to insufficient sessional marks though meeting the minimum requirements of the end semester examination, wishes to improve on his/ her sessional marks, he/she will have to register for the particular course and

attend the course with permission of the HOD concerned and the Registrar. The sessional and external marks obtained by the candidate in this case will replace the earlier result.

17.5 A candidate can apply for the revaluation of his/her end semester examination answer paper in a theory course within 2 weeks from the declaration of the results, on payment of a prescribed fee through proper application to the Registrar/Controller of Examinations through the Head of the Department. The Registrar/ Controller of Examination will arrange for the revaluation and the results will be intimated to the candidate concerned through the Head of the Department. Revaluation is not permitted for practical courses and for project work.

17.6 The weightage for internal marks in finalizing results and grades shall be waived off after completion of 5 semesters.

18. Grade Card

18.1 After results are declared, grade sheet will be issued to each student, which will contain the following details:

(i) Program and branch for which the student has enrolled.

(ii) Semester of registration.

(iii) List of courses registered during the semester and the grade scored.

(iv) Semester Grade Point Average (GPA)

(v) Cumulative Grade Point Average (CGPA).

19. Class / Division

19.1 Classification is based on CGPA and is as follows:

CGPA $\geq$ 8.0 : **First Class with distinction**

6.5 $\leq$ CGPA < 8.0 : **First Class**

5.0 $\leq$ CGPA < 6.5 : **Second Class.**

19.2 (i) Further, the award of 'First class with distinction' is subject to the candidate becoming eligible for the award of the degree having passed the examination in all the courses in his/her first appearance within the minimum duration of the programme.

(ii) The award of 'First Class' is further subject to the candidate becoming eligible to the award of the degree having passed the examination in all the courses within the below mentioned duration of the programme.

Program	No. of Semesters
M.Tech.(Full-Time)	5
M.Tech.(Part -Time)	7
M.B.A. (Full - Time)	5
M.B.A. (Part - Time)	7
M.C.A.(Full - Time)	7
M.C.A.(Part -Time)	9

(iii) The period of authorized discontinuation of the programme (vide clause 11.1) will not be counted for the purpose of the above classification.

20. Transfer of credits

20.1 Within the broad framework of these regulations, the Academic Council, based on the recommendation of the transfer of credits committee so constituted by the Chancellor may permit students to earn part of the credit requirement in other approved institutions of repute and status in the country or abroad.

21. Eligibility for the award of (M.TECH / M.B.A. / M.C.A.) Degree

21.1 A student will be declared to be eligible for the award of the (M.TECH / M.B.A. / M.C.A.). Degree if he/she has

i) registered and successfully credited all the core courses,

ii) successfully acquired the credits in the different categories as specified in the curriculum corresponding to the discipline (branch) of his/her study within the stipulated time,

iii) has no dues to all sections of the Institute including Hostels, and

iv) has no disciplinary action pending against him/her.

The award of the degree must be recommended by the Academic Council and approved by the Board of Management of the University.

22. Power to modify

22.1 Notwithstanding all that has been stated above, the Academic Council has the right to modify any of the above regulations from time to time subject to approval by the Board of Management.

HINDUSTAN UNIVERSITY
HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE
M.TECH. THERMAL ENGINEERING

Semester - I

Sl.	Course No	Course Title Code	L	T	P	C	TCH
THEORY							
1	PMA101	Advanced Engineering Mathematics	4	0	0	4	4
2	PTE 101	Advanced Heat Transfer	4	0	0	4	4
3	PTE 102	Advanced Thermodynamics	4	0	0	4	4
4	PTE 103	Advanced Fluid Mechanics	4	0	0	4	4
5	PTE 104	Instrumentation in Thermal Systems	4	0	0	4	4
6	PRA 101	Refrigeration Systems Design	4	0	0	4	4
PRACTICAL							
7	PTE 151	Thermal Engineering Lab	0	0	3	1	3
		Total				**25**	**27**

SEMESTER II

Sl.	Course No	Course Title Code	L	T	P	C	TCH
THEORY							
1	PTE 201	Fuels and Combustion	4	0	0	4	4
2	PTE 202	Advanced Internal Combustion Engineering	4	0	0	4	4
3	PTE 203	Energy Management and Audit	4	0	0	4	4
4	-	Elective - I*	4	0	0	4	4
5	-	Elective - II*	4	0	0	4	4
6	-	Elective - III*	4	0	0	4	4
PRACTICAL							
7	PTE 251	Simulation Lab	0	0	3	1	3
8	PTE 252	Design Project	0	0	6	2	6
		Total				**27**	**33**

SEMESTER - III

Sl.	Course No	Course Title Code	L	T	P	C	TCH
THEORY							
1	-	Elective - IV*	4	0	0	4	4
2	-	Elective - V*	4	0	0	4	4
3	-	Elective - VI*	4	0	0	4	4
PRACTICAL							
4	PTE 351	Project Work Phase I	0	0	12	6	12
5	PTE 352	Practical Industrial Training and viva voce (during Previous semester vacation)	-	-	-	1	-
		Total				**19**	**24**

SEMESTER - IV

Sl.	Course No	Course Title Code	L	T	P	C	TCH
THEORY							
1	PTE 451	Project Work Phase - II	0	0	24	12	24
		Total				**12**	**24**

ELECTIVE COURSES

Sl.	Course No	Course Title Code	L	T	P	C	TCH
THEORY							
1	PTE 701	Computational Fluid Dynamics	4	0	0	4	4
2	PTE 702	Renewable Energy Systems	4	0	0	4	4
3	PTE 703	Cogeneration & Waste Heat Recovery Systems	4	0	0	4	4
4	PTE 704	Energy System Modeling & Analysis	4	0	0	4	4
5	PTE 705	Advanced power Plant Engineering	4	0	0	4	4
6	PTE 706	Fundamentals of Turbulence Modeling	4	0	0	0	4
7	PRA 203	Refrigeration Machinery & Components	4	0	0	4	4
8	PRA 701	Cryogenic Engineering	4	0	0	4	4
9	PRA 702	Food Processing, Preservation & Transport	4	0	0	4	4
10	PTE 707	Thermal Energy Systems	4	0	0	4	4
11	PTE 708	Fans, Blowers & Compressors	4	0	0	4	4
12	PTE 709	Quantitative and Qualitative Research	4	0	0	4	4
13	PTE 710	Environmental Engineering & Pollution Control	4	0	0	4	4

* Student is permitted to choose an elective from other programmes. The electives may include the core subjects offered by other programmes.

Semester wise Credits

Semester I **25**

Semester II **27**

Semester III **19**

Semester IV **12**

Total Credits **83**

SEMESTER - I

PMA101 - ADVANCED ENGINEERING MATHEMATICS
[Common to M.Tech (Aero/Mech/Auto/CAD/Thermal/R&AC and IC Engine)]

L	T	P	C
3	1	0	4

Goal

Develop the Mathematical skills to formulate certain practical problems, solve them and analytically and numerically and to interpret the results.

Objectives

The course should enable the student to

1. Functional and the concepts of calculus of variation and its properties. Learns techniques to find the extremals of the variational problems involving one many unknown functions, functional dependent on higher order derivatives and isoperimetric problems.
2. Classify the initial and boundary value problems. Understands the D'Alemberts solution of the one dimensional wave equation. Understand the Fourier transform techniques for solving heat flow problems in infinite and semi infinite rod.
3. Learn Harmonic functions and their properties. Understands solving the Laplace equation using Fourier transforms in a half plane with infinite strip and in a semi infinite strip.
4. Classify the partial differential equations. Learn the methods of solving second order partial differential equations numerically.
5. Mapping and learns the concept of conformal mapping by doing the transformation from z plane to w plane

Outcomes

The students should be able to:

1. Find the extremals of the functional of different types and uses their technique to find the geodesic and solves isoperimetric problems. Using direct method finds the approximate solution and compares with the exact solutions using Ritz and Kantorovich methods.
2. Form the wave equations with initial conditions and solve them using D'Alemberts solutions. Solves the wave equations using Laplace transform for displacements in long string - long string under its weight and free and forced vibrations. Applies Fourier transform techniques for solving the heat flow problems with infinite and semi infinite rods.
3. Find the steady state temperature by solving the Laplace equation using Fourier transform techniques. Solves the heat flow problems in a half plane with infinite strip and in a semi infinite strip
4. Solve the initial and boundary value problems related heat flow, both one and two dimensional and vibration problems and obtains their numerical solutions. Understands the numerical techniques of solving the partial differential equation in engineering applications.
5. Apply conformal mapping to fluid and heat flow problems.

UNIT I CALCULUS OF VARIATIONS **12**

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- Isoperimetric problems - Direct methods-Ritz and Kantrovich methods

UNIT II TRANSFORM METHODS **12**

Laplace transform methods for one dimensional wave equation - Displacements in a long string - Longitudinal vibration of an elastic bar - Fourier Transform methods for one dimensional heat conduction problems in infinite and semi-infinite rod

UNIT III ELLIPTIC EQUATIONS **12**

Laplace equation - Properties of Harmonic functions - Solutions of Laplace equation by means of Fourier transform in a half plane in an infinite strip and in a semi-infinite strip

UNIT IV NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS **12**

Solution of Laplace and Poisson equation on a rectangular region by Lieebmann's method - Diffusion equation by the explicit and Crank Nicolson - Implicit methods - Solution of wave equations by explicit scheme Cubic spline interpolation.

