JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
ANANTAPUR ANANTAPUR-515002 (A.P) INDIA

ACADEMIC REGULATIONS COURSE STRUCTURE AND DETAILED SYLLABI

MASTER OF TECHNOLOGY

REFRIGERATION & AIR-CONDITIONING

M.Tech Regular Two Years P.G. Degree Course
(Applicable for the batches admitted from 2011-12)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
Academic Regulations For The Award Of Full Time M.Tech. P.G. Degree
(WITH EFFECT FROM THE ACADEMIC YEAR 2011-12)

The Jawaharlal Nehru Technological University Anantapur shall confer M.Tech. Post Graduate degree to candidates who are admitted to the Master of Technology Programs and fulfill all the requirements for the award of the degree.

1.0 ELIGIBILITY FOR ADMISSIONS:

Admission to the above programme shall be made subject to the eligibility, qualifications and specialization prescribed by the University for each programme, from time to time.

Admissions shall be made either on the basis of merit rank obtained by the qualified candidates at an Entrance Test conducted by the University or on the basis of GATE / PGECET score, subject to reservations prescribed by the University or Government policies from time to time.

2.0 **COURSE WORK:**

2.1 A Candidate after securing admission must pursue the M.Tech. course of study for Four semesters duration.

2.2 Each semester shall be of 20 weeks duration including all examinations.

2.3 A candidate admitted to a programme should complete it within a period equal to twice the prescribed duration of the programme from the date of admission.

3.0 ATTENDANCE:

3.1 A candidate shall be deemed to have eligibility to write end semester examinations if he has put in atleast 75% of attendance on cumulative basis of all subjects/courses in the semester.

3.2 Condonation of shortage of attendance up to 10% i.e., from 65% and above and less than 75% may be given by the college on the recommendation of the Principal.

3.3 Condonation of shortage of attendance shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence.

3.4 If the candidate does not satisfy the attendance requirement he is detained for want of attendance and shall reregister for that semester. He / she shall not be promoted to the next semester.

4.0. EVALUATION:

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

4.1 For the theory subjects 60% of the marks will be for the External End Examination. While 40% of the marks will be for Internal Evaluation, based on the better of the marks secured in the two Mid Term-Examinations held, one in the middle of the Semester (I-IV units) and another immediately after the completion of instruction (V-VIII) units with Three questions to be answered out of four in 2hours, evaluated* for 40 marks.

*****Note: All the Questions shall be of equal weightage of 10 marks and the marks obtained for 3questions shall be extrapolated to 40 marks, any fraction rounded off to the next higher mark

4.2 For practical subjects, 60 marks shall be for the End Semester Examinations and 40 marks will be for internal evaluation based on the day to day performance.

4.3 For Seminar there will be an internal evaluation of 50 marks. A candidate has to secure a minimum of 50% to be declared successful. The assessment will be made by a board consisting of HOD and two internal experts at the end of IV semester instruction.

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

4.5 In case the candidate does not secure the minimum academic requirement in any of the subjects (as specified in 4.4.) he has to reappear for the Semester Examination either supplementary or regular in that subject, or repeat the course when next offered or do any other specified subject as may be required.

5.0 RE-REGISTRATION FOR IMPROVEMENT OF INTERNAL EVALUATION MARKS:

Following are the conditions to avail the benefit of improvement of internal evaluation marks.

5.1 The candidate should have completed the course work and obtained examinations results for I & II semesters.

5.2 He should have passed all the subjects for which the Internal evaluation marks secured are more than 50%.

5.3 Out of the subjects the candidate has failed in the examination due to Internal evaluation marks secured being less than 50%, the candidate shall be given one chance for each Theory subject and for a maximum of **three** Theory subjects for Improvement of Internal evaluation marks.

5.4 The candidate has to re-register for the chosen subjects and fulfill the academic requirements.

5.5 For each subject, the candidate has to pay a fee equivalent to one third of the semester tuition fee and the amount is to be remitted in the form of D.D. in favour of the

Registrar, JNTUA payable at Anantapur along with the requisition through the Principal of the respective college.

5.6 In the event of availing the Improvement of Internal evaluation marks, the internal evaluation marks as well as the End Examinations marks secured in the previous attempt(s) for the reregistered subjects stand cancelled.

6.0 EVALUATION OF PROJECT WORK:

Every candidate shall be required to submit thesis or dissertation after taking up a topic approved by the college/ institute.

6.1 Registration of Project work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the courses (theory and practical courses of I & II Sem)

6.2 An Internal Departmental Committee (I.D.C) consisting of HOD, Supervisor and one internal senior expert shall monitor the progress of the project work.

6.3 The work on the project shall be initiated in the penultimate semester and continued in the final semester. The duration of the project is for two semesters. The candidate can submit Project thesis with the approval of I.D.C. after 36 weeks from the date of registration at the earliest and one calendar year from the date of registration for the project work. Extension of time within the total permissible limit for completing the programme is to be obtained from the Head of the Institution.

6.4 The student must submit status report at least in three different phases during the project work period. These reports must be approved by the I.D.C before submission of the Project Report.

6.5 A candidate shall be allowed to submit the thesis / dissertation only after passing in all the prescribed subjects (both theory and practical) and then take viva voce examination of the project. The viva-voce examination may be conducted once in two months for all the candidates submitted during that period.

6.6 Three copies of the Thesis / Dissertation certified in the prescribed from by the supervisor & HOD shall be presented to the HOD One copy is to be forwarded to the University and one copy to be sent to the examiner.

6.7 The college shall submit a panel of three experts for a maximum of 5 students at a time. However, the thesis / dissertation will be adjudicated by one examiner nominated by the University.

