SCHEME OF COURSE WORK:

Course Details:

Course Title	Refrigeration and air-conditioning					
Course Code	19ME2250	**LTPC**	**3**	**0**	**0**	**3**
Program	M.Tech.					
Specialization	Thermal Engineering					
Semester	I					
Prerequisites	Engineering Thermodynamics and Thermal Engineering					
Course to which is a prerequisite	NA					

Course Outcomes:

CO1	Explain different refrigeration systems, design steam jet and non-conventional refrigeration systems
CO2	Analyze simple vapor compression refrigeration systems, select refrigerants, design multi-evaporator systems
CO3	Discuss and design low temperature systems and vapor absorption refrigeration systems, discuss different defrosting methods
CO4	Explain psychrometric properties and analyze different air conditioning systems
CO5	Determine capacities and design air conditioning systems at different loads

Program Outcomes:

PO Code	**Program Outcome (PO)**
PO1	exhibit in-depth knowledge in thermal engineering specialization
PO2	think critically and analyse complex engineering problems to make creative advances in theory and practice
PO3	solve problem, think originally and arrive at feasible and optimal solutions with due consideration to public health and safety of environment
PO4	use research methodologies, techniques and tools, and will contribute to the development of technological knowledge
PO5	apply appropriate techniques, modern engineering tools to perform modeling of complex engineering problems with knowing the limitations
PO6	understand group dynamics, contribute to collaborative multidisciplinary scientific research
PO7	demonstrate knowledge and understanding of engineering and management principles and apply the same with due consideration to economical and financial factors
PO8	communicate complex engineering problems with the engineering community and society, write and present technical reports effectively
PO9	engage in life-long learning with a high level of enthusiasm and commitment to improve knowledge and competence continuously
PO10	exhibit professional and intellectual integrity, ethics of research and scholarship and will realize the responsibility towards the community
PO11	examine critically the outcomes of actions and make corrective measures

Course Outcome Vs Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M		M	S			M					
CO2	M	S		S		S	M					
CO3	M	S	S	M			M					
CO4		S	S	M			M					
CO5		S	S	S			M					

S - Strongly correlated, M - Moderately correlated, Blank - No correlation

Assessment Methods:
Assignment/Quiz/Seminar/Case Study, Mid term exam and End term examination.

Teaching-Learning and Evaluation

Week	Topic/Content	CO	Sample Questions	Teaching-Learning Strategy	Assessment method & Schedule
1	Bell-Coleman cycle and Brayton Cycle	CO1	The capacity of a refrigerator working on reversed Carnot cycle is 250 TOR when operating between -10^{o}C and 26^{o}C. Calculate (i) The quantity of ice produced at -4^{o}C within 24 hours when water is supplied at 20^{o}C. (ii) Minimum power required. Consider CP (Water) = 4.18 kJ/kgK, CP (ice) = 1.0 kJ/kgK and hfg (ice) = 337 kJ/kg	Lecture and problem solving	Assignment (week 4-6) Mid term exam (week 9)
2, 3	Aircraft refrigeration, simple, bootstrap, regenerative and reduced ambient systems, problems based on different systems	CO1	An aircraft flying at a speed of 800 km/hr at an altitude of 7500 m where the ambient pressure and temperature are 0.35 bar and 250 K. The pressure ratio of the main compressor is 5.2. The cabin pressure is maintained at 1.01325 bar and temperature at 25^{o}C. Effectiveness of the HE is 0.8 and air flow rate is 2 kg/sec. Calculate (i) Power required and (ii) Refrigeration capacity. Assume ramming, compression and expansion are isotropic	Lecture and problem solving	Assignment (week 4-6) Mid term exam (week 9)
4	Performance of VCR, properties and selection of pure and mixed refrigerants	CO2	Explain the working of a VCR system. Represent the cycle on *T-s* and *P-h* coordinates	Lecture and problem solving	Assignment (week 4-6) Mid term exam (week 9)
5	Multi-evaporator and compressors: methods of improving COP, sub-cooler heat exchanger, optimum inter stage pressure for two-stage refrigeration system	CO2	With a neat sketch explain the working of a refrigeration cycle with two stages of compression.	Lecture	Assignment (week 4-6) Mid term exam (week 9)
6	Single load systems, multi load systems with single compressor, multiple evaporator and compressor system, dry ice system, cascade systems	CO2	a. Explain the working of a single load VCR system with multiple expansion and flash chambers b. A compound refrigeration system is used for multi load purposes as shown. *R*-12 is used as refrigerant.	Lecture and problem solving	Assignment (week 4-6)

