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ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. / B. Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, NOV / DEC 2023

B.E. MECHANICAL ENGINEERING
Semester – V
ME5501 THERMAL ENGINEERING
(Regulation 2019)

Time: 3hrs

Max.Marks: 100

- CO 1 Evaluating the fuel properties and arrive at proximate and ultimate analysis of fuels
- CO 2 Understanding the different types of boilers and compute their performance
- CO 3 Assessing the performance of an air compressor
- CO 4 Comprehending the working principle of various refrigeration systems
- CO 5 Determining the different psychrometric properties and heat load

BL – Bloom's Taxonomy Levels

(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analysing, L5 - Evaluating, L6 - Creating)

Note:

- Approved data book are allowed.
- Read and understand each question carefully.
- State necessary assumptions made for answering the questions.
- Good luck!

PART- A (10 x 2 = 20 Marks)
(Answer all Questions)

Q. No	Questions	Marks	CO	BL
1	What are the causes of incomplete combustion?	2	1	L1
2	Define enthalpy of formation and enthalpy of combustion.	2	1	L2
3	What are the principle heat losses that occur in a boiler?	2	2	L2
4	Why boiler blow-down is required?	2	2	L1
5	Why clearance is necessary and what is its effect on the performance of reciprocating compressor?	2	3	L2
6	Define the term isothermal compression efficiency.	2	3	L1
7	Why is the throttling valve not replaced by an isentropic turbine in the ideal vapor-compression refrigeration cycle?	2	4	L2
8	Define refrigerating effect. What is one tonne of refrigeration?	2	4	L1
9	After a long walk in the 8°C outdoors, a person wearing glasses enters a room at 25°C and 40 percent relative humidity. Determine whether the glasses will become fogged.	2	5	L3
10	What is an adiabatic saturation?	2	5	L2

PART- B (5 x 13 = 65 Marks)

Q. No	Questions	Marks	CO	BL
11 (a)	A fuel having the formula $C_7 H_{16}$ is burnt with 10% excess air. Assuming 90% carbon is burnt to CO_2 and the remaining to CO , determine		1	L4
	(i) the volumetric analysis of dry flue gases	7		
	(ii) air to fuel ratio by mass.	6		
OR				
11 (b) (i)	Explain the construction and working of bomb calorimeter.	9	1	L3
	(ii) Enumerate the advantages of liquid and gaseous fuels over solid fuels.	4		
12 (a)	A boiler is capable of generating 8 kg steam per kg of fuel at $400^\circ C$. Feed water is supplied at pressure of 30 bar, $40^\circ C$ and leaves economiser at $150^\circ C$ for entering to evaporator. Steam leaves evaporator with dryness fraction of 0.98 and enters the super heater. Fuel used has calorific value of 29000 kJ/kg. Considering no pressure loss inside the boiler, determine boiler efficiency and fraction of heat given to steam in each section of boiler.	13	<u>2</u>	L4
OR				
12 (b) (i)	With a neat sketch explain the working of a babcock and Wilcox Boiler. What are its merits & demerits?	9	2	L3
	(ii) List the boiler mountings and accessories.	4		
13 (a) (i)	What are the advantages or effects of multi stage compression with intercooling over single stage compression for the same pressure ratio?	4	3	L4
	(ii) Drive the expression for work done for a multistage compressor with perfect intercooling.	9	3	
OR				
13 (b)	A double-acting, single-stage reciprocating air compressor has a bore of 330 mm, stroke of 350 mm, clearance of 5%, and runs at 300 rpm. It receives air at 95 kPa and $25^\circ C$. The delivery pressure is 4.5 bar and the index of compression is 1.25. The free air conditions are 1.013 bar and $20^\circ C$. Determine		<u>3</u>	L4
	(i) FAD,	4		



- (ii) heat rejected during the compression, and 4
- (iii) power input to compressor, if its mechanical efficiency is 80%. 5

14 (a) Explain with sketch the working principle of Li-Br Water vapour absorption refrigeration system. 13 4 L3

OR

14 (b) A food storage locker requires a refrigeration capacity of 50 kW. It works between a condenser temperature of 35°C and an evaporator temperature of - 10°C. The refrigerant is ammonia. It is sub-cooled by 5°C before entering the expansion valve by the dry saturated vapour leaving the evaporator. Assuming a single cylinder, single-acting compressor operating at 1000 r.p.m. with stroke equal to 1.2 times the bore. 4 L4

Determine :

- (i) The power required, and 7
- (ii) The cylinder dimensions. 6

15 (a) An office is to be air conditioned for 50 staff, when the outdoor conditions are 30°C DBT and 75% RH. If the quantity of air supplied is 0.4 m³/min/person. Find the following: 5 L5

- (i) Capacity of the Cooling coil in tonnes of refrigeration. 3
- (ii) Capacity of the heating coil in kW. 3
- (iii) Amount of water vapour removed per hour. 3

Assume that required air inlet conditions are 20°C DBT and 60% RH. Air is conditioned first by cooling and dehumidifying and then by heating.

- (iv) If the heating coil surface temperature is 20°C, find the by-pass factor of the heating coil. 4

OR

15 (b) (i) Explain any four psychometric processes with sketch. 4 5 L4

(ii) A 142 m³/min moist air at 5°C with specific humidity of 0.002 kg/kg of dry air is mixed adiabatically with 425 m³/min of moist air stream at 24°C and 50% relative humidity. If the pressure is constant throughout at 1 bar. Determine

- (i) the humidity ratio, and 4
- (ii) the temperature of the mixed stream. 5



PART- C (1 x 15 = 15 Marks)
(Q.No.16 is compulsory)

Q. No	Questions	Marks	CO	BL
16.	<p>Refrigerant-134a enters the compressor of a refrigerator at 140 kPa and -10°C at a rate of $0.3 \text{ m}^3/\text{min}$ and leaves at 1 MPa. The isentropic efficiency of the compressor is 78 percent. The refrigerant enters the throttling valve at 0.95 MPa and 30°C and leaves the evaporator as saturated vapor at -18.5°C. Show the cycle on a T-s diagram with respect to saturation lines, and determine</p> <p>(i) the power input to the compressor, (ii) the rate of heat removal from the refrigerated space, and (iii) the pressure drop and rate of heat gain in the line between the evaporator and the compressor.</p>		3	L6

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