6.8 If the report of the examiner is favorable viva-voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the thesis / dissertation. The board shall jointly report candidates work as:

1.	Very Good	Grade A
2.	Good	Grade B
3.	Satisfactory	Grade C
4.	Not satisfactory	Grade D

If the report of the viva-voce is not satisfactory (Grade D) the candidate will retake the viva-voce examination after three months. If he fails to get a satisfactory report at the second viva-voce examination he will not be eligible for the award of the degree unless the candidate is permitted to revise and resubmit the thesis.

7.0 AWARD OF DEGREE AND CLASS:

A candidate shall be eligible for the award of respective degree if he satisfies the minimum academic requirements in every subject and secures 'satisfactory' or higher grade report on his thesis/dissertation and viva-voce. Based on overall percentage of marks obtained, the following class is awarded.

First class with Distinction:	70% or more
First class	below 70% but not less than 60%
Second class	below 60% but not less than 50%

8.0 WITH – HOLDING OF RESULTS:

If the candidate has not paid dues to the university or if any case of in-discipline is pending against him, the result of the candidate shall be withheld and he will not be allowed/ promoted into the next higher semester. The issue of degree is liable to be withheld in such cases.

9.0 TRANSITORY REGULATIONS:

Candidates who have discontinued or have been detained for want of attendance or who have failed after having undergone the course in earlier regulations and wish to continue the course are eligible for admission into the unfinished semester from the date of commencement of class work with the same or equivalent subjects as and when subjects are offered, subject to 4.5 and 2.3 sections. Whereas they continue to be in the academic regulations they were first admitted.

10.0 GENERAL:

i. **The academic regulations should be read as a whole for purpose of any interpretation**.
ii. **Disciplinary action for Malpractice / improper conduct in examinations is appended**.
iii. **There shall be no places transfer within the constituent colleges and affiliated colleges of Jawaharlal Nehru Technological University Anantapur.**
iv. **Where the words "he", "him", "his", occur in the regulations, they include "she", "her", "hers".**
v. **In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.**
vi. **The University may change or amend the academic regulations or syllabi at any time and the changes or amendments shall be made applicable to all the students on rolls with effect from the dates notified by the University.**

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RULES FOR DISCIPLINARY ACTION FOR MALPRACTICE / IMPROPER CONDUCT IN EXAMINATIONS

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

4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
6.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
7.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The

		candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the impostor is an outsider, he will be handed over to the police and a case is registered against him.
8.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.

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

Malpractices identified by squad or special invigilators

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

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

Course Structure and syllabi for

M.Tech- MECHANICAL ENGINEERING (REFRIGERATION & AIR-CONDITIONING)

for affiliated Engineering Colleges 2011-12

I YEAR I Semester

S. No	Course code	Subject	Theory	Lab.	Credits
1.	9D17101	Advanced Thermodynamics	4		4
2.	9D17102	Conduction and Radiation Heat Transfer	4		4
3.	9D17103	Refrigeration	4		4
4.	9D17104	Air-Conditioning-I	4		4
5.	9D17105	Advanced Fluid Mechanics	4		4
6.	 9DBS101 9D17106 9D17107	ELECTIVE-I a. Computational Methods b. Maintenance and Reliability c. Object oriented programming through C^{++}	4		4
7.	9D17108	Refrigeration Lab		3	2
		contact periods/week	24	3	26
			Total 27		

I YEAR II Semester

S. No	Course code	Subject	Theory	Lab.	Credits
1.	9D17201	Air-Conditioning-II	4		4
2.	9D17202	Convective Heat & Mass Transfer	4		4
3.	9D17203	Refrigeration Equipment & Controls	4		4
4.	9D17204	Cryogenic Engineering	4		4
5.	9D17205	Food Processing Technology	4		4
6.	 9D17206 9D17207 9D17208	ELECTIVE-II a. Computational Fluid Dynamics b. Energy Conservation and Management c. Solar Heating & Cooling System	4		4
7.	9D17209	Air-Conditioning Lab		3	2
		contact periods/week	24	3	26
			Total 27		

II YEAR (III & IV Semesters)

S. No	Course code	Subject		credits
1	9D17401	Seminar		2
2	9D17402	Project work		16

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(9D17101) ADVANCED THERMODYNAMICS

1.THERMODYNAMIC RELATIONS:
Introduction-Helmhotz free energy function-Gibbs free energy function-coeffficient of volumetric expansion-isothermal compressibility-differential relation for U,H,G&F-Maxwell relations.

2.GENERALIZED RELATION:
Generalized relation for Cp, Cv, K,B-relations for internal energy and enthalpy-the various Tds equation-clapeyron equation-gas tables-enthalpy and internal energy-pressure ratio-volume ratio-change of entropy-Introduction to third law of thermodynamics.

3.NONREACTIVE GAS MIXTURES:
Introduction-basic definitions for gas mixtures-PVT relations ship for mixtures of ideal gases-properties of mixtures of ideal gases-entropy change due to mixing- mixtures of perfect gases at different initial pressure and temperatures.

4. THERMODYNAMIC PROPERTIES OF REFRIGERANTS:
Enthalpy calculation, enthalpy departure term-enthalpy from residual in internal energy-entropy calculation-entropy departure term.

5.EXERGY:
Introduction-availability of heat-availability of a closed system-availability function of the closed system-availability of steady flow system-availability function of open system.

6.IRREVERSIBILITY:
Introduction-irreversibility for closed and open system-steady flow process effectiveness-second law analysis of the power plant.

7.GAS POWER CYCLES:
Review of auto, diesel and dual cycles - Sterling cycle-Erickson cycle-Atkinson cycle-Brayton cycle- Lenoir cycle.