UNIT V CONFORMAL MAPPING AND APPLICATIONS **12**

The Schwarz - Christoffel transformation - Transformation of boundaries in parametric form - Physical applications - Application to fluid and heat flow.

Total - 60

REFERENCES

1. Gupta A.S., "Calculus of Variations with Applications", Prentice Hall of India(P) Ltd., New Delhi, 6th print, 2006
2. Sankar Rao K. - "Introduction to Partial Differential Equations", Prentice Hall of India(P) Ltd., New Delhi, 5th print, 2004
3. Jain R.K, and Iyengar S.R.K., - "Advanced Engineering Mathematics", Narosa publications 2nd Edition, 2006
4. Grewal, B.S - "Numerical Methods in Science and Engineering", Kanna Publications, New Delhi.
5. Kandasamy P., Thilagavathy. K and Gunavathy, K - "Numerical Methods", S Chand and Co., Ltd., New Delhi, 5th Edition, 2007
6. Spiegel M. R., "Theory and problems of Complex Variables with an Introduction to Conformal Mapping and Its applications", Schaum's outline series, Mc Graw Hill Book Co., 1987.

.6. Give insight to Numerical Methods In Heat Transfer.

PTE101 - ADVANCED HEAT TRANSFER

L	T	P	C
4	0	0	4

Goal

The course is intended to build up necessary background for understanding the physical behaviour of various modes of heat transfer like conduction, Turbulent convective Heat Transfer, Phase change Heat Transfer and radiation.

Objectives

The course should enable the students to:

1. Learn the physical behaviour of various modes of heat transfer like conduction, Turbulent convective Heat Transfer, Phase change Heat Transfer and radiation
2. Know the application of various experimental heat transfer correlations in engineering calculations.
3. Understand the thermal analysis and sizing of heat exchangers.
4. Understand the concepts of Radiation Heat Transfer.
5. Learn the concepts of Turbulent boundary layer and its importance in convection phenomenon.
6. Give insight to Numerical Methods In Heat Transfer.

Outcome

The students should be able to:

1. Understand the difference between various modes of Heat Transfer.
2. Know about Finite Difference Method and Finite Volume Method.
3. Understand various correlations involve in Compact Heat Exchanger and Fins.
4. Learn to apply various correlations used in Convective Heat Transfer.
5. Design/size Heat Exchanger.

UNIT - I CONDUCTION AND RADIATION HEAT TRANSFER **10**

One dimensional energy equations and boundary condition, three-dimensional heat conduction equations, Extended surface heat transfer, Conduction with moving boundaries, Radiation in gases and vapour. Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media - interaction of radiation with conduction and convection.

UNIT - II TURBULENT FORCED CONVECTIVE HEAT TRANSFER **12**

Momentum and Energy Equations, Turbulent Boundary Layer Heat Transfer, Mixing length concept, Turbulence Model - K-? Model, Analogy between Heat and Momentum Transfer - Reynolds, Colburn, Vou Karman, Turbulent flow in a Tube, High speed flows.

UNIT - III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER 8

Condensation with shear edge on bank of tubes, Boiling - pool and flow boiling, Heat exchanger, ? - NTU approach and design procedure, compact heat exchangers.

UNIT - IV NUMERICAL METHODS IN HEAT TRANSFER 10

Finite difference formulation of steady and transient heat conduction problems - Discretization schemes - Explicit, Crank Nicolson and Fully Implicit schemes,Control volume formulation, Steady one dimensional convection and Diffusion Problems, Calculation of the flow field - SIMPLER Algorithm.

UNIT - V MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION 5

Mass Transfer, Vaporization of droplets, Combined heat and mass transfer, Heat Transfer Correlations in various applications like I.C. Engines, Compressors & turbines.

TUTORIAL: 15, TOTAL: 60

REFERENCES

1. Incropera F.P. and DeWitt. D.P.,Fundamentals of Heat & Mass Transfer, John Wiley & Sons, 5th Edition , 2009.
2. Ozisik. M.N., Heat Transfer - Basic Approach, McGraw-Hill Co., 1985
3. Schlichting, Gersten, Boundarylayer Theory, Springer, 8th Edition, 2009.
4. P.K. Nag, Heat Transfer, Tata McGraw-Hill, 2nd Edition , 2009.
5. Rohsenow. W.M., Harnett. J.P., and Ganic. E.N.,Handbook of Heat Transfer Applications, McGraw-Hill, NY, 3rd Edition,1998.
6. Ghoshdasdidar. P.S.,Compiler simulation of flow and Heat Transfer,Tata McGraw-Hill,1998
7. Patankar. S.V.Numerical heat Transfer and Fluid flow,Hemisphere Publishing Corporation,2009

PTE102 - ADVANCED THERMODYNAMICS

L	T	P	C
4	0	0	4

Goal

To provide the students with knowledge on various thermodynamic properties and make them aware of the practical implications of themodynamic relations.

Objectives

The course should enable the students to

1. Gain knowledge availability analysis and thermodynamic properties.
2. Understand real gas behaviours and multi - component systems.
3. Learn chemical thermodynamics and equilibrium.
4. Gain knowledge on statistical thermodynamics.
5. Learn irreversible thermodynamics.

Outcomes

The students has knowledge of

1. Availability analysis and thermodynamic properties.
2. Real gas behaviours and multi - component systems.
3. Chemical thermodynamics and equilibrium.
4. Statistical thermodynamics and it impact on various applications.
5. Irreversible thermodynamics and it's varied application.

UNIT - I AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS **12**

Availability, Irreversibility and Second-Law Efficiency for a closed System and steady-state Control Volume.Availability Analysis of Simple Cycles.Thermodynamic Potentials,Maxwell relations, Generalised relation for changes in Entropy, Internal Energy and Enthalpy, Generalised Relations for Cp and Cv Clausius Claypeyron Equation, Joule-Thomson Coefficient,Bridgman Tables for thermodynamic relations.

UNIT - II REAL GAS BEHAVIOUS AND MULTI - COMPONENT SYSTEMS **12**

Different Equations of State, Fugacity, Compressibility, Principle of Corresponding States, Use of generalized charts for enthalpy and entropy departure, fugacity coefficient, Lee-Kesler generalized three parameter tables. Fundamental property relations for systems of variable composition, partial molar prosperities, Real gas mixtures, Ideal solution of real gases and liquids, Equilibrium in multi phase systems, Gibbs phase rule for non-reactive components.

UNIT - III CHEMICAL THERMODYNAMICS AND EQUILIBRIUM **12**

Thermo chemistry, first Law analysis of reacting systems, Adiabatic Flame temperature,Entropy change of reacting systems, Second Law analysis of reacting systems, Criterion for reaction equilibrium composition.

UNIT - IV STATISTICAL THERMODYNAMICS **12**

Microstates and Macrostates, Thermodynamic probability, Degeneracy of energy levels, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein Statistics, Microscopic Interpretation of heat and work, Evaluation of entropy, Partition function, Calculation of the Microscopic properties from partition functions.

UNIT - V IRREVERSIBLE THERMODYNAMICS **12**

Conjugate Fluxes and Forces, Entropy Production, Onsager's Reciprocity relations, thermo-electric phenomena and formulations.

TUTORIAL:15,

TOTAL: 60

REFERENCES

1. Kenneth Wark Jr., Advanced Thermodynamics for Engineers, McGraw-Hill Inc.,1995.
2. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Sons, 1998.
3. Holman, J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc., 1998.
4. Smith, J.M and Van Ness., H.C., Introduction to chemical Engineering Thermodynamics, Fourth Edition, McGraw-Hill Inc., 6th Edition , 2007.
5. Sonntag, R.E., and Vann Wylen, G, Introduction to Thermodynamics, Classical and Statistical, third Edition, John Wiley and Sons, 1991.
6. Sears,F.W.andSalingerG.I.,Thermodynamics,KineticTheoryandStatisticalThermodynamics, third Edition, Narosa Publishing House, New Delhi, 3rd Edition , 1998.
7. DeHoft, R.T. Thermodynamics in Materials Science, McGraw-Hill Inc., 1993.
8. Rao, Y.V.C., Postulational and Statistical thermodynamics, Allied Publisher Limited, New Delhi, 1994.

PTE103- ADVANCED FLUID MECHANICS

L	T	P	C
4	0	0	4

Goal

The goal of the programme is to provide advance concepts for ideal and non ideal flows, to impart the knowledge of various types of flow like two dimensional flow, turbulent flow and compressible flow through ducts and to provide the details shock waves.

Objectives

The course should enable the students to:

1. To understand advance concepts for ideal and non ideal flows.
2. To understand various types of flow like two dimensional flow, turbulent flow and compressible flow through ducts.
3. To understand the details of shock waves.

Outcome

The students should be able to:

1. To know advance concepts for ideal and non ideal flows.
2. To get the knowledge of various types of flow like two dimensional flow, turbulent flow and compressible flow through ducts.
3. To know the details of shock waves.

UNIT - I INTRODUCTION **12**

Ideal and non-ideal flows, general equations of fluid motion, Navier - stokes equations and their exact solutions. Boundary layer theory, wedge flows, laminar flow over plates and through cylinders.

