Q. Code:999743

Reg. No. | | | | | | | | | | | | |

B.E / B.TECH. DEGREE EXAMINATIONS, MAY 2024

Fourth Semester

AE22403 - THERMAL ENGINEERING AND HEAT TRANSFER

(Automobile Engineering)

(Regulations 2022)

(Use of Approved Heat and Mass Transfer Data book, Psychrometric table/chart and Steam tables is permitted)

TIME: 3 HOUR **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO1	Analyse the thermodynamic cycles of internal combustion engines, and air compressors.	**3**
CO2	Discuss the properties of moist air and use Psychrometric chart to analyse the properties of moist air and explain the basic working principles of various types of air conditioning systems.	**3**
CO3	Classify the various modes of heat transfer and estimate the rate of heat transfer by steady state and unsteady state conduction.	**3**
CO4	Discuss the phenomenon of boundary layer and estimate the rate of heat transfer by convective heat transfer.	**3**
CO5	Discuss the concept of radiation and estimate the rate of heat transfer by radiation heat transfer. Also, analyse the performance of heat exchangers based on flow pattern.	**4**

PART - A (20 x 2 = 40 Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	The thermal efficiency of an Otto cycle is 50 % and specific heat ratio is 1.4. What is the compression ratio?	**1**	**3**
2.	Differentiate between cut-off and cut-off ratio related to Diesel cycle?	**1**	**2**
3.	In a heat engine cycle, the heat supplied is 1200 kJ and heat rejected is 600 kJ. Calculate its efficiency if it is (i) Diesel cycle and (ii) Otto cycle.	**1**	**3**
4.	Differentiate between perfect intercooling and incomplete intercooling in a multistage reciprocating air compressor. In which case, the save in work is more.	**1**	**3**
5.	Define the term "degree of saturation" related to psychrometry. What is its value for saturated air?	**2**	**2**
6.	The air is cooled from 35°C to 15°C using cooling coil. Determine coil temperature if the By-pass factor is 0.3?	**2**	**3**
7.	State the sensible heat factor for cooling & dehumidification process with the help of psychrometric chart.	**2**	**3**
8.	What are the important factors, which affect the comfort air conditioning?	**2**	**2**

9.	Heat transfer takes place according to which of the following law? a) Newton's second law of motion b) First law of thermodynamics c) Newton's law of cooling d) Second law of thermodynamics	**3**	**2**
10.	Which is the best insulating material among the following: (i) Asbestos (ii) Cellular glass (iii) Mineral fibre	**3**	**2**
11.	The inner face temperature of a slab of thickness 0.4 m is 500°C and outer face temperature is 70°C. What will be the temperature of slab at a thickness 0.1 m from the inner face? Assume uniform cross-sectional area.	**3**	**3**
12.	What is the significance of Biot number?	**3**	**2**
13.	Write the significance of Grashof number. In which mode of convection, this number is used.	**4**	**2**
14.	Choose relevant empirical equation for Nusselt number for the flow of gas across the tube banks with 30 rows.	**4**	**2**
15.	The convection heat transfer coefficient depends upon a) the thermal properties of fluid b) geometry of the system c) characteristics of the fluid flow d) all of the above	**4**	**2**
16.	Generally, all the fluid particles in flowing fluid a) flow at a constant velocity b) flow at various velocities c) flow at a velocity as high as possible d) none of the above	**4**	**2**
17.	The Stefan-Boltzmann law of thermal radiation is applicable for a) white body b) gray body c) black body d) all the bodies	**5**	**2**
18.	Show the temperature variation of hot and cold fluid in a counter-flow heat exchanger.	**5**	**2**
19.	Differentiate between LMTD and NTU approaches.	**5**	**3**

20.	Two large black plates are maintained at a temperature of 900 K and 500 K respectively. Calculate net heat exchange between the plates per unit area.	**5**	**3**	

PART - B (5 x 10 = 50 Marks)