8. DIRECT ENERGY CONVERSION:
Introduction- thermoelectric converters- thermo-ionic converters magneto hydrodynamics generators-solar power cells plant- fuel cell hydrogen-hydrogen fuel cells-direct and indirect oxidation fuel cells-biochemeical fuel cells.(no problems)

Reference Books:

1. Advanced Thermodynamics: **Van Wyllan**, TMGH
2. Engineering Thermodynamics: **P.K.Nag**, TMGH
3. Advanced Thermodynamics: **Ray & Sarao**, Central Publishers

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(9D17102) CONDUCTION AND RADIATION HEAT TRANSFER

CONDUCTION:

1) Introduction of three modes of heat transfer, steady, unsteady state heat transfer process, governing equation and boundary conditions
2) Two dimensional steady state conduction, semi-infinite and finite flat plate; temperature field in infinite and finite cylinders.
3) Conduction through spherical shells, numerical methods, relaxation method and finite difference methods – simple problems.

UNSTEADY STATO HEAT CONDUCTION

4) Heating and cooling of bodies with negligible internal resistance, sudden changes in the surface temperature of infinite plates, cylinders and semi-infinite bodies-simple problems.
5) Unsteady state heat conduction-systems with negligible surface resistance, Heat transfer in large flat plate, Heat flow in infinitely think plate.

RADIATION:

6) Review of the thermal radiation – gas radiation, mean beam length exchange between gas volume and black enclosure, heat exchange between gas volume and gray enclosure, problems.
7) Radiation network for an absorbing and transmitting medium, radiation exchange with specular surfaces, radiation exchange with transmissivit6y and reflecting absorbing medium. Formulation for numerical solution.
8) Solar radiation: Radiation properties of environment, effect of radiation on temperature measurement, the radiation heat transfer coefficient, problems.

Reference Books:

1) Heat Transfer-**Gibhart** – Mc. Graw Hill
2) Conduction Heat Transfer-**Schneder** Addition Wieslthy
3) Conduction of Heat in Solids-**Carslaw & Jaeger**.
4) Heat transfer-**J.P. Holman**, International Student edition
5) Fundamentals of heat and mass transfer-**R.C. Sachdev**

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(9D17103) REFRIGERATION

1. Vapor Compression Refrigeration:
   Analysis of vapor compression refrigeration cycle – reversed Cornot cycle for vapour – effect of suction temperature and condensing temperature on cycle performance – Practical refrigeration cycle – subcooled liquid and super heated vapor refrigeration cycles their effect on performance.

2. Multi pressure Systems- removal of flash gas intercooling –compound compression (conversion)- multi vapor systems- cascade systems- dual compression- system practices.

3. Simple vapor Absorption systems- actual vapor absorption cycle- representation of the cycle on H-C diagram- common refrigerant- (Absorbent)Adsorbent) systems.

4. Practical single effect Water- Lithium Bromide Absorption system- double effect system- Electrolux refrigerator- newer mixtures for absorption systems.

5. Air refrigeration – Principle-application to air craft refrigeration-air craft refrigeration systems:- Basic, Boot-strap, reduced ambient-Ranque Hilsh tube refrigeration-DART. .

6. Steam jet water vapor systems- thermoelectric refrigeration systems – vortex refrigeration system – pulse tube refrigeration-Academic refrigeration.

7. Refrigerants: Desirable properties- thermo dynamic-chemical and transport properties – designation of refrigerants – inorganic, halo carbon refrigerants – secondary refrigerants – Properties of mixtures of refrigerants

8. Ozone depletion potential and global warming potential – effect of refrigerants-alternative
   Refrigerants- newer refrigerants.

Reference Books:

1) R & A/C by **F.Stoecker & Jerold.** W.Jones-MGH Intrl., 1982.
2) R & A/C by **C.P.Arora**, TMHG-2000.
3) R & A/C by **Manohar Prasad**.
4) Principles of Refrigeration by **Roy.J.Dossat**, 1997
5) Refrigeration by **Gosney**- Oxford University Press- 1980.

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(9D17104) AIR – CONDITIONING - I

1) Psychrometry: Properties of Moist air- Psychrometric relations – Psychrometric chart – Psychrometric processes in air-conditioning equipment – Bypass factor – Sensible heat factor
2) APPLIED PSYCHROMETRY:
   Effective and grand sensible heat factors- Selection of Air- Conditioning apparatus for cooling and dehumidification-High latent cooling load applications- All outdoor air application.
3) Air-conditioning Processes – Mixing process- Summer, Winter and Year- round air conditioning systems – hot and dry out door condition, Hot and humid outdoor condition – winter air conditioning system – year round air- conditioning system.
4) Process of Cooling, Heating and Dehumidifying coils – air washers – Cooling by dry and wet coils – use of hygroscopic solution in air washers – Adiabatic dehumidifier – Humidifier- water injection – steam injection.
5) Requirements of Comfort Air-conditioning – Thermodynamics of human body – Body regulation process against heat or cold – comfort and comfort chart – Effective temperature – Factors governing optimum effective temperature – Design considerations – Selection of outside and Inside design conditions.
6) Ventilation systems: Natural ventilation systems – Mechanical – Extraction system – Supply systems – Combined supply and extraction systems – Air cleaning – Equipment used for odour suppression and air sterilization.
7) Air-conditioning controls systems – basic elements of the control systems – temperature, humidity and pressure controls and refrigeration flow controls room thermostat.
8) Heat pump – Different heat pump circuits air, ground water, earth – The linked air cycle heat pump – solar energy collections – Drying of meterials.