UNIT - II TWO DIMENSIONAL FLOW **12**

Subsonic flow, physical significance of irrotational motion - Kelvin's theorem - Differential equation in terms of velocity Potential and stream function - Flow with small purtubaration - flow past a wave shaped wall - Gothert's rule - Prandtl Glanert rule - Hodograph method

UNIT - III TURBULENT FLOW **12**

Turbulence, models and flow equations: steady and unsteady turbulent boundary layers.

UNIT - IV COMPRESSIBLE FLOW THROUGH DUCTS **12**

Introduction to compressible viscous flow, governing equations, flow with friction flow with heat transfer flow though nozzle and diffusers.

UNIT - V SHOCK WAVE **12**

Normal and oblique shocks - Prandtl - Meyer expansion - Rankine - Hugnoit relation, Application of method of characteristics applied to two dimensional case - simple supersonic wind tunnel Design of supersonic wind tunnel and nozzle

TOTAL: 60

REFERENCES

1. T Radhakrishnan - Gas Dynamics, Prentice Hall, New Delhi.16 M.E. Thermal Engg
2. Mohanty A K- Fluid Mechanics, Prentice Hall of India, 1986
3. Shapiro A F -The Dynamics of Compressible flow Vol 1, The Ronald Press company 1963
4. Shames- Mechanics of Fluids, Megraw-Hill Inc
5. Schlichting H - Boundary layer theory, McGraw Hill-Inc
6. Yahya S.M, "Fundamentals of Compressible flow", New Age International (P) Ltd.New Delhi,1996.

PTE 104 - INSTRUMENTATION IN THERMAL SYSTEMS

L	T	P	C
4	0	0	4

Goal

To provide the students with knowledge on various instrument and methods of measurement used in thermal engineering.

Objectives

The course should enable the students to

1. Classify the measuring instruments and understand the type of errors as to arrive at the correct measurement.
2. Understand the use of microprocessors in measuring instruments.
3. Learn the methods of measuring the physical quantities

4. Gain knowledge about various flow visualization methods.

5. Learn the various measurement analysis techniques.

Outcomes

The students has knowledge of

1. Identifying the various measuring instruments and read error free measurement.

2. Use microprocessors as a part of measuring system.

3. Measuring various physical quantities with apt methods.

4. Various types of flow visualization methods

5. Various measurement analysis techniques for apt applications.

UNIT - I MEASUREMENT CHARACTERISTICS **15**

Instrument Classification, Characteristics of Instruments - Static and dynamic, Experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments.

UNIT - II MICROPROCESSORS AND COMPUTERS IN MEASUREMENT **8**

Data logging and acquisition, Use of intelligent instrument for error reduction, Elements of micro-computer interfacing, Intelligent instruments in use.

UNIT - III MEASUREMENT OF PHYSICAL QUANTITIES **13**

Measurement of thermo-physical properties, Instruments for measuring temperature, pressure and flow, Use of intelligent instruments for the physical variables.

UNIT - IV FLOW VISUALISATION **11**

Techniques, Shadow graph, Schlieren, interferometer, Laser Doppler anemometer, Heat flux measurement, Telemetry in engines.

UNIT - V MEASUREMENT ANALYSIS **13**

Chemical, Thermal, Magnetic and Optical gas analysers, Measurement of smoke, dust and moisture, Gas Chromatography, Spectrometry, Measurement of pH, Review of basic measurement techniques.

TOTAL : 60

REFERENCES

1. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 7th Edition, 2008..

2. Barney, Intelligent Instrumentation, Prentice Hall of India, 1988.

3. Prebrashensky. V., Measurement and Instrumentation in Heat Engineering, Vol.1 and 2, MIR Publishers, 1980.

4. Raman, C.S. Sharma, G.R., Mani, V.S.V., Instrumentation Devices and Systems,Tata McGraw-Hill, New Delhi, 1983.

5. Doeblin, Measurement System Application and Design, McGraw-Hill, 1978.

6. Morris. A.S, Principles of Measurements and Instrumentation Prentice Hall of India, 1998.

PRA 101 - REFRIGERATION SYSTEMS DESIGN

L	T	P	C
4	0	0	4

Goal

To expose the principles and design of various systems involved in refrigeration.

Objectives

The course should enable the students to:

1. Know about Refrigeration cycles
2. Understand the Various Components: its working and design
3. Know about system balancing and Controls involved in Refrigeration units
4. Learn about unconventional refrigeration cycles .

Outcome

The students should be able to:

1. Understand the various types of refrigeration systems and Psychrometric processes.
2. Learn the classification of refrigerants and its properties
3. Understand about different controls relays and motors employee in refrigeration.
4. Estimate the cooling load
5. Know about the Air-Conditioning equipments and their applications.

UNIT - I REFRIGERATION CYCLES - ANALYSIS **13**

Carnot Cycle, Air Refrigeration Cycles, Vapor Compression Refrigeration Cycle from Basic - Analysis Multipressure Systems, Cascade Systems.

UNIT - II MAIN SYSTEM COMPONENTS **15**

Compressors, Condensers, Evaporators - Types and performance, Expansion devices - types and selection.

UNIT - III REFRIGERANTS - HANDLING **9**

Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact. - Montreal / Kyoto protocols - Eco Friendly Refrigerants.

UNIT - IV SYSTEM BALANCING & CONTROLS **14**

Estimation of Cooling Load, System Equilibrium, Balancing and matching of components, and Cycling Controls, Electric Circuits in - Refrigerators, Window A/C, Types of motors, Relays, Different Types of Refrigeration Tools, Evacuation and Charging Unit, Recovery and Recycling Unit, Vacuum Pumps.

UNIT - V UNCONVENTIONAL REFRIGERATION CYCLES **9**

Vapor Absorption Systems - Aqua Ammonia & LiBr Systems, Steam Jet Refrigeration, Thermo Electric Refrigeration.

TOTAL : 60

REFERENCES

1. Dossat R.J., Principles of refrigeration, John Wiley, S.I. Version ,4th Edition , 2006.
2. W.F. Stoecker, Refrigeration and Air conditioning, McGraw-Hill Book Company, 1989.
3. Jordan and Priester, Refrigeration and Air conditioning, 1985.
4. Goshnay W.B., Principles and Refrigeration, Cambridge University Press, 1982.
5. Langley, Billy C., 'Solid state electronic controls for HVACR' Prentice-Hall 1989.

WEB REFERENCES

1. http://gort.ucsd.edu/newjour/i/msg02859.html
2. http://www.brazeway.com/refrigeration
3. http://Progdev.sait.ab.ca/pwen220/119.ref-com.htm
4. http://147.46.94.112/journal/sej.

PTE 151 - THERMAL ENGINEERING LAB

L	T	P	C
0	0	3	1

Goal

To gain experimental knowledge on the performance and operation of heat engine, air conditioner and boiler.

Objectives

The course should enable the students to:

1. Understanding the basic concept and utilisation of heat for accomplishing useful work.
2. Understanding the basic concept and working of refrigerator and IC engines.
3. To learn the basic principle of air conditioning system and its COP.
4. To learn the basic working of solar water heater, cooling tower.

Outcome

The students should be able to:

1. Analyse the flue gas emission for SI and CI engine.
2. Understand the types of engine available and it's working..
3. Analyze the performance and working of different types of air conditioning system.
4. Understand the practical working of renewable energy sources.

CYCLE 1

1. Performance test on Spark Ignition engines.
2. Emission measurement in Spark Ignition and Compression Ignition Engines.
3. Performance test on variable compression ratio petrol and diesel engines.
4. Performance study in a cooling tower
5. Performance study in a refrigeration and heat pump systems
6. Performance Study in a solar water heater

CYCLE 2

1. Properties of fuel oils, biomass, biogas
2. Solar Radiation measurement
3. Boiler efficiency testing
4. Performance of Heat Exchangers
5. Study on Fuel Cell Systems
6. Study on Thermal Storage Systems

EQUIPMENTS REQUIRED

1. Mutlicyclinder Automotive Engine
2. CO/HC/Nox Analysers
3. Smoke meter
4. Variable Compression ratio petrol and diesel engines
5. Cooling tower test rig
6. Refrigeration cum Heat Pump test rig
7. Solar flat plate water heater test rig
8. Instruments for measuring solid / liquid / gas fuels properties
9. Solar Radiation measuring instruments
10. Non-IBR Boiler test rig
11. Heat exchanger test rig

PTE 201 - FUELS & COMBUSTION

L	T	P	C
4	0	0	4

Goal

The goal of the programme is to introduce about various types of fuels, to impart the knowledge of stoichiometry & kinetics of fuels and to provide the details of various combustion equipments.

Objectives

The course should enable the students to:

1. To understand about various types of fuels.
2. To understand the knowledge of stoichiometry & kinetics of fuels.
3. To understand the details of various combustion equipments.

Outcome

The students should be able to:

1. To know about various types of fuels.
2. To know the stoichiometry & kinetics of fuels.
3. To know the details of various combustion equipments.

UNIT - I CHARACTERIZATION **11**

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels - Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination - Calorific Value - Gross & Net Calorific Values - Calorimetry - DuLong's Formula for CV Estimation - Flue gas Analysis - Orsat Apparatus - Fuel & Ash Storage & Handling - Spontaneous Ignition Temperatures.

