B.E./B.TECH. DEGREE EXAMINATION, DECEMBER 2020

Fourth Semester

ME16403-THERMAL ENGINEERING

(Regulation 2016)

(Use of approved steam table, Mollier diagram Psychometric Chart permitted in the examination)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. Mean effective pressure of Otto cycle is
   a. Inversely proportional to pressure ratio
   b. directly proportional to pressure ratio.
   c. does not depend upon pressure ratio.
   d. proportional to square root of pressure ratio.
2. Action of steam used in steam turbine is
   a. Static
   b. dynamic.
   c. pressure
   d. both (a) and (b) above
3. 30% Reaction turbine refers to
   a. 70% enthalpy drop in fixed blades 30 % enthalpy drop in moving blades.
   b.30% enthalpy drop in fixed blades 70% enthalpy drop in moving blades.
   c. enthalpy drop in both moving and fixed blades.
   d. none of the above.
4. The dehumidification process on the psychometric chart is shown by
   a. Horizontal line.
   b. Vertical line.
   c. Inclined line.
   d. Curved line
5. Illustrate the requirements of a fuel injection system of a diesel engine.
6. State the signification of critical pressure ratio.
7. List the methods of controlling output of the reciprocating compressor.
8. List out the properties of ideal refrigerant.

PART B - (4 X16 = 64 marks)

09. (a) (i) Establish an expression for the air standard efficiency of an engine working on Otto cycle. Derive an expression for a change in compression ratio. If the compression ratio is increased from 6 to 8, what will be the percentage increase in efficiency? **(8)**

(ii) What will be the loss in the ideal efficiency of a diesel engine with compression ratio 14 if the fuel cut-off is delayed from 6% to 9%? Assume clearance volume is one. **(8)**

(OR)

(b) (i) Describe the phenomenon of detonation in SI engine and on what factors does detonation depend. **(8)**

(ii) Find the dimension of the cylinder of an oil engine which develops 36 kW bp under the following conditions. **(8)**

Mean effective pressure = 6 bar No of explosion/min= 80

Ratio of stroke to diameter = 2 Mechanical efficiency = 80 %

10. (a) (i) A group of convergent-divergent nozzle is required to pass 9 kg of steam per second, the pressure of supply being 5.6 bars absolute and the back pressure is 1.4 bar absolute. The steam is initially dry saturated and the expansion is assumed to be in equilibrium. The loss by friction in the divergent part is 12 percentage of the total adiabatic enthalpy drop. Find for complete expansion, the total areas of cross-section required at the throats and exit of the group. **(8)**

(ii) Assuming a frictionless adiabatic flow find the size of the nozzle to deliver 0.23 kg of steam per second into a reservoir where the pressure is maintained constant at 0.18 bar absolute. The steam is supplied to the nozzle at 7 bar absolute pressure and superheated to a final temperature of 250° C. During the flow to the throat assume $pv^{1.3}$=constant. **(8)**

(OR)

(b) (i) Show that the maximum efficiency of a parson's reaction turbine is given by ($2\cos^2\alpha/1+\cos^2\alpha$) where α is the angle with the direction of motion of blade at which steam enters the blades. **(8)**

(ii) In a four stage pressure compounded turbine the steam is supplied at a pressure of 23.5 bar and superheated to a temperature 340° C. The exhaust pressure is 0.06 bar and overall turbine efficiency is 0.72. Assuming that the work is shared equally between the stages and that the condition line is straight, estimate the stage pressures, the efficiency of each stage and the reheat factor. **(8)**

11. (a) (i) Show that the heat rejected per stage per kg of air in a reciprocating compressor with perfect intercooling is given by **(8)**

$$\left[C_p+C_v\left(\frac{\gamma-1}{n-1}\right)\right](T_2-T_1)$$

Where (T_2-T_1) is the temperature raise during compression, n is polytropic index γ is adiabatic index and C_p and C_v are two specific heats of air.

(ii) A two stage air compressor with complete inter-cooling delivers air to the mains at a pressure of 30 bar, the suction conditions being 1 bar and 27° C. If both cylinders have the same stroke, find the ratio of the cylinder diameter, for the efficiency of compression to be a maximum. Assume index of compression to be 1.3 **(8)**

(OR)

(b) (i) A single stage air compressor is required to compress 72 cubic meter of air per minute from 15° C and one atmosphere to 8 atmosphere. Find the temperature at the end of (a). isothermal (b). adiabatic (c). polytropic compression, following $pV^{1.25}=C$. **(16)**

12. (a) (i) How can you achieve the cooling effect inside the room without compressor and explain with neat sketch? **(16)**

(OR)

(b) (i) A food storage locker requires a refrigeration capacity of 12 tons of refrigeration and works between the evaporator temperature of -8° C and a condenser temperature of 30° C. The refrigerant Freon-12 is sub-cooled by 5°C before entry to expansion valve and the vapor is superheated to -2° C before leaving the evaporator coils. Assuming all processes reversible expect throttling and a two cylinder single acting compressor operating at 1000 r.p.m. with stroke equal to 1.5 times to bore and with 2% of clearance, determine the following (i). COP **(16)**

(ii). Theoretical power. (iii). Bore and stroke.

Take γ=1.13 for Feron 12 and properties are

Saturation Temperature °C	Pressure bar	Enthalpy kJ/kg		Entropy kJ/kg K		Specific volume of vapor m^3/kg
		liquid	Vapor	liquid	Vapor	
-8	2.3519	192.647	348.012	0.97287	1.55897	0.7168
30	7.4490	228.540	363.566	1.09795	1.54334	0.02350