			Calculate the power required in kW to run the system and COP of the combined system		Mid term exam (week 9)
7, 8	**Vapor absorption system (VAR)**: simple absorption system, practical ammonia absorption system, Electrolux Refrigerator, Domestic Electrolux Refrigerator, Lithium–Bromide VAR system, actual analysis of ammonia absorption system	CO3	Draw a neat line diagram of an Electrolux refrigerator and explain its working principle. What is the imp role of hydrogen in this refrigeration system?	Lecture	Assignment (week 14-16) Mid term exam (week 18)
8	**Methods of Defrosting:** automatic periodic defrosting, solid absorbent system, water defrosting, defrosting by reversing cycle, automatic hot gas defrosting	CO3	What is the significance of defrosting? Explain any two different methods of defrosting	Lecture	Assignment (week 14-16) Mid term exam (week 18)
9	Mid Term Examination				
10	**Methods of Defrosting:** thermos-bank defrosting, electric defrosting, electric air switch defrosting system, two outdoor unit system, multiple evaporators defrosting system	CO3	Explain with neat sketches working of the following two defrosting methods. (i) Water defrosting system, and (ii) Themo bank Defrosting system	Lecture	Assignment (week 14-16) Mid term exam (week 18)
11	**Air-conditioning**: psychrometric properties & processes, summer air-conditioning systems, winter air conditioning systems, year around air-conditioning	CO4	(a) Explain with a neat sketch the working of a summer air-conditioning system (b) Twelve grams of moisture per kg of dry air is removed from atmospheric air when it is passed through an air-conditioning system and its temperature becomes 27^{o}C. The atmospheric conditions are 44^{o}C DBT and 6 % R .H. Find the following: i. Relative humidity. ii. Wet-bulb temperature. iii. Dew-point temperature. iv. Take air pressure as 1.01325 bar.	Lecture and problem solving	Assignment (week 14-16) Mid term exam (week 18)

12	Requirements of comfort air-conditioning, thermodynamics of human body, comfort chart-design considerations, need for ventilation	CO4	What are the requirements of comfort air-conditioning. Explain in detail.	Lecture	Assignment (week 14-16) Mid term exam (week 18)
12-13	**Air-conditioning systems**: central station air-conditioning system, unitary air-conditioning system, self-contained air-conditioning units.	CO4	Describe the central station air conditioning system	Lecture	Assignment (week 14-16) Mid term exam (week 18)
14	**Design of air-conditioning systems**: cooling load calculations, different heat sources, bypass factor (BF), effective sensible heat factor (ESHF), cooling coils and dehumidifying air washers	CO5	An Air-conditioning plant is to be designed for a small office room for winter conditions. Outdoor conditions = 10 ^{o}C DBT and 8 ^{o}C WBT. Required indoor conditions 20 ^{o}C DBT and 60 % RH. Amount of free air circulation = 0.3 m^3/min/person. Seating capacity of the office = 50. The required condition is achieved first by adiabatic humidifying and then by heating. Calculate the following: (a) Heating capacity of the coil in kW and the surface temperature required if the bypass factor of the coil is 0.32. (b) The capacity of the humidifier	Lecture and problem solving	Assignment (week 14-16) Mid term exam (week 18)
15	**Design of air-conditioning systems**: different heat sources, bypass factor (BF), effective sensible heat factor (ESHF)	CO5	The following data is given for the space to be air conditioned: Outside air conditions = 45°C DBT and 28°C WBT, inside design conditions = 23°C DBT and 47% RH, room sensible heat load = 45 kW, room latent heat load = 15 kW, By-pass factor of the cooling coil = 0.21, Return air from the room is mixed with the outside air before entry to the cooling coil in the ratio of 3.5: 1 by mass.	Lecture and problem solving	Assignment (week 14-16) Mid term exam (week 18)

			Determine (a) Supply air flow rate. (b) Outside air sensible heat. (c) Outside air latent heat (d) Grand total heat. (e) Effective room sensible heat factor		
16	**Design of air-conditioning systems**: cooling coils and dehumidifying air washers	CO5	An air-conditioned auditorium is maintained at 28^{o}C DBT and 50% RH when outdoor condition is 32^{o}C DBT and 28^{o}C WBT. Total sensible and latent heat loads are 150 kJ/hr and 50 kJ/hr. Consider 60% of return air is recirculated and mixed with 40% of fresh air after the cooling coil. The temperature of air leaving the cooling coil is 15^{o}C. Calculate (i) RSHF (ii) Condition of air entering the auditorium, (iii) Amount of makeup air (iv) ADP of the coil and (v) Bypass factor of the conditioning coil	Lecture and problem solving	Assignment (week 14-16) Mid term exam (week 18)
17	Revision of syllabus				
18	Mid Term Examination-II				
19-20	End Term Examination				