UNIT - II SOLID FUELS & LIQUID FUELS **13**

(a) Solid Fuels

Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Washability - Coking & Caking Coals - Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels - Manufactured Solid Fuels.

(b) Liquid Fuels

Types - Sources - Petroleum Fractions - Classification - Refining - Properties of Liquid Fuels - CalorificValue, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number etc, - Alcohols - Tar Sand Oil - Liquefaction of Solid Fuels.

UNIT - III GASEOUS FUELS **10**

Classification - Composition & Properties - Estimation of Calorific Value - Gas Calorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas - Dry & Wet Natural Gas - Stripped NG - Foul & Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas - Town Gas - Coal Gasification - Gasification Efficiency Non Thermal Route - Biogas - Digesters - Reactions - Viability -Economics.

UNIT - IV COMBUSTION : STOICHIOMETRY & KINETICS **15**

Stoichiometry - Mass Basis & Volume Basis - Excess Air Calculation - Fuel & Flue Gas Compositions - Calculations - Rapid Methods - Combustion Processes - Stationary Flame - Surface or Flameless Combustion - Submerged Combustion - Pulsating & Slow Combustion, Explosive Combustion.

Mechanism of Combustion - Ignition & Ignition Energy - Spontaneous Combustion - Flame Propagation - Solid, Liquid & Gaseous Fuels Combustion - Flame Temperature - Theoretical, Adiabatic & Actual - Ignition Limits - Limits of Inflammability.

UNIT - V COMBUSTION EQUIPMENTS **11**

Coal Burning Equipments - Types - Pulverized Coal Firing - Fluidized Bed Firing - Fixed Bed & Recycled Bed - Cyclone Firing - Spreader Stokers - Vibrating Grate Stokers - Sprinkler Stokers, Traveling Grate Stokers.

Oil Burners - Vaporizing Burners, Atomizing Burners - Design of Burners.Gas Burners - Atmospheric Gas Burners - Air Aspiration Gas Burners - Burners Classification according to Flame Structures - Factors Affecting Burners & Combustion.

TOTAL : 60

REFERENCES

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 2007.
2. Bhatt, Vora Stoichiometry, 2nd Edition, Tata McGraw Hill, 4th Edition , 2009.
3. Blokh AG,Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn, 1988
4. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966
5. Sharma SP, Mohan Chander, Fuels & Combustion, Tata McGraw Hill, 1984.

PTE 202 - ADVANCED INTERNAL COMBUSTION ENGINEERING

L	T	P	C
4	0	0	4

Goal

To expose the students to advanced concepts involved in combustion and emission of IC engines.

Objectives

The course should enable the students to:

1. Understand the combustion phenomena of I.C Engines.
2. Understand the significance of alternative fuel and emission I.C Engines.

Outcome

The students should be able to:

1. Know about the advances taken place in IC engines and the important role of combustion in improving the performance.
2. Know about the alternative fuels and emission to meet the world standard.

UNIT - I SPARK IGNITION ENGINES **12**

Spark ignition engine mixture requirements - Fuel - Injection systems - Monopoint, Multipoint injection, Direct injection - Stages of combustion - Normal and abnormal combustion - Factors affecting knock - Combustion chambers.

UNIT - II COMPRESSION IGNITION ENGINES **12**

States of combustion in C.I. Engine - Direct and indirect injection systems - Combustion chambers - Fuel spray behaviour - Spray structure, Spray penetration and evaporation - Air motion - Introduction to Turbo charging.

UNIT - III POLLUTANT FORMATION AND CONTROL **12**

Pollutant - Sources - Formation of carbon monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter - Methods of controlling Emissions - Catalytic converters and Particulate Traps - Methods of measurements and Introduction to emission norms and Driving cycles.

UNIT - IV ALTERNATIVE FUELS **12**

Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications.

UNIT - V RECENT TRENDS **12**

Lean Burn Engines - Stratified charge Engines - homogeneous charge compression ignition engines - Plasma Ignition - Measurement techniques - Laser Doppler, Anemometry.

TOTAL NO: 60

REFERENCES

1. R.B.Mathur and R.P. Sharma, Internal combustion Engines, 2009.
2. V. Ganesan, Internal Combustion Engines, II Edition, Tata McGraw-Hill, 3rd Edition 2010.
3. Duffy Smith, Auto fuel Systems, The Good Heart Willox Company, Inc. 1987.
4. K.K. Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2008

PTE 203 - ENERGY MANAGEMENT AND AUDIT

L	T	P	C
4	0	0	4

Goal

To provide the essentials of energy management and audit along withseveralenergy conversion practices.

Objectives

The course should enable the students to

1. Understandthe realities behind energy conversion and its importance with exergy change.
2. Understand the objectives of energy Management and responsibilities of Energy Managers..
3. To know the responsibility of energy auditors.
4. To understand the elements of Monitoring and targeting system and do the data analysis.
5. To understand the thermal energy management in various thermal devices.

Outcome

The students should be able to

1. Recognize the elaborate realities about energy conservation and exergy analysis.
2. Know the rudimentary prerequisite of energy management.
3. Understand the various approach of various energy audits &tasks of energy managers.
4. Understand the concepts of energy monitoring and targeting.
5. Understand the energy conservation realities invarious heat transfer devices.

UNIT-I ENERGY CONSERVATION AND EXERGY ANALYSIS: 9

Energy conservation and its importance; The Energy Conservation Act. Exergy Transfer and Exergy Change.

UNIT-II ENERGY MANAGEMENT: 11

Definition and objectives of Energy Management; Importance; Indian need of Energy Management; Duties and responsibilities of energy managers.

UNIT-III ENERGY AUDIT: 15

Types and Methodology; Energy Audit Reporting Format; Understanding Energy Costs; Benchmarking and Energy Performance; Matching Energy Usage to Requirement; Maximising System Efficiency; Fuel and Energy Substitution; Energy Audit Instruments; Duties and Responsibilities of Energy Auditors.

UNIT-IV ENERGY MONITORING AND TARGETING : 15

Definition ; Elements of Monitoring and Targeting System; A Rationale for monitoring , Targeting and Reporting; Data and Information Analysis; Relating Energy Consumption and Production; CUSUM; Case Study.

UNIT-V THERMAL ENERGY MANAGEMENT: 10

Energy Conservation in Boilers, Steam turbines and industrial heating systems; Application of FBC; Co-generation and waste heat recovery; Thermal insulation; Building Energy Management.

TOTAL=60

REFERENCES

1. Larry C Whitetal, Industrial Energy Management & Utilization.
2. Power System Engineering 2nd Ed. D P Kothari, I J Nagrath, Tata McGraw-Hill Co 2008
3. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists,. Logman Scientific & Technical, ISBN-0-582-03184, 1990.
4. Reay D.A, Industrial Energy Conservation, 1stedition, Pergamon Press, 1977.

WEB REFERENCE

1. http://www.em-ea.org/Guide%20Books/Book-1/1.3%20Energy%20management%20&%20Audit.pdf

2. http://www.em-ea.org/gbook11.asp
3. http://www.energymanagertraining.com/energy_audit_instruments/new_energy_audit_equipment.htm
4. http://www.ecourses.ou.edu/cgi-bin/ebook.cgi?doc=&topic=th&chap_sec=07.0

PTE 251 - SIMULATION LABORATORY

L	T	P	C
0	0	3	1

Goal

To expose the students to learn the simulation of various thermal components using latest simulation softwares.

Objectives

To expose the students to have working knowledge on MATLAB or C ++ and analysis tool such as ANSYS.

Outcome

The students can program any mathematical model using MATLAB or C ++ or other simulation softwares.

I CYCLE

1. Steady State Conduction in Solid
2. Steady State Convection in Solid
3. Steady State Radiation in Solid
4. Combined conduction and convection
5. Unsteady state conduction and convection
6. Unsteady state conduction and radiation **24**

II CYCLE

1. Steady state conduction in Fluids
2. Steady state convection in Fluids
3. Two-phase flows
4. Condensation and boiling heat transfer
5. Solar Radiation Model
6. Energy system simulations **21**

TOTAL: 45

PTE 252- DESIGN PROJECT

L	T	P	C
0	0	6	2

Goal

To design and fabricate components related to refrigeration and air conditioning and demonstrate its working.

Objectives

The course should enable the students to:

1. Provide opportunity for the students to implement their skills acquired in the previous semesters to practical problems.
2. Expose the students to Technical report writing.

Outcomes

The students should be able to:

1. Complete understanding of making a product is achieved
2. Knowledge on preparing a technical report is gained.

The objective of this Lab is to provide opportunity for the students to expose to the various application and analysis of R & AC equipments using latest softwares.

Cycle I:

a. Steady and Unsteady state conduction in Solids

b. Steady state natural convection

c. Steady state Radiation between Black bodies

d. Combined conduction & convection (Fluid - Solid)

e. Unsteady state Conduction & Convection Fluid - Solid

f. Steady and unsteady state conduction and convection in Fluids

g. Steady state Forced convection between Grey bodies.

h. Combined conduction & convection in Fluids.

Cycle II

The students should do the simulation project individually and in exceptional cases 2 members may be permitted to take one small item for design and simulation. Every project work shall have a guide who is the member of the faculty of the institution.

