Q. Code: 190498

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

B.E / B.TECH. DEGREE EXAMINATIONS, MAY 2023
Fourth Semester
ME18401 – THERMAL ENGINEERING
(Mechanical Engineering)
(Regulation 2018 / Regulation 2018A)
(Use of Steam table, Mollier chart and Psychometric chart is permitted)

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

CO 1 Student are able to compare and contrast the various system & components of IC engine and also to analyze their performance of air standard cycles

CO 2 Student are able to understand the various system used in IC engine and also to analyze their performance.

CO 3 Students are able to distinguish the different types of nozzle, turbines and compressor and to analyze their performance.

CO 4 Students are able to distinguish the different types of air compressor and to analyze their performance

CO 5 Students are able to analyze the performance of different air conditioning system and to design an air conditioning system for chosen application

PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	Compare C.I and S.I Engines as the following points concerned (a). Fuel used (b). Working cycle (c). Method of ignition (d). Method of fuel injection.	**1**	**2**
2.	During the exhaust process in High speed Diesel engine both IV and EV will open for some degrees. This is called as ----------.	**1**	**2**
3.	An engineer claims his engine to develop 3.75 kW. On testing, the engine consumes 0.44 kg of fuel per hour having a calorific value of 42000 kJ/kg. The maximum temperature of recorded in the cycle is 1400^0 C and minimum is 350^0 C. Find whether the engineer is justified in his claim.	**2**	**3**
4.	Which engine will have more cooling requirement two-stroke engine or four stroke engine? Why?	**2**	**2**
5.	What is the type of energy conversion in a steam nozzle?	**3**	**2**
6.	In a steam turbine irrespective of load how mass of steam varied and state its types.	**3**	**2**
7.	What is meant by perfect inter cooling?	**4**	**2**
8.	Differentiate rotary air compressor and reciprocating air compressor.	**4**	**2**
9.	Sketch the vapour compression refrigeration cycle.	**5**	**2**
10.	Using a Skeleton psychrometric chart, represent the following psychrometric process. a). Cooling and dehumidification b). Evaporative cooling.	**5**	**2**

PART- B (5 x 14 = 70 Marks)

			Marks	CO	RBT LEVEL
11. (a)	Compare Otto cycle and Diesel cycle for the basis for same compression ratio 10 and equal heat rejection of 840 kJ/kg. The suction conditions are 1 bar and 328 K.		**(14)**	**1**	**3**
	(OR)				
(b)	An engine working on Otto cycle has a volume of 0.5 m^3, pressure 1 bar and temperature 27^0 C at the commencement of compression stroke. At the end of compression stroke the pressure is 10 bar. Heat added during the constant volume process is 200 kJ. Calculate the maximum pressure and temperature in the cycle. Also find (a). Percentage clearance, (b).air standard efficiency and (c). mean effective pressure.		**(14)**	**1**	**3**
12. (a)	**(i)**	In a pressure –crank angle diagram show the different stages of combustion in CI engine	**(7)**	**2**	**2**
	(ii)	Discuss the necessity of cooling system in IC engine and explain the same with help of thermostat.	**(7)**	**2**	**2**
	(OR)				
(b)	The following data is given for 4- stroke, 4- cylinder diesel engine. Diameter of the cylinder= 35 cm, piston stroke = 40 cm, speed of the engine = 315 rpm, Indicated mean effective pressure = 7 bar, B.P of the engine= 260 kW, Fuel consumption = 80 kg/hr, C.V of fuel = 4300kJ/kg, Mass of dry gas formed per minute =29.87 kg, Mass of steam formed = 1.455 kg/min, cooling water circulated = 90 kg/min. Rise in temperature of cooling = 38^0 C, Piston cooling oil used = 45 kg/min, Rise in temperature of cooling oil =23^0 C, C_p for cooling oil = 2.2 kJ/kg K. Exhaust gas temperature =322^0 C, C_p for exhaust gas = 1.1 kJ/kg. Ambient temperature=22^0 C, C_p for superheated steam =2 kJ/kg, Latent heat of steam 2520 kJ/kg Find (a). The mechanical and indicated thermal efficiency. (b). Draw up heat balance sheet on minute basis and percentage basis.		**(14)**	**2**	**3**

13. (a)	**(i)**	For the convergent divergent nozzle, obtain the condition for achieving maximum discharge with minimum area.	**(7)**	**3**	**2**
	(ii)	Steam at a pressure of 10 bar and 0.98 dry is passed through a convergent and divergent nozzle to a back pressure of 0.1 bar. The mass flow rate is 0.55 kg/sec. Find (a) The pressure at throat (b). Number of nozzle used if each nozzle has a throat area is 0.5 cm^2.	**(7)**	**3**	**3**
		(OR)			
(b)	**(i)**	With suitable diagram explain any one methodology of reducing rotor speed in steam turbine	**(7)**	**3**	**2**
	(ii)	In a 50 % reaction turbine stage running at 50 revolutions per second, the exit angles are 30^0 and inlet angles are 50^0. The mean diameter is one m. The steam flow rate is 10000 kg/min and stage efficiency is 85 %. Determine (i). The power output of the stage (ii). The specific enthalpy of the drop in the stage. (iii). The percentage increase in the relative velocity of steam when it flows over the moving blades.	**(7)**	**3**	**3**

14. (a)		The following observation are recorded during a trial on a two stage single acting reciprocating air compressor. FAD = 6 m^3/min. Atmospheric pressure and temperature are 1 bar and $27^0\ C$. Delivery pressure = 40 bars, speed =400 rpm, intermediate pressure = 6 bar. Temperature at the end of inlet to second stage = $27^0\ C$. Law of compression $pv^{1.3} = C$. Mechanical efficiency = 80 % Stroke of LP = Diameter of LP = Stroke of HP. Calculate (i). Cylinder diameter (ii). Power required. Neglect clearance.	**(14)**	**4**	**3**
		(OR)			
(b)	**(i)**	Compare rotary and reciprocating compressors.	**(7)**	**4**	**2**
	(ii)	Describe the function of the impeller and diffuser in a centrifugal compressor.	**(7)**	**4**	**2**
15. (a)		A F_{12} vapour compression refrigeration system has a condensing temperature of 50^0 C and evaporating temperature of 0^0. The refrigeration capacity is 7 tons. The liquid leaving the condenser is saturated liquid, the refrigerant enters the compressor at dry and compression is isentropic. Determine (i). The refrigeration flow rate (ii). The power required to run the compressor (iii). The heat rejected in the plant (iv). C.O.P. of the system. Use the properties of F_{12} as listed below	**(14)**	**5**	**3**

Temp °C	Pressure bar	Enthalpy of liquid kJ/kg	Enthalpy of vapour kJ/kg	Entropy of liquid kJ/kg K	Entropy of Vapour kJ/kg K
50	12.199	84.868	206.298	0.3034	0.6792
0	3.086	36.022	187.397	0.1418	0.6960

Take enthalpy at the end of isentropic compression = 210 kJ/kg

(OR)

(b)		Compare the working principle of winter and summer air conditioning systems.	**(14)**	**5**	**3**

PART- C (1 x 10 = 10 Marks)

(Q.No.16 is compulsory)

		Marks	CO	RBT LEVEL
16.	Show that thermal efficiency of the diesel cycle is reduced with increase in cut – off ratio. Assume suitable numerical values.	**(10)**	**1**	**4**

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