Reference Books:

1. Hand Book of Air conditioning system design –**Carrier**
2. Refrigeration & Air- conditioning –**C.P.ARORA**, TMGH,2000.
3. Refrigeration & Air-conditioning – **Domkundwar and Arora**, DanpatRai & Sons, 2000.
4. Refrigeration & Air conditioning – **Stoecker.**
5. Refrigeration & Air conditioning – **V.K.Jain.**
6. Guide and data book- **ASHRE**

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(9D17105) ADVANCED FLUID MECHANICS

1. Basic Concepts: Continuum hypothesis – Eulerian and Lagrangian descriptions. Derivation of general differential equations – continuity momentum and energy of incompressible flow- Navier Stokes equation for Viscous Fluids (Rectangular Co-Ordinate Systems)- Euler's equations for ideal fluids- Bernoulli's equations (one dimensional) – applications
2. Laminar Flow Viscous Incompressible Fluids: Flow similarity – Reynolds number, flow between parallel flat plates, coquette-flow, plane poiseuille flow, Hagen – poiseuille flow.
3. Laminar boundary layer: Boundary layer concept, Prandtl's approximations, Blassius solution for a flat plate without pressure gradient – momentum integral equation – Von-Kerman integral relation – Pohlhausen method of obtaining approximate solutions.
4. Displacements thickness, momentum thickness and energy thickness. Boundary layer separation and control. Kerman integral equation.
5. Introduction to turbulence: Origin of turbulence, nature of turbulent flow – Reynolds equations and Reynolds stresses, velocity profile.
6. Compressible Fluid Flow Basics: Mach number, Flow pattern in compressible flow, classification of compressible flow, isentropic flow, stagnation properties.
7. Gas Dynamics: Compressible flow through duct and nozzles – area velocity relations. Flow through convergent and convergent divergent nozzles. Real nozzles flow at design conditions. Introduction to normal compression shock – normal shock relations. Introduction to Fanno Raleigh equations.
8. Flow in ducts with friction: Fanno line, adiabatic constant area- Flow of perfect gas, chocking due to friction in constant area flow- Introduction to constant area flow with heat transfer (Raleigh line)

Reference Books:

1. "Foundations of Fluid Mechanics", **Yuan S.W.** Prentice Hall – Eastern economy edition 1983
2. " Gas Dynamics", **Zucrwo M.J. and Hoffman J.D.**Vol-I & Vol-II, John Wiley and Sons Inc. 1977
3. "Fundamentals of Compressible Flow", - **Yahya S.M.** Wiley Eastern
4. "A Brief Introduction to Fluid Mechanics" **Young, Munsen and Okiisyi,** 2nd Edition, John Wiley 2000.
5. , " Fluid Mechanics **Frank.M.White** 5th Edn – McGraw Hill 2005.

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(9DBS101) COMPUTATIONAL METHODS
(Electives – I)

Unit – I
Introduction to numerical methods applied to engineering problems: Examples, solving sets of equations – Matrix notation – Determinants and inversion – Iterative methods – Relaxation methods – System of non-linear equations – computer programs

Unit – II
Numerical integration: Newton-Cotes integration formulas – Simpson's rules, Gaussian quadrature. Adaptive integration

Unit – III
Optimization:
One dimensional unconstrained optimization, multidimensional unconstrained optimization – direct methods and gradient search methods, constrained optimization

Unit – IV
Boundary value problems and characteristic value problems: Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method – Characteristic value problems.

Unit – V
Numerical solutions of partial differential equations: Laplace's equations – Representations as a difference equation – Iterative methods for Laplace's equations – poisson equation – Examples – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method – Finite element method.

Unit – VI
Parabolic partial differential equations: Explicit method – Crank-Nickelson method – Derivative boundary condition – Stability and convergence criteria – Finite element for heat flow – computer programs.

Unit – VII
Hyperbolic partial differential equations: Solving wave equation by finite differences-stability of numerical method –method of characteristics-wave equation in two space dimensions-computer programs.

Unit – VIII

Curve fitting and approximation of functions: Least square approximation fitting of non-linear curves by least squares –regression analysis- multiple linear regression, non linear regression - computer programs.

Reference Books:

1. "Numerical Methods for Engineers", Steven C.Chapra, Raymond P.Canale Tata Mc-Graw hill
2. "Applied numerical analysis", Curtis F.Gerald, partick.O.WheatlyAddison-wesley,1989
3. "Numerical methods", Douglas J..Faires,Riched BurdenBrooks/cole publishing company,1998.Second edition.
4. "Numerical mathematics and computing", Ward cheney &David Kincaid Brooks/Cole publishing company1999,fourth edition.
5. "Mathematical methods for physics and engineering"Riley K.F.M.P.Hobson.&.Bence S.J.Cambridge university press,1999.

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(9D17106) MAINTENANCE & RELIABILITY ENGINEERING
(Electives – I)

1. Elements of probability theory, probability of union and intersection of events, mutually exclusive events, statistical independence, random variables, PDF and CDF, binomial, Poisson and Gaussian distributions.
2. Component reliability –definition of reliability and hazard functions, failure distributions, exponential Weibull and game distributions, uniform distribution, bath tub curve.
3. Reliability of non-repairable systems, reliability network, series, parallel and rout of configurations, decomposition method, cut set & tie set method methods of improving reliability.
4. Maintainability and availability, MTBF and MTTR, probability and frequency of failure, state space analysis, Markov process, steady state probability, and dependent failures.
5. Failure types and causes of failure – failure classification, case studies, human factors analysis of different causes of failures.
6. Fault detection, non-destructive testing, X-ray and Gamma ray radiography, Xerography, Electromagnetic methods, ultrasonic methods.
7. Maintenance and type of maintenance – conditions monitoring techniques Signature analysis – vibration and noise monitoring, faults and vibration modes, permissible limits of vibrations, temperature monitoring, infrared camera.
8. Wear monitoring, analysis of wear partials, ferography, spectroscopic analysis, performance trend monitoring, choice of condition monitoring methods.