The students are required to design and simulate the chosen item in the college and demonstrate its working apart from submitting the project report. The report should contain the required drawings, information flow diagrams, process charts related to simulation.

TOTAL=90

PTE 352 - PROJECT WORK PHASE - I

L	T	P	C
0	0	12	6

Goal

To identify their area of work to do the major project and frame objectives and scope of the identified work to be carried out in Phase - II by carrying out a thorough literature survey in the required field.

Objectives

The course should enable the students to

1. Expose and focus the student to the specialized field chosen and to know the recent developments in that field bydoing literature survey.

Outcome

The students should be able to

1. Identify the scope of the project work to be done in Phase-II and the research methodology to be followed by formulating the work plan.

   Aim is to train the students in research work, writing report and presentation

Phase - I :

Shall consist of identification of the project after literature survey. Students should present a review paper & submit it to the internal examiners.

Report should summarise the methodology to be adopted and work plan for the project work Phase - II.

TOTAL=180

PTE 451 - PROJECT WORK PHASE - II

L	T	P	C
0	0	24	12

Goal

To carry out their major development of any design of component in the areas of Computational Fluid Dynamics, Computational Fluid Dynamics, Heat Exchanger Design, Energy Conservation Management and Audit, Alternate fuels and evaluate its performance.

Objectives

The course should enable the students to

1. Expose the student to actual design methodology by appropriate analysis and providing hands on skills.

Outcome

The students should be able to

1. Identify the design methodology adopted for the present work and should be able to apply it for other similar applications.

Requirement: Actual project work with presentation & submission of project report in thesis form to the examiners. The students should publish at least one paper in National / International conference or Journal before submission of the thesis. Proof of acceptance must be enclosed in the thesis.

TOTAL=360

PTE701 - COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
4	0	0	4

Goal

To teach the students about the type fluid mechanics which uses numerical methods and algorithm to solve complex problems in fluid flow.

Objectives

The course should enable the students to:

1. Learn about different governing equation and boundary condition
2. Enable the students to understand the various discretisation techniques and solving solution methodologies.
3. Understanding the Navier-stroke equation for different flow field.
4. Understand the requirement of the different turbulence model for solving the Reynolds Average Navier-stroke equation
5. Learn the different grid generation methods.

Outcome

The students should be able to:

1. Know the formation different governing equation like continuity, momentum and Energy equation
2. Derive discretisation equation using finite difference method and finite volume methods, Numerical error associated with first order and second order.
3. Derive Reynolds average Nevier-stroke equation
4. Fix the closure problem associated with Reynolds average Nevier stroke equation using different turbulence model.
5. Generate the grid required in the computational domain for solving the Navier-stroke equation.

UNIT - I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 8

Basics of CFD, Governing equations of Fluid Dynamics - Continuity momentum and Energy equations, Physical Boundary conditions, Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT - II DISCRETISATION TECHNIQUES AND SOLUTION METHODOLOGIES 18

Methods of deriving discretisation equations - Finite difference & Finite volume methods, Finite difference discretisation of wave equation, Laplace equation, Burger's equation, numerical error and stability analysis. Time dependent methods - Explicit, Implicit - Crank - Nicolson methods, time split methods. Solution methodologies - Direct & interactive methods - Thomas algorithm - Relaxation method - Alternate Direction Implicit method.

UNIT- III CALCULATION OF FLOW - FIELD FOR N - S EQUATIONS 16

Finite volume formulation of steady one-dimensional convection and Diffusion problems, Central, upwind, hybrid and power-law schemes - Discretization equations for two dimensional convection and diffusion. Representation of the pressure - gradient term and continuity equation - Staggered grid - Momentum equations - Pressure and velocity corrections - Pressure Correction equation, SIMPLE algorithm and its variants.

UNIT - IV TURBULENCE MODELLING 10

Time averaged equation for turbulent flow, Turbulence Models - Zero equation model, oue equation model, two equation k-£ models, Advanced models.

UNIT - V GRID GENERATION 8

Algebraic Methods - Differential Equation methods - Adaptive grids

TOTAL: 60

REFERENCES

1. Muralidhar K. and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2nd Edition , 2008.
2. Ghoshdasdidar, P.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
3. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 2009.
4. Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier Stokes Equation", Pineridge Press Limited, U.K., 1981.
5. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer - Verlag, 1987.
6. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer - Verlag, 1987.
7. Bose, T., "Numerical Fluid Dynamics" Narosa Publishing House, 1997.
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9. D. A. Anderson, John. C. Tannehill, Richard H. Pletcher - Computational Fluid Mechanics and Head Transfer, Hemisphere publishing corporation, McGraw - Hill book company, USA, 1984.

PTE 702- RENEWABLE ENERGY SYSTEMS

L	T	P	C
4	0	0	4

Goal

To expose the students on sources of energy crisis and the alternates available.

Objectives

The course should enable the students to:

1. understand the principle of working and the components of different non-conventional sources of energy and their utilization.
2. Get an exposure on the power plants working with non conventional energy.

Outcome

The students should be able to:

1. Appreciate the need of Renewable Energy and the effect of emission on global warming.
2. Know about the various forms of Renewable Energy, their principles of working.

UNIT - I INTRODUCTION **10**

World energy use - Reserves of energy resources - Environmental aspects of energy utilisation - Renewable energy scenario in India - Potentials - Achievements - Applications.

UNIT - II SOLAR ENERGY **13**

Solar thermal - Flat plate and concentrating collectors - Solar heating and cooling techniques - Solar desalination - Solar Pond - Solar cooker - Solar thermal power plant - Solar photo voltaic conversion - Solar cells - PV applications.

UNIT - III WIND ENERGY **11**

Wind data and energy estimation - Types of wind energy systems - Performance - Details of wind turbine generator - Safety and Environmental Aspects.

UNIT - IV BIOMASS ENERGY **11**

Biomass direct combustion - Biomass gasifier- Biogas plant - Ethanol production - Bio diesel - Cogeneration - Biomass applications.

UNIT - V OTHER RENEWABLE ENERGY SOURCES **15**

Tidal energy - Wave energy - Open and closed OTEC Cycles - Small hydro - Geothermal energy - Fuel cell systems.

TOTAL: 60

REFERENCES

1. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 2nd Edition 2004..
2. Twidell, J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 1986.

3. G.N. Tiwari, Solar Energy - Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002

4. L.L. Freris, Wind Energy Conversion systems, Prentice Hall, UK, 1990.

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7. S.P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Company Ltd. New Delhi, 3rd Edition , 2009.

PTE 703 - COGENERATION WASTE HEAT RECOVERY SYSTEMS

L	T	P	C
4	0	0	4

Goal

The goal of the course is to study about the cogeneration and waste heat recovery systems or combined heat and power systems (CHP) and also how cogeneration of power besides mitigating the problem of power shortage also helps in energy conservation as well as reducing green house gas emissions.

Objectives

The course should enable the students to:

1. Learn about the principles of operation of various cogeneration and waste heat recovery systems and concept of trigeneration.
2. Study about the various cogeneration systems and issues and applications of cogeneration technologies.
3. Study and design various waste heat recovery systems.
4. Study about economics of CWHR plants.

Outcome

The students should be able to:

1. Choose proper cogeneration and waste heat recovery system for a particular application.
2. Learn what are the issues to be faced to establish a cogeneration plant or any other plant.
3. Design proper waste heat recovery system for the given application also to model and simulate the system.
4. Get complete idea about the economics of establishing a plant.

UNIT - I INTRODUCTION **12**

Introduction - Principles of Thermodynamics - Cycles-Topping -Bottoming - combined cycle - Organic Rankine Cycles - Performance indices of cogeneration systems - Waste heat recovery - sources and types - Concept of trigeneration

UNIT - II COGENERATION TEHNOLOGIES **12**

Configuration and thermodynamic performance - Steam turbine cogeneration systems - Gas turbine cogeneration systems -Reciprocating IC engines cogeneration systems - Combined cycles cogeneration systems - Advanced cogeneration systems : fuel cell, Stirling Engines

UNIT - III ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES **12**

Cogeneration plants electrical interconnection issues - Utility and cogeneration plant interconnection issues - Applications of Cogeneration in utility sector - Industrial sector - building sector - rural sector - Impacts of cogeneration plants - fuel, electricity and environment.

UNIT - IV WASTE HEAT RECOVERY SYSTEMS **12**

Selection criteria for waste heat recovery technologies - Recuperators - Regenerators - Economizers - Plate Heat Exchangers -Thermic fluid heaters- Waste Heat Boilers- Classification, Location, Service Conditions, Design Considerations - Fluidized bed heat exchangers - Heat pipe exchangers - Heat pumps - Apsorption systems.

UNIT - V ECONOMIC ANALYSIS **12**

Investment cost - Economic concepts - Measures of economic performance - Procedure for economic analysis - Examples - Procedure for optimized system selection and design - Load curves - Sensitivity analysis - Regulatory and financial frame work for cogeneration and waste heat recovery systems

TOTAL : 60

REFERENCES :

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2. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963.
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5. Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.
6. EDUCOGEN - The European Educational tool for cogeneration, Second Edition, 2001

PTE 704 - ENERGY SYSTEM MODELING & ANALYSIS

L	T	P	C
4	0	0	4

Goal

To teach the students about the method to convert the physical model of energy system into mathematical equation to predict the performance and to optimize of the energy system in the real world.