		Marks	CO	RBT LEVEL
21. (a)	In an engine working on ideal Diesel cycle inlet pressure and temperature are 1 bar and 17°C respectively. Pressure at the end of adiabatic compression is 35 bar. The volume ratio of adiabatic expansion is 5. Calculate the temperature at salient points in the cycle. Assume $\gamma = 1.4$, $C_p = 1.004$ kJ/kg-K and $C_V = 0.717$ kJ/kg-K	**(10)**	**1**	**3**
	(OR)			
(b)	A reciprocating air compressor running at 400 rpm has a bore of 100 mm and a stroke of 110 mm. The clearance is 4 % of stroke. If compression and expansion follows the law $pV^{1.28} = C$, determine the power required to run the compressor and the FAD. Inlet conditions are 0.96 bar and 40°C and delivery is at 7 bar. Standard conditions for free air are 1 bar & 20°C.	**(10)**	**1**	**3**
22. (a)	Atmospheric air at 20°C and 50% RH passes through a heater and then through a humidifier and finally leaves at 30°C and 60% RH. Calculate the change in specific enthalpy and specific humidity of the air. What is the sensible heat factor? Also, calculate by-pass factor if the heating coil temperature is 50°C.	**(10)**	**2**	**4**
	(OR)			
(b)	In a car, 1 kg of air (on dry basis) from cabin at 20°C, 90 % RH is mixed adiabatically with the 2 kg of outside air (on dry basis) at 40°C and 40% RH before entering the air conditioning system. Determine properties of air after mixing.	**(10)**	**2**	**4**
23. (a)	A wall of 0.5 m thickness is to be constructed from a material which has an average thermal conductivity of 1.4 W/m-K. The wall is to be insulated with a material having an average thermal conductivity of 0.35 W/m-K so that the heat loss per m^2 will not exceed 1450 W. Assuming that the inner and outer surface temperatures are 1200°C and 15°C respectively, calculate the thickness of insulation required.	**(10)**	**3**	**3**
	(OR)			

(b)	A pure aluminium plate of 400 mm x 500 mm x 5 mm size at 400°C is suddenly quenched into liquid at 20°C. Determine the time required for the plate to reach a temperature of 80°C and 20°C. Assume h = 5000 W/m^2-K.	**(10)**	**3**	**3**
24. (a)	Engine oil flows through a 50 mm diameter tube of 2 m length at an average temperature of 150°C. The flow velocity is 80 cm/s. Calculate the average heat transfer coefficient if the tube wall is maintained at a temperature of 200°C.	**(10)**	**4**	**4**
	(OR)			
(b)	A pipe of 100 mm diameter and 2 m height is maintained at a constant temperature of 130°C and is suspended vertically. If the stagnant air at 30°C surrounds the pipe, find heat transfer rate between hot pipe and cold air. If the pipe is suspended horizontally, what is the change of heat transfer rate?	**(10)**	**4**	**4**
25. (a)	Two large parallel planes with emissivities of 0.3 and 0.5 are maintained at temperatures of 527°C and 127°C respectively. A radiation shield having emissivity of 0.05 on both sides is placed between them. Calculate (i) Heat transfer rate between them without shield and (ii) Heat transfer rate between them with shield.	**(10)**	**5**	**3**
	(OR)			
(b)	A counter flow heat exchanger is employed to cool 0.55 kg/s (Cp = 2.45 kJ/kg-K) of oil from 115°C to 40°C by the use of water. The inlet and outlet temperature of cooling water are 15°C and 75°C respectively. The overall heat transfer coefficient is expected to be 1450 W/m^{2}K. Calculate (i) The mass flow rate of water, (ii) The effectiveness of heat exchanger and (iii) The surface area required.	**(10)**	**5**	**3**

PART - C (1 x 10 = 10 Marks)

(Q.No.26 is compulsory)

		Marks	**CO**	**RBT LEVEL**
26.	Discuss the general arrangement of air conditioner in a modern passenger cars and busses. Discuss the mode of heat transfer in condensers in such systems.	**(10)**	**5**	**3**

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