Reference Books:

1. "Reliability engineering" By **Balaguruswamy.**
2. "Testing and inspection of materials" by **H.E.Davies**
3. "Instrumentation, Measurement and analysis" by **Prof. B.C. Nakra**
4. "Mechanical fault diagnosis" By **R.A.Collacolt**.
5. Maintenance Engineering Hand Book

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(9D17107) OBJECT ORIENTED PROGRAMMING THROUGH C++
(Electives – I)

UNIT I: Concepts of OOP
Evaluation of OOP- Procedure- Structure of Oriented Programming, OOP vs. Procedure-Oriented Programming, OOP Concepts: Objects, Classes, Data abstraction and Encapsulation, Inheritance, Polymorphism, Dynamic Binding, Message Passing, Benefits of OOP, Object Oriented Languages, Application of OPPs

UNIT II: C++ Programming Basics
Application of C++, A Simple C++ Program, An Example with Class, Structure of C++ Program, Creating the Source File, Compiling and Linking, Tokens, Type Conversions Data Types, Variables, Constants, Expressions, Statements, Operators, Arrays of Strings, Storage Classes , Standard Input and Output

UNIT III:
Control Structures: Decision Statements - If and Switch Statements, Loop Control Statements - while, for, do-while, Nested for Loops, Other Related Statements-break, continue, go to.
Functions: The Main Function, Function Prototyping, Call by Reference, Return by Reference, Inline Functions, Arguments, Function Overloading, Library Functions, Memory Management with new and delete manipulators, Operator Overloading

UNIT IV: Class and Objects
Specifying a Class Define Member Functions, Making Outside Functions Inline, Member Functions, Arrays within a Class , Memory Allocation for Objects, Static Data Members, Static Members Functions, Arrays of Objects, Object as a Function Arguments, Friendly Functions, Returning Objects, Pointers to Member Functions, Local Classes, Constructers and Destructors.

UNIT V: Inheritance: Extending Classes
Defining Derived Classes, Single Inheritance, Making a Private Member Inheritable, Multilevel Inheritance, Hierarchical Inheritance, Hybrid Inheritance, Virtual Base Class, Abstract Classes, Constructers in Derived Classes, Member Class: Nesting of Classes, Overriding Base Class Members.

UNIT VI: Pointers, Virtual Functions and Polymorphism

Pointers, Pointers to Objects, this Pointer, Pointers to Derived Classes, Virtual & Non Virtual Overriding, Virtual Functions, Rules for Virtual Functions, Pure Virtual Functions, Static and Dynamic Binding, Virtual Base Classes

UNIT VII: Streams and Files

C++ Streams, C++ Stream Classes, Unformatted I/O Operations, Formatted Console I/O Operations, Managing Output with Manipulators, Working with Files: Classes for File Stream Operations, Opening and Closing a File, Detecting end of file, File pointer and Their Manipulations, Sequential Input and Output Operations, Updating a File: Random Access, Error Handling during File Operations, Command Line Arguments.

UNIT VIII: Templates and Exception Handling

Class Templates, Class Templates with Multiple Parameters, Function Templates, Function Templates with Multiple Parameters, Overloading of Template Functions, Member Function Templates, Non-Type Templates Arguments. Exception Handling- Exception Handling Mechanisms, Throwing Mechanism, Catching Mechanism, Rethrowing an Exception, Specifying Exceptions.

Reference Books:

1. Object Oriented Programming with C++, **E. Balagurusamy**. TMH Publishing Co. Ltd.
2. Object Oriented Programming with ANSI & Turbo C++, **Ashok N. Kamthene**, Pearson Education.
3. Object Oriented Programming with C++, **Yashavant P. Kanetkar**, BPB Publications
4. C++ The Complete Reference, **Herbert Schildt**, TMH Publishing Co. Ltd.
5. Programming with C++, **D Ravichandran**, TMH Publishing Co. Ltd.

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(9D17108) REFRIGERATION LAB
-Vapor compression Refrigeration system (V.C.R.S)

1. Find out the cop. and time taken for ICE making in the Domestic Vapor Compression Refrigeration.
2. Find out the pull-down characteristics of V.C.R.S.
3.Find out the c.o.p. of vapor Absorption Refrigeration system.
4. Find out the cooling capacity and c.o.p. of evaporative condensing test rig.
5.Performance evaluation of thermo – electric refrigeration.
6.Parametric study of a VCR system in a computerized test-rig.
7. Study of vortex tube
8. Estimation of effective performance ratio when VCR in used as a heat pump

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(9D17201) AIR-CONDITIONING-II

1) Air-distribution – room air distribution – types of supply air outlets – Mechanism of flow through outlets – Considerations for selection and location of outlets – Distribution patterns of outlets friction loss in ducts- grills, diffusers – registers – location of outlets and return air opening – friction loss in ducts – rectangular equivalents of circular sucts – Air ducts design: duct construction – Duct design procedures – Equal Friction, Static Regain, Velocity Reduction methods.

2) BUILDING SURVEY:
Location of equipment and – Heat gain through glass – Shading from reveals, overhangs and fins- Effect of shading device – Calculation of Solar heat gain through ordinary glass using tables.

3) HEAT TRANSFER IN BUILDING STRUCTURES:
Fabric heat gain, overall heat transfer coefficient, periodic heat transfer through walls and roofs – solair temperature – Empirical methods to calculate heat transfer through walls and roofs using decrement factor and time lag-Equivalent temperature difference method – Infiltration – Stack effect – wind action – load due to infiltration.

4) COOLING LOAD CALCULATIONS:
Occupancy load, lighting load, appliance load-Product load-system heat gains-cooling and heating load estimates-Heat storage, diversity and stratification.