Objectives

The course should enable the students to:

1. Learn about the overview of Modelling in energy system and some real life problem of model.
2. Learn the modelling of Heat exchanger, solar collectors, distillation, rectification, turbomachinery component, refrigeration system.
3. Learn about the constraint and objective function in the optimization technique.
4. Learn about the Energy economy models.
5. Few application and case studies in Energy system problem.

Outcome

The students should be able to:

1. Do exergy balance for closed and control volume system and to apply this for energy system.
2. Model Heat exchanger, solar collectors, distillation, rectification, turbomachinery component, refrigeration system.
3. Optimize the energy system.
4. Do energy economy model using dynamic programming. And univarient and multivariate.
5. Model the practical energy system.

UNIT -I INTRODUCTION **12**

Primary energy analysis - Dead states and energy components-Exergy balance for closed and control volume systems-applications of exergy analysis for selected energy system design - Modelling overview- levels and steps in model development - examples of models - Curve fitting and regression analysis

UNIT - II MODELLING AND SYSTEMS SIMULATION **12**

Modelling of energy systems - Heat Exchanger, Solar collectors, Distillation, Rectifications, Turbo machinery components, Refrigeration systems - information flow diagram, Solution of set of nonlinear algebraic equations, Successive substitution, Newton Raphson Method. Examples of energy systems simulation

UNIT - III OPTIMISATION **12**

Objectives-constraints, Problem formulation - Unconstrained problems - Necessary and Sufficiency conditions. Constrained Optimisation- Lagrange multipliers, Constrained variations, Linear Programming - Simplex tableau, pivoting, sensitivity analysis

UNIT - IV ENERGY- ECONOMY MODELS **12**

Multiplier Analysis - Energy and Environmental Input / Output Analysis - Energy Aggregation - Econometric Energy, Demand Modeling - Overview of Econometric Methods -Dynamic programming - Search Techniques - Univariate / Multivariate.

UNIT - V APPLICATIONS AND CASE STUDIES **12**

Case studies of optimisation in Energy systems problems- Dealing with uncertainty- probabilistic techniques - Trade-offs between capital and energy using Pinch Analysis.

TOTAL: 60

REFERENCES

1. S.S.Rao, Optimisation theory and applications, Wiley Eastern, 1990
2. S.S. Sastry, Introductory methods of numerical Analysis, Prentice Hall, 4th Edition, 2005.

   P. Meier, Energy Systems Analysis for Developing Countries, Springer Verlag,1984.
3. R.de Neufville, Applied Systems Analysis, McGraw Hill, International Edition,1990 .
4. Beveridge and Schechter,Optimisation Theory and Practice,McGraw Hill, 1970.
5. W.F. Stoecker, Design of Thermal Systems, McGraw Hill, 3rd Edition , 1989.
6. A.Bejan, G.Tsatsaronis and M.Moran, Thermal Design and Optimization John Wiley & Sons, 1996

PTE 705 - ADVANCED POWER PLANT ENGINEERING

L	T	P	C
4	0	0	4

Goal

To introduce the advances in operations and applications of different types of power plants. Expose the students to basics of various power plants so that they will have the comprehensive idea of power system operation. To become familiar with operation of various power plants.

Objectives

The course should enable the students to:

1. To know the current energy scenario in India.
2. Know the Layout of various types of Power Plant.
3. Understand the details of Steam Boilers and the Cycles.
4. Know about combined cycle power generation
5. Understand the environmental issues and government policies.

Outcome

The students should be able to:

1. Understand the operation of various power plants in India
2. Understand process of working of Steam Boilers, Combustion equipment.
3. To know about the working of combined cycle power plant and its advantages.
4. Understand the government/ legislation policies imposed on pollution control.

UNIT - II INTRODUCTION **9**

Overview of the Indian power sector - Load curves for various applications - Types of power plants - Merits and demerits - Criteria for comparison and selection.

UNIT - II STEAM AND GAS TURBINE POWER PLANTS **15**

Rankine Cycle - Performance - Thermodynamic analysis of cycles-Cycle improvements. Superheaters, Reheaters, Condenser and feed water heaters - Operation and performance -Layouts.

Gas Turbine Cycles - optimization - Thermodynamic analysis of cycles - Cycle improvements - multi spool arrangement. Intercoolers, Reheaters, Regenerators - operation and performance -Layouts.

UNIT - III ADVANCED POWER CYCLES **13**

Binary and Combined Cycle - Coupled cycles - Comparative analysis of Combined heat and power cycles - IGCC - AFBC/PFBC cycles - Thermionic Steam power plant.

UNIT - IV NUCLEAR AND MHD POWER PLANTS **13**

Overview of Nuclear power plants - Radio activity - Fission process- reaction rates - Diffusion theory, Elastic scattering and slowing down - Criticality calculations - Critical heat flux - Power reactors - Nuclear safety. MHD & MHD-Steam Power plants.

UNIT - V ENVIRONMENTAL ISSUES **10**

Air and water pollution - Acid rains - Thermal pollution - Radioactive pollution - Standardization - Methods of control. Environmental Legislations/Government Policies. Economics of power plants.

TOTAL: 60

REFERENCES

1. Haywood, R.W., Analysis of Engineering Cycles, 4th Edition, Pergamon Press, Oxford, 1991.
2. Wood, A.J., Wollenberg, B.F., Power Generation, operation & control, John Wiley, New York, 1984.
3. Nag, P.K., Power Plant Engineering, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2010.
4. Arora and Domkundwar, A course in power Plant Engineering, Dhanpat Rai & CO, 2010.
5. Gill, A.B., Power Plant Performance, Butterworths, 1984.
6. Lamarsh, J.R., Introduction to Nuclear Engg, 2nd edition,Addison - Wesley,1983.

PTE 706 - FUNDAMENTALS OF TURBULENCE MODELLING

L	T	P	C
4	0	0	4

Goal

To expose the students to various turbulence models to achieve the closure to the governing equations in order to solve problems by numerical methods involving fluid flow and heat transfer analysis.

Objectives

The course should enable the students to:

1. Introduce the governing equations and turbulence closure problems.
2. Enable the students to understand Zero equation, one equation and two equation models

to achieve closure of RANS equation

3. Create confidence to solve complex problems in the field of heat transfer and fluid dynamics by using non linear eddy viscosity models.
4. Expose the student to high end turbulence models like Reynolds stress model, LES and DES and DNS.

Outcome

The students should be able to:

1. Know the RANS equation and closure problem of the governing equation.
2. Appreciate the various turbulence models available to achieve the closure and solve the fluid flow and heat transfer problems.
3. Appreciate the concepts of near wall modelling and wall function
4. Solve numerically the problems associated with Fluid Flow and Heat Transfer using commercial codes.

UNIT-I **10**

Navier-Stokes Equations: validity for turbulence, Averaging processes, Reynolds averaged equations, Turbulence closure problems, Mixing length theory, Cebeci-Smith model, Baldwin-Lomax model, universal velocity profile.

UNIT-II **15**

Linear Eddy-viscosity models- One equation models-Prandtl's one-equation model, Baldwin-Barth model, Spalart-Allmaras model; Two equation models- k-epsilon models- Standard k-epsilon model, Realisable k-epsilon model, RNG k-epsilon model, Near-wall treatment; k-omega models- Wilcox's k-omega model, Wilcox's modified k-omega model, SST k-omega model, Near-wall treatment; Realisability issues- Kato-Launder modification, Durbin's realizability constraint, Yap correction, Realisability and Schwarz' inequality.

UNIT-III **10**

Nonlinear eddy viscosity models-Explicit nonlinear constitutive relation- Cubic k-epsilon, Explicit algebraic Reynolds stress models (EARSM); v2-f models- model, model.

UNIT-IV **10**

Reynolds stress model (RSM), Large eddy simulation (LES)- Smagorinsky-Lilly model, Dynamic subgrid-scale model, RNG-LES model, Wall-adapting local eddy-viscosity (WALE) model, Kinetic energy subgrid-scale model, Near-wall treatment for LES models; Detached eddy simulation (DES), Direct numerical simulation (DNS).

UNIT-V **15**

Turbulence near-wall modeling- wall function; Applications of Turbulence Models- Two-dimensional channel flow, Flow past backward facing step, Flow in a square duct, flow in a curved duct.

Total: 60

References

1. Bradshaw P., Turbulence, Springer-Verlag, Berlin, 1976.
2. MENTER F. R. Two-equation eddy-viscosity turbulence models for engineering applications, 1994
3. DAVIDSON L. An introduction to turbulence models, Chalmers university of technology, Getebörg, Sweden, 2003
4. http://www.cfd-online.com/Wiki/Turbulence_modeling, March 2007
5. http://www.cfd.tu-berlin.de, March 2007
6. http://en.wikipedia.org/wiki/Flops, March 2007.
7. WILCOX, D.C., Turbulence Modelling for CFD, DCW Industries, California, USA, 1994
8. APSLEY, D., CFD, Turbulence modelling in CFD, 2004
9. Pope S. B., Turbulent Flow, Cambridge University Press, Cambridge, U.K., 2001.

PRA 203 - REFRIGERATION MACHINERY & COMPONENTS

L	T	P	C
4	0	0	4

Goal

To expose the principles, design aspects and design codes of various components involved in refrigeration design.

