Reg. No. :

Question Paper Code : 91841

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019
Fourth/Sixth Semester
Mechanical Engineering
ME 6404 – THERMAL ENGINEERING
(Common to Mechanical Engineering (Sandwich))
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. Which air standard cycle (Otto/Diesel/Dual) is more efficient for the same heat input ? Justify.
2. Define Cut off ratio for a diesel cycle.
3. State the merits of a diesel engine over a petrol engine.
4. What is meant by valve overlap ?
5. State the effect of friction in steam nozzle.
6. What is the need of governors in steam turbine ?
7. Define the volumetric efficiency of compressor.
8. State the effect of clearance on work done in a reciprocating compressor.
9. What is the effect of sub-cooling of a refrigerant in a vapour compression cycle ?
10. Define Bypass factor of a heating coil.

PART – B **(5×13=65 Marks)**

11. a) An engine works on an Otto cycle. It has a compression ratio of 8.9 and the intake conditions of air are 1 bar, 25°C. Heat added under constant volume is 800 kJ/kg. Find the pressure and temperature at salient points, air-standard efficiency and mean effective pressure. Assume for air C_v = 0.718 kJ/kg.K and γ = 1.4 and R = 0.287 kJ/kg.K and also draw the p-v and T-s diagrams. **(13)**

(OR)

b) For an air standard diesel cycle the following data is available :
Compression ratio = 16, Heat added = 2500 kJ/kg. Lowest temperature in the cycle = 300 K, Lowest pressure in the cycle is 1 bar. Calculate ; i) Pressure and temperature at each point in the cycle ii) Thermal efficiency. Assume C_p = 1 kJ/kg.K and C_v = 0.714 kJ/kg.K. **(13)**

12. a) i) Sketch the typical valve timing diagram of a high speed 4 stroke petrol engine. **(5)**

ii) Explain the functioning of a forced circulation cooling system with a neat sketch. **(8)**

(OR)

b) What is knocking in a CI engine ? With a sketch, explain the knocking in a CI engine. Also mention the effect of various engine parameters on knocking. **(13)**

13. a) What is critical pressure ratio in a nozzle ? Derive the relation for critical pressure ratio in a steam nozzle. **(3+10)**

(OR)

b) Steam issues from the nozzles of a De Laval turbine with a velocity of 1000 m/sec. The nozzle angle is 20°. Mean blade velocity is 400 m/sec. The blades are symmetrical. The mass flow rate is 1000 kg/h. Friction factor is 0.8, nozzle efficiency is 95%. Determine : (i) Blade angles (ii) Axial thrust on the rotor turbine (iii) Work done per kg of steam, (iv) Power developed (v) Blade efficiency (vi) Stage efficiency. **(13)**

14. a) A single stage double acting air compressor delivers $15 m^3$/min of air measured at 1.013 bar 27°C. The air is delivered at 7 bar. The conditions at the end of suction stroke are pressure 0.98 bar and temperature 35°C. The clearance volume is 4% of stroke volume, the L/D ratio is 1.3 and the compressor runs at 300 rpm. Calculate the volumetric efficiency, cylinder dimensions and isothermal efficiency of the compressor. Take index of expansion and compression as 1.3 and R = 0.287 kJ/kg.K. **(13)**

(OR)

b) i) Define inter-cooling and perfect inter-cooling. List the merits and demerits of multistage compression. **(6)**

ii) Derive the necessary condition for minimum work input in a multistage compression process. Support your answer with a p-v diagram. **(7)**

15. a) i) Describe the operation of vapour absorption refrigeration system with a sketch. Mention its merits and demerits over a vapour compression cycle. **(10)**

ii) Define RSHF and GSHF. **(3)**

(OR)

b) i) Discuss the functioning of a winter air-conditioning system. Draw a schematic of the same. How is it different from a summer air-conditioning system ? **(10)**

ii) Define 1 TR of refrigeration. Mention its significance. **(3)**

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PART – C (1×15=15 Marks)

16. a) The brake power of a six cylinder four stroke CI engine absorbed by hydraulic dynamometer is given by BP = W × N/20000 kW where W is brake load and N is speed in rpm. Bore of cylinder is 9.5 cm and stroke is 12 cm. Speed of the engine is 2400 rpm, brake load = 500 N. Ambient conditions are 1 bar and 298 K. Fuel density is 830 kg/m^3 and time for 100 cc fuel consumption is 19.3 sec. Orifice diameter is 3 cm and C_d is 0.62. Manometric head across the orifice is 14.5 cm of mercury. A/F ratio is 35 : 1. Find BMEP, BSFC, air flow rate and volumetric efficiency.

(OR)

b) A refrigerant plant using CO_2 as a refrigerant works between 298 K and 268 K. The dryness fraction of CO_2 is 0.8 at entry of compressor. Find out the ice formed per month if the relative efficiency is 50%. Take that ice is formed at 0°C from water at 10°C. The quantity of CO_2 circulated is 6 kg/min. Assume C_p for water as 4.187 kJ/kg.K and latent heat of fusion of ice as 335 kJ/kg. Properties of CO_2 are given below :

Temp. K	Liquid Heat (kJ/kg)	Latent Heat (kJ/kg)	Entropy of liquid (kJ/kg.K)
298	81.25	121.5	0.2513
268	–7.53	245.8	–0.04187