5) AIR-CONDITIONING SYSTEMS:
Central station Air conditioning system- All water, All air, air water unitary, Split, district Air conditioning systems.

6) THERMAL INSULATION FOR AIR CONDITIONINIG SYSTEMS:
Method of Heat transfer, desired properties of ideal insulating materials, types of insulating materials, Heat transfer through insulation, economic thickness of insulation, insulation of heated Buildings, insulation for cooling Buildings and cold storage, pipe insulation.

7) **AIR HANDLING APPARATUS:** Fans and Blowers-types of Fans-Fan characteristics-Centrifugal Fans-Axial Fans-Fan arrangements- Filters- general service – Noise – sources &control

8) **APPLICATIONS OF AIR-CONDITIONING:**
Industrial, Commercial, transport Air conditioning-Special applications-Computer, Hospital Cold storages, Printing, Textile & Leather industries.

Reference Books:

1. Hand Book of Air conditioning systems design –Carrier
2. Refrigeration & Air-conditioning –**C.P.ARORA**, TMGH, 2000.
3. Refrigeration & Air-conditioning – **Domkundwar and Arora, Danpatrai & Sons**,2000.
4. Refrigeration & Air –conditioning –**Stoecker.**
5. Refrigeration & Air-conditioning –**V.K.Jain.**
6. Guide and Data Book-**ASHRAE**

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(9D17202) CONVECTIVE HEAT & MASS TRANSFER:

1. Introduction to convection, review of conservation equations – Forced convection in laminar flow – Exact and approximate solutions of Boundary layer energy equation for plane isothermal plate in longitudinal flow – problems.

2. Forced convection heat transfer in laminar tube flow – forced convection in turbulent flow – Internal Flows – Correlations – Problems.

3. Approximate analysis of laminar free convective heat transfer on a vertical plate- external flows- correlations – problems

4. Boiling and condensation: Analysis of film condensation on a vertical surface – pool boiling – forced convection boiling inside tubes – problems.

MASS TRANSFER:

5. Definitions of concentration and velocities relevant to mass transfer, Fick's law, species conservation equation in different forms.

6. Steady State Diffusion in dilute solutions in stationary media, transient diffusion in dilute solutions in stationary media, one-dimensional non dilute diffusion in gases with one component stationary.

7. Convective mass transfer governing equations – forced diffusion from flat plate- dimensionless correlations for mass transfer.

8. Simultaneous heat and mass transfer – analogy between heat, mass and momentum transfer.

Reference Books:

1. Heat Transfer – **J.P. Holman**
2. Heat and Mass Transfer- **R.C Sachdeva**
3. Convective Heat and Mass Transfer- **Kays**
4. Heat and Mass transfer – **V. Gupta and I Srinivasan**- Tata Mc. Graw Hill

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(9D17203) REFRIGERATION EQUIPMENT AND CONTROLS

1. Compressors – types – equivalent shaft work – Volumetric efficiency – factors affecting total volumetric efficiency – compound compression with inter cooling – rotary compressors – surging – screw compressors – lubricating oils.

2. Condensers – types – Water cooled condensers – Air cooled, Evaporative types – Economic water rate – Economic water velocity – over all heat transfer co-efficient – design – temperature distribution and heat flow in a condenser – pressure drop – fouling factor – LMTD correction factor (no problems)

3. Cooling towers and spray ponds – classification – performance of cooling towers – analysis of counter flow cooling towers – enthalpy – temperature diagram of air and water – cooling ponds – types – cross flow cooling towers – procedure for calibration of outlet conditions

4. Evaporators – types – Flooded and dry Evaporators, natural and forced convection type – Shell and coil, plate type – secondary Evaporators – temperature distribution and heat flow in evaporator – pressure drop – fouling correction factor (no problems).

5. Defrosting – necessity – methods – manual, automatic, periodic defrosting, solid and liquid adsorbents, water defrosting, defrosting by reversing the cycle, automatic hot gas defrosting, thermo balance defrosting, electric control defrosting. (no problems).

6. Expansion devices – capillary tube, thermostatic expansion valves – float valves, externally equalized valves – automatic expansion valves – solenoid control valve – location of piping and pump design consideration. (no problems)

7. Performance of complete vapour compression system – performance of condensing unit- compressor – Evaporator – balancing of load in two stage compression. (no problems)

8. Installation of vapour compression refrigeration system – evaluation and dehydration testing for leakages – charging – adding oil. (no problems)

Reference Books:

1. "Refrigeration and Air Conditioning" – by **Stoecker – TMGH** – International Edition, 1982.
2. "Refrigeration and Air Conditioning" – by **Domkundwar – Dhanpat Rai & Co**.,- 2000.
3. "Refrigeration and Air Conditioning" – by **C.P.Arora – TMGH** – 2000.
4. Guide and Data book applications-**ASHRAE**

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(9D17204) CRYOGENIC ENGINEERING

1. Introduction necessity of low temperature – Multistage Refrigeration's system – Cascade system – Manufacture of dry ice-Joule Thomson coefficient.

2. Liquification of air – Lindae system – Analysis – Dual pressure cycle analysis- Liquefaction of Hydrogen and Helium – problems.

3. Application of Lower temperature – Effect on the properties of metals- strength – Thermal properties- super conductivity- super fluidity.

4. Applications like expansion fitting – cryobiology – cryosurgery – space research – computers underground power lines.

5. Low temperature insulation – reflective insulation – evacuated powders- Rigid foams- Super insulation.

6. Cryogenic Instrumentation-Low temperature measurements, measurement of micro-temperatures.

7. Cooling by adiabatic de-magnetization – Gas separation and cryogenic systems – separation of gases – Rectifying columns- Air separating – single and double columns Air separation plant.