Objectives

The course should enable the students to:

1. Understand the Various Components: compressors, condensers, evaporators and expansion devices its working and design
2. Know about various refrigeration accessories and its control
3. Exposed to various codes used in design of refrigeration systems

Outcome

The students should be able to:

1. Know to analyse the manufacturers catalogue.
2. Select the capacity of various components based on design requirements.
3. Understand use age of various accessories and controls involved in RAC systems
4. Use BIS codes to analyze and compare the performance of different refrigeration systems

UNIT -I REFRIGERANT COMPRESSORS **12**

Hermetic compressors - Reciprocating, Rotary, Scroll Compressors, Open type compressors - Reciprocating, Centrifugal, Screw Compressors. Semi hermetic compressors - Construction, working and Energy Efficiency aspects. Applications of each type.

UNIT - II DESIGN OF CONDENSERS **13**

Estimation of heat transfer coefficient, Fouling factor, Friction factor. Design procedures, Wilson plots, Designing different types of condensers, BIS Standards, Optimisation studies.

UNIT - III DESIGN OF EVAPORATORS **13**

Different types of evaporators, Design procedure, Selection procedure, Thermal Stress calculations, Matching of components, Design of evaporative condensers.

UNIT - IV REFRIGERATION SYSTEM COMPONENTS **12**

Evaporators and condensers - Different types, capacity control, circuitry, Oil return, Oil separators - Different types Refrigerant driers strainers, Receivers, Accumulators, Low pressure receivers, Air Washers, Spray ponds.

UNIT - V SYSTEM ACCESSORIES AND CONTROLS **10**

Refrigerant Pumps, Cooling Tower fans, Compressor Motor protection devices, Oil equalising in multiple evaporators, Different Defrosting and capacity control methods and their implications - Testing of Air conditioners, Refrigerators, Visicoolers, Cold rooms, Calorimetric tests.

TOTAL :60

REFERENCES

1. Chlumsky, "Reciprocating & Rotary compressors", SNTL Publishers for Technical literaure, 1965.
2. Hains, J.B, " Automatic Control of Heating & Airconditioning" Mc Graw Hill, 1981.
3. Althose, A.D. & Turnquist, C.H. " Modern Refrigeration and Airconditioning" Good Heart - Wilcox Co. Inc., 1985.
4. Recent release of BIS Code for relevant testing practice.
5. ASHRAE Hand book : Equipments, 1998
6. Cooper &Williams, B. " Commercial, Industrial, Institutional Refrigeration, Design, Installation and Trouble Shooting " Eagle Wood Cliffs (NT) Prentice Hall, 1989.

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1. http://www.chensources.com/ctowers22.shtml
2. http://www.fortunecity.com/campus/german/201/ctowers.html
3. http://www.aquasystemsinsc.com/metric-files.html
4. http://www.ori.org

PRA 701 - CRYOGENIC ENGINEERING

L	T	P	C
4	0	0	4

Goal

The goal of the course is to learn about cryogenic properties and cryogenic temperatures and

applications of the same in various fields.

Objectives

The course should enable the students to:

1. Learn about the concept of cryogenics and applications in various fields.
2. Learn about various cycles of cryogenics.
3. Learn about the cryogenic refrigerators for different applications.
4. Learn about the handling and instrumentation of cryogenic fluids.

Outcome

The students should be able to:

1. Select the proper cryogenic fluid for particular application like cryometallurgy, medical applications.
2. Select proper liquefaction cycle.
3. Decide proper cryogenic refrigerator and cooler for particular application.
4. Find the way to handle cryogenic fluid and right instrumentation to measure the properties of cryogenic fluid.

UNIT - I INTRODUCTION **11**

Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of Cryogenics in Space Programs, Superconductivity,Cryo Metallurgy,Medical applications.

UNIT - II LIQUEFACTION CYCLES **13**

Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve - Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle Dual Cycle, Ortho-Para hydrogen conversion, Eollins cycle, Simpson cycle, Critical Components in Liquefaction Systems.

UNIT - III SEPARATION OF CRYOGENIC GASES **12**

Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis - McCabe Thiele Method, Adsorption Systems for purification.

UNIT - IV CRYOGENIC REFRIGERATORS **11**

J.T.Cryocoolers, Stirling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators Regenerators used in Cryogenic Refrigerators, Dilution refrigerators, Magnetic Refrigerators.

UNIT - V HANDLING OF CRYOGENS **13**

\Cryogenic Dewar, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Instrumentation to measure Flow, Level and Temperature.

TOTAL : 60

REFERENCES

1. Klaus D, Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.
2. Randall F. Barron, Cryogenic Systems, McGraw-Hill, 1985.
3. Scott R.B., Cryogenic Engineering, Van Nostrand and Co., 1962.
4. Herald Weinstock, Cryogenic Technology, 1969.
5. Robert W. Vance, Cryogenic Technology, Johnwiley & Sons, Inc., New York, London.

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1. www.nasa.gov
2. www.cryogenicsociety.org/
3. www.iifiir.org/
4. www.linde.com
5. www.airliquide.com/
6. www.cern.ch
7. www.nist.gov.

PRA 702 - FOOD PROCESSING, PRESERVRTION AND TRANSPORT

L	T	P	C
4	0	0	4

Goal

To provide an equivalent depth of knowledge in several food processing techniques, their protection and the transference techniques.

Objectives

The course should enable the students to

1. Recognize the basic microbiology of food products.
2. Understand the various food processing techniques.
3. To know about the process of freezing and drying in food processing techniques.
4. To know the basic facts of Energy conservation techniques.
5. To understand the design features of refrigerated transportation.

Outcome

The students should be able to

1. Analyze the mechanism of food spoilage and acquire additional parameters of food products.
2. Predict the method of food processing technique for energy conservation.

3. Analyse the food preserving techniques related with drying limitations.

4. Evaluate the various energy conservation technique adopted for freezers and cold storages.

5. Explore the feasibilities of design features of refrigerated transport.

UNIT I INTRODUCTION **15**

Microbiology of Food Products, Mechanism of Food Spoilage, Refrigeration Technologies of Food Products. Thermodynamic Properties, Cooling Process and Heat Transfer, Parameters of Food Products and their Effect on Quality. Moisture Losses from Respiration of Food Products, Optimum Cold Storage Conditions.

UNIT II PROCESSING AND PRESERVATION **13**

Food Processing Techniques, Standard Norms for Processing, Plant Layout, Preservation of Milk, Butter, Fruits, Vegetables, Meat Products. Environment Friendly Food Processing Techniques, Cryofreezing, Energy Conservation in Food Industries.

UNIT III FREEZING AND DRYING **11**

Precooling, Quick Freezing, Freeze Drying Principles, Techniques and Equipments, Cold Storage and Freezers. Freezing and Drying Limitations. Irradiation Techniques. Food Preserving Techniques for Remote Areas.

UNIT IV COLD STORAGE DESIGN AND INSTRUMENTATION **13**

Design, Selection, Matching, Installation and Maintenance of Cold Storages & Freezers. Insulation, Instrumentation and Control. Energy Conservation Techniques for Freezers and Cold Storages

UNIT V TRANSPORT **11**

Refrigerated Transportation, Refrigerated Containers and Trucks. Design Features, Piping and Role of Cryogenics in Freezing and Transport.

TOTAL : 60

REFERENCES

1. Alan Rodes, Principles of Industrial Microbiology, Pregmon International Pub., 1989.

2. Ibraham Dincer, Heat Transfer in Food Cooling Applications, Tailor & Francis Pub., 1997.

3. Stanley E. Charm, Fundamentals of Food Engineering, III Ed. AVI Pub. Company Inc. 1989.

4. Clive V.I. Dellino, Cold and Chilled Storage Technology, Van Nostrand Reinhold Pub. New York, 1991.

5. Arora C.P., Refrigeration and Air conditioning II Ed. McGraw-Hill, Pub., 2007.

6. ASHRAE Handbook, Cold Storage Application - Collection of papers from ASHRAE Winter meeting at Delirious and Chicago, Jan 1988 and 1989.

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1. http://microbial.org/vlmicro/vl_food.htm

2. http://www.howstuffworks.com/food-preservation.htm

3. http://www.fao.org.wfs/final/e/volumed/t//a-e.htm

4. http://www.iifiir.org

PTE 707- THERMAL ENERGY SYSTEMS

L	T	P	C
4	0	0	4

Goal

The goal of the course is to learn different aspects of designing and simulating thermal and energy systems. The course is designed in order to demonstrate how knowledge from junior level classes such as thermodynamics, heat transfer, fluid mechanics, engineering economics, and numerical analysis can be used to design and simulate energy systems.

Objectives

The course should enable the students to:

1. Utilize the students' knowledge of thermodynamics, heat transfer and fluid mechanics in the design of integrated thermal systems.
2. Utilize accurate and efficient computational methods for the solution of thermal system models.

Outcome

The students should be able to:

1. design and apply knowledge of mathematics, science and engineering
2. design a system, component or process to meet desired needs
3. understand the professional and ethical responsibility
4. use statistics and linear algebra
5. work professionally in both thermal and mechanical systems areas including the design and realization of such systems
6. work effectively as team members in mechanical engineering projects.

UNIT - I DESIGN OF THERMAL SYSTEM **8**

Design Principles, Workable systems, Optimal systems, Matching of system components, Economic analysis, Depreciation, Gradient present worth factor.

UNIT - II MATHEMATICAL MODELLING **8**

Equation fitting, Nomography, Emperical equation, Regression analysis, Different modes of mathematical models, selection, computer programmes for models.

UNIT - III MODELLING THERMAL EQUIPMENTS **13**

Modelling heat exchangers, evaporators, condensers, absorption and rectification columns,

compressor, pumps, simulation studies, information flow diagram, solution procedures.

UNIT - IV SYSTEMS OPTIMIZATION **23**

Objective function formulation, Constraint equations, Mathematical formulation, Calculus method, Dynamic programming, Geometric programming, Linear programming methods, solution procedures.

UNIT - V DYNAMIC BEHAVIOUR OF THERMAL SYSTEM **8**

Steady state simulation, Laplace transformation, Feedback control loops, Stability analysis, Non-linearties.

TOTAL : 60

REFERENCES

1. J.N. Kapur, Mathematical Modelling, New Age International(p) ltd., New Delhi , 2008.
2. W.F. Stoecker, Design of Thermal Systems, McGraw-Hill, 3rd Edition, 1989.
3. W.F. Stoecker, Refrigeration and Air conditioning, TMH, 1985.
4. Fanger P.O., Thermal Comport, McGraw-Hill, USA, 1972.
5. McQuiston FC & Parker TD, Heating, Ventilating and Air conditioning, Analysis and Design, John Wiley & Sons, USA, 1988.

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1. http://www.engr.usak.ca/dept/mee/research/thermal_fluid.html
2. http://at.youku.ca/cgi-bin/amca/cadl-26
3. http://www.gre.ac.uk/research/cms/centre
4. http://naca.larc.nasa.gov

PTE 708- FANS, BLOWERS & COMPRESSORS

L	T	P	C
4	0	0	4

Goal

To expose the students in Axial and Centrifugal Flow Thermal Turbomachinery.

Objectives

The course should enable the students to:

1. Learn the principles and theory behind the Thermal Turbo machinery
2. Learn the theory and details of Centrifugal Fans and Compressors.
3. Learn the theory and details of Axial Fans and Compressors.
4. Understand the details and theory behind testing, control and application of Thermal Turbo machinery.

Outcome

The students should be able to:

1. Understand the velocity triangles and calculate the specific work, various losses involved in the Thermal Turbo machines.
2. Know about principles and theories behind the axial and centrifugal turbomachines.
3. Exposure to various testing procedures involving Fans, Compressors and Blowers and also exposure on Noise control of Turbomachinery.

UNIT I PRINCIPLES OF TURBO MACHINERY 13

Introduction to turbo machines - Transfer of energy to fluids - Performance characteristics - Fan laws - Dimensionless parameters - Specific speed - Selection of centrifugal, axial, mixed flow, Axial flow machines.

UIT II ANALYSIS OF CENTRIFUGAL BLOWERS 13

Centrifugal Blowers: Theoretical characteristic curves, Eulers characteristics and Eulersvelocity triangles, losses and hydraulic efficiency, flow through impeller casing inlet nozzle volute,diffusers, leakage disc friction, mechanical losses, multivane impellers, of impulse type, crossflowfans.

UNIT III ANALYSIS OF AXIAL FLOW 13

Axial flow fans: Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist stage design, surge and stall, stator and casing, mixed flow impellers.

UNIT IV TESTING AND CONTROL OF FANS 8

Fan testing, noise control, materials and components blower regulation, speed control,throttling, control at discharge and inlet.

UNIT V DESIGN AND APPLICATIONS OF BLOWERS 13

Special design and applications of blowers, induced and forced draft fans for air conditioning plants, cooling towers, ventilation systems, booster systems.

TOTAL : 60

REFERENCES

1. Stepanoff A.J., Turboblowers, John Wiley & Sons, 1970.
2. Brunoeck, Fans, Pergamon Press, 1973.
3. Austin H. Church, Centrifugal pumps and blowers, John Wiley and Sons, 1980.
4. Dixon, Fluid Mechanics, Thermodynamics of turbomachinery Pergamon Press, 2010.
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3. http://www.apgate.com

PTE 709 - QUANTITATIVE AND QUALITATIVE RESEARCH

L	T	P	C
4	0	0	4

Goal

To make students to Understand and interpret research reports when you read them, indentifying their major elements and underlying methodologies.

This module is intended to supplement what you will learn from your coursework and reading. It may also help you get an idea of what research is before you take courses in research methods.

Objectives

The course should enable the students to:

1. Identify different research methods and these are compatible with different situations, and therefore it is important to know which method is best suitable for use with a particular hypothesis or question.
2. Give exposure to answer unanswered questions or exploring which currently not exist in a research.

Outcome

The students should be able to:

1. Identify the major differences between qualitative and quantitative research.
2. Describe the pros and cons of using qualitative data collection techniques.
3. Understand in-depth interviewing and focus groups as questioning techniques.
4. Discuss observation methods and explain how they are used to collect primary data.

UNIT - I RESEARCH METHODOLOGY **11**

Types of research- Literature survey- Patent survey- literature review reporting- ethics and interventions of research- planning for research- research tools- seven management tools- graphical representations - Codes - Standards.

UNIT - II QUANTITATIVE METHODS **13**

Descriptions-statistics-distribution-sampling-hypothesistesting-regression-ANOVA-reliability- validity-uncertainty - sensitivity analysis- use of SPSS.

UNIT - III QUALITATIVE METHODS **13**

Historical analogy-market research- survey analysis - delphi methodology-determination ofindex-life cycle analysis - modeling and simulation.

UNIT - IV MEASUREMENT IN RESEARCH **15**

Need for measurement- types of measuring instruments- Configurations and functional descriptions of instruments- Performance characteristics- Static and dynamic characteristics- manipulation, Transmission and recording of data- Data acquisition and processing systems- Computer aided experimentation.

UNIT - V RESEARCH REPORT PREPARATION **8**

Principles of Written communication- Content preparation- Synopsis writing- Result analysis- Discussion section - Case studies.

TOTAL=60

REFERENCES

1. Robert B. Burns, Introduction to Research methods, SAGE Publications London- 2000
2. Herman J. Ader, Gidon J. mellenbergh, Research Methodology, SAGE Publications London- 1999
3. Jeremy Miles& Mark Sherlin, Applying Regression and Correlation, A Guide for students and researchers SAGE Publications London- 2008.
4. Ernest O. Doebelin, Measurement Systems- Application and Design IV Edition McGraw-Hill International Edition NY-5th Edition, 2007.

PTE 710 - ENVIRONMENTAL ENGINEERING & POLLUTION CONTROL

L	T	P	C
4	0	0	4

Goal

To diffuse the knowledge on environmental pollution and its control. To enhance the working knowledge of engineers in the design, operation and control of equipment used for control of industrial and municipal pollution.

To provide an environment to foster the attainment of research & development targets related to environmental pollution control engineering.

Objectives

The course should enable the students to:

1. To understand the global atmospheric change due to global warming.
2. To understand the effect of air pollution and its control.
3. To recognize the effects of Water pollution
4. To understand the process of collection, disposal and energy recovery from waste.
5. To learn about environmental impact and various other pollutions.

Outcome

The students should be able to:

1. Understand the causes of global climatic change and its impact.
2. Understand the control measurement and equipments of air pollutions.
3. Understand the concepts of waste water treatment
4. To understand the technique of waste minimizing and recovering energy from waste.
5. To understand government policies that protect the environment.

UNIT - I INTRODUCTION **12**

Global atmospheric change - Green house effect -Ozone Depletion - Natural Cycles - Mass and Energy Transfer - Material balance - Environmental chemistry and biology - Impacts - Environmental legislations.

UNIT - II AIR POLLUTION **12**

Pollutants - Sources and Effect - Air Pollution meteorology - Atmospheric dispersion -Indoor air quality - Control Methods and Equipments - Issues in Air Pollution control - Air sampling and measurement.

UNIT - III WATER POLLUTION **12**

Water resources - Water Pollutants - Characteristics - Quality - Water Treatment systems - Wastewater treatment - Treatment, Utilization and Disposal of Sludge - Monitoring compliance with Standards.

UNIT - IV WASTE MANAGEMENT **12**

Sources and Classification - Solid waste - Hazardous waste - Characteristics - Collection and Transportation - Disposal - Processing and Energy Recovery - Waste minimization.

UNIT - V OTHER TYPES OF POLLUTION FROM INDUSTRIES **12**

Noise Pollution and its impact - Oil Pollution - Pesticides - Instrumentation for EIA test - Water Pollution from Tanneries and other Industries and their control - Environment Impact assessment for various projects - Case studies

TOTAL: 60

REFERENCES

1. H.Ludwig, W.Evans, Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands, N.J,1991.
2. Arcadio P Sincero and G. A. Sincero, Environmental Engineering - A Design Apporach, Prentice Hall of India Pvt Ltd, New Delhi, 2004.
3. G.Masters, Introduction to Environmental Engineering and Science, Prentice Hall of India Pvt Ltd, New Delhi, 2003.
4. H.S.Peavy, D.R..Rowe, G.Tchobanoglous, Environmental Engineering, McGraw- Hill BookCompany, NewYork,1985.