8. Storage and handling of cryogenic liquids – Dewars and other types of containers.

Reference Books:

1. Cryogenics by **Barron**. Oxford University Press 1980.
2. Cryogenic Engineering by **Timmerhaus**
3. Cryogenic Engineering by **Huston:** Mc. Graw Hill
4. Refrigeration and Air- Conditioning by **S. Domkundwar**.

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(9D17205) FOOD PROCESSING TECHNOLOGY

1. Factors causing spoilage of foods and their dependency on temperature and thermo physical Properties of food products**,** theories and method of chilling, freezing and free de-
humidification- preparation for freezing, freezing methods: commercial freezing methods- sharp,
quick and air blast freezing , freeze-dry.
2. Methods of pre-cooling fruits and vegetables – hydro cooling, forced air cooling and vacuum cooling-Pre cooling analysis – Equipment.
3. Processing of meat products: Refrigeration systems for carcass chilling and holding – chilled brine spray, sprayed coil – dry coil systems, chilling and freezing variety meats – overnight chilling quick chilling, effect of freezing temp on qualify of meat product.
4. Fishery products: icing of fish - saltwater icing, freezing methods – slow freezing, blast freezing, plate freezing and immersion freezing of fish
5. Dairy products: Milk processing handling, dairy plant procedure, standardizing, pasteurization, homogenizing, and container filling.
6. Fruit juice concentrations: Processing and quality control – selection, grading and handling of fresh fruit, washing, juice extraction, heat treatment, flavor fortification, packaging storage and distribution – convection methods – freezing and mechanical separation, low temperature vacuum evaporation, direct refrigerant contact method, indirect refrigerant contact methods, high temperature short time evaporations.
7. Refrigerated warehouse: factors affecting ware house design – building location, design reduction, shipping and receiving plant forms, utility space, controlled atmospheric storage rooms, jacketed storages, automated ware house – insulation, cold storage doors.

8. Refrigerated trucks, trailer & containers: temperature control methods, body design & construction, auxiliary equipment, types of refrigeration systems – railway refrigeration cars.

Reference Books:

1. Guide and data book-**ASHRE**
2. Refrigeration & Air –conditioning-**C.P.Arora**
3. Hand Book of Air Conditioning system design – Carrier

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(9D17206) COMPUTATIONAL FLUID DYNAMICS (ELECTIVE – II)

UNIT-I

Elementary details in numerical Techniques: Number system and errors, Representation of integers, Fractions, Floating point Arithmetic, loss of significance and error propagation, condition and instability, computational methods for error estimation, Convergence of Sequences.

UNIT - II

Applied Numerical Methods: Solution of a system of simultaneous Linear Algebraic Equations, iterative
schemes. of Matrix Inversion, Direct Methods for Matrix inversion, Direct Methods for banded matrices.

UNIT - III

Finite Difference Applications in Heat conduction and Convention - Heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer.

UNIT - IV

Finite Differences, discretization, consistency, stability, and Fundamentals of fluid flow modeling: Introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.

UNIT - V

Introduction to first order wave equation, stability of hyperbolic and elliptic equations, fundamentals of fluid flow modeling. conservative property, the upwind scheme.

UNIT - VI

Review of Equations Governing Fluid Flow and Heat Transfer: Introduction, conservation of mass, Newton's second law of motion, expanded forms of Navier-stokes equations, conservation of energy principle, special forms of the Navier-stokes equations.

UNIT - VII

Steady flow, dimensionless form of Momentum and Energy equations, Stokes equation, conservative body force fields, stream function - Vorticity formulation.

UNIT -VIII

Finite Volume Method: Approximation of surface integrals, volume integrals, interpolation and differentiation practices, Upwind interpolation, Linear interpolation and Quadratic interpolation

Reference Books:

1. Numerical heat transfer and fluid flow, **Suhas V. Patankar**, Butter-worth Publishers
2.Computational fluid dynamics, Basics with applications, **John. D. Anderson**! Mc Graw Hill.
3.Computational Fluid Flow and Heat Transfer, **Niyogi,** Pearson Publications
4.Fundamentals of Computational Fluid Dynamics, **Tapan K. Sengupta**, Universities Press.

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(9D17207) ENERGY CONSERVATION AND MANAGEMENT (ELECTIVE – II)

1. **ENERGY CONSERVATION:**

   Heat for efficient energy conservation – technologies for energy conservation – outline of waste heat and material reclamation, load management, alternate energy sources, and energy storage.

2. **THERMAL INSULATION & REFRACTORS:**

   Heat loss through un-insulated surfaces, effects of insulation on current carrying wires – economic thickness of insulation – critical radius of insulations – properties of thermal insulators – classification of insulation materials – classification of refractors – properties of refractors – criteria for good refractory material – applications of insulating & refractory materials.

3. **WASTE HEAT RECOVERY SYSTEMS:**

   Guideline to identify waste heat – feasibility study of waste heat – shell and tube Heat exchanger – thermal wheel – heat pipe heat exchanger – heat pump – waste Heat boilers - incinerators.

4. **HEAT RECOVERY SYSTEMS & HEAT EXCHANGER NETWORKS:**

   Liquid to liquid heat exchangers – gas to liquid heat recovery systems, regenerators, recuperators, rotating regenerators – miscellaneous heat recovery methods – selection of materials for heat exchangers – combined radiation and convective heat exchanger, U-tube heat exchanger, tube heat exchanger, fluidized bed heat exchanger – economizer.

5. **ENGINEERING ECONOMICS:**

   Managerial objectives , steps in planning – efficiency of organization – capital budgeting – classification of costs – interest – types – nominal and effective

interest rates – discrete and continuous compounding – discounting – time value of money – cash flow discounting – time value of money - cash flow diagrams – present worth factor, capital recovery factor, equal payments – equivalent between cash flows.

6. PROJECT MANAGEMENT:

Method of investment appraisal – rate of return method, pay back method, net present value method (NPV) – adoption of the methods in energy conservation campaign – types of projects – propose of project management – classification – role and qualities of project manger – types of budgets – budget committee – budgeting.

7. ENERGY:

Energy Sources, Reserves, Grades of energy, Global and National energy scenarios, Energy transformation effects: Effect on energy use on environment, Air Pollution: Sources, Effects on human health, visibility and global climatic change, Controls; Water pollution: Sources, Classification and control, Solid Waste Management.

8. ENERGY AND ENVIRONMENTAL ECONOMICS

Energy efficiency analysis, Energy efficient technologies, Economics of Efficient energy use: Life cycle cost, pay back period, break-even, NPV; The Economy and the Environment.

Reference Books:

1. Waste heat recovery systems-**D. A. Reay** / Pergmon press
2. Hand book of energy audits-**Albert Thumann**
3. Energy Management-**W.R. Murphy & G.Mickay**, Butterworth
4. Energy Conservation-**P. W. O'Callaghan**, Pargamon Press 1981
5. Engineering Heat Audits-**C.P. Gupta & Rajendra Prakesh**, Nechand & Bros
6. Hand book of energy audits-**Albert Thumann**, The F.Airmont Press Inc., Atlanta Georgia, 1979.
7. Energy Management Principles – **Crag B. Smithm**, Pergamon Press
8. The role of Energy Manager-**EEO.,** U.K.
9. Industrial Engineering & Management-**Dr. O.P.Khanna**, Dhanapat Rai & sons1992.
10. PERT –CPM'- **L.S. Srinath**
11. "Energy Ecology and Environment-A Technological Approach", **N.D.Kaushika and KshitijiKaushik**, Capital Publishing Company, 2004.
12. "Principles of Energy Conversion", **A.W.Culp, JR**, Tata McGraw-Hill, 2000.
13. Environmental Pollution control Engineering", **C.S.Rao,** Wiley Estern, 1994.
14. International Energy outlook-2010, Energy Information Administration. U.S.Dept of Energy.
15. Energy and the Environment, **James A. Fay & Dan S**. **Golomb**, Oxford, 2002.

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(9D17208) SOLAR HEATING & COOLING SYSTEM (ELECTIVE – II)

1. SOLAR RADIATION:

Solar Constant, Spectral distribution of Extraterrestrial radiation, Terrestrial solar Radiation, solar radiation Geometry, sun rise, sunset and day length, Local solar time, computation of incident angle on inclined surface at a given location, empirical equations for estimating solar radiation, solar radiation measurement.

2. FLAT PLATE COLLECTORS:

Working Principal, Heat transfer analysis, Heat removal factor, Thermal efficiency. Working Principals of Novel flat plate collector.

3. CONCENTRATING COLLECTORS:

Thermodynamic limits of concentrating collectors, classification of Concentrating collector, working principles of parabolic, Compound parabolic and dish collectors. Traking requirements and traking Methods. Advantages and Disadvantages of concentrating collectors over flat plate collections.

4. SOLAR THERMAL ENERGY STORAGE:

Need of solar thermal energy storage, Sensible Heat Storage Systems-Desirable characteristics of sensible heat storage systems, sensible heat storage materials.

Latent Heat Storage Systems-Desirable properties of phase-change materials, advantages and disadvantages of phase change storage system. Solar pond as a thermal storage system.

5.APPLICATIONS OF SOLAR THERMAL SYSTEMS:

Classification and working of-solar water heating systems, solar Air heating systems, solar drying systems. Solar cookers, solar stills.

6.SOLAR REFIGERATION:

Solar operation of vapovr absorption and compression refrigeration cycles. Open cycle absorption / desorption solar cooling alternatives, advanced solar cooling systems.

7. SOLAR COOLING & DEHUMIDIFICATION:

Desiccant cooling- Solid and Liquid desicants-improving desicant cycle-hybrid systems.

8. NON- MECHANICAL SYSTEMS:

Active and passive systems, Trombe wall Australian Rock system – solar assisted heat pump. Solar thermo electric refrigeration and air-conditions. Economics of solar cooling.

Reference Books:

1. Principles of solar Engineering-F.Kreith & J.K.Kreider – **McGraow Hill book company**
2. Solar cooling & heating volumes, I,II & III T.Negat vezirogulu
3.Solar Heating and cooling by Kreith and Kreider.
4. Renewable Energy sources and Emerging Technologies-D.P.Kothari, K.C.Sirgal and Rakesh Ranjan-**PHI Learing pvt Ltd,** New Delhi.
5. Air Conditioning Principles and Systems an energy approach – Edward G.Pita-**PHI Learing Pvt Ltd**, New Delhi.
6.Renewable energy resources-Tiwari and Ghosal – **Narosa** Publications
7.Solar energy (Principles of Thermal Collectors and Storage) – S.P.Sukhatme-**Tata-McGraw Hill**
8.Non-Conventional energy sources: G.S.Rai-**Khanna Publications**
9.Renewable energy sources & Conventional Technology: Bamsath : **Leamany & Meliss**
10. Solar energy fundamentals and applications – H.P.Gary-**Tata McGraw Hills**-New Delhi.

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(9D17209) AIR –CONDITIONING LAB

1. Study the Humidification and Dehumidification process
2. Find out the Efficiency of the Air – Washer test rig.
3. Study on Gas charging unit
4. Find out the over –all efficiency of cooling Tower.
5. Find out the capacity and by – pass factor of the window air conditioning.
6. Study the various processes and by – pass factor by using Air conditioning test Rig.
7. Study on Heat pump
8. Study on Air-condition systems Split – Air conditioning system and central Air conditioning system.