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Question Paper Code : X 20839

B.E./B.Tech. DEGREE EXAMINATIONS, NOV./DEC. 2020
Fourth/Sixth Semester
Mechanical Engineering
ME 6404 – THERMAL ENGINEERING
(Common to Mechanical Engineering (Sandwich))
(Also Common to PTME 6404 – Thermal Engineering for B.E. Part time – Third Semester – Mechanical Engineering – Regulation 2014)
(Regulations 2013)

Time : Three Hours Maximum : 100 Marks

(Use of approved Thermodynamics Tables, Mollier diagram, Psychrometric chart and Refrigerant property tables permitted in the Examinations)

Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. What are assumptions made in air standard cycles ?
2. Draw the Brayton cycle on P-v and T-s diagrams.
3. What is the effect of friction on the flow through a steam nozzle ?
4. What is meant by perfect inter-cooling ?
5. What is the effect of super saturation in the nozzles ?
6. Define stage efficiency.
7. Define volumetric efficiency of an air compressor.
8. State the conditions which lower the volumetric efficiency of an air compressor.
9. Define Relative humidity of air.
10. What is the significance of RSHF in summer air conditioning ?

PART – B **(5×13=65 Marks)**

11. a) An air-standard diesel cycle has a compression ratio of 18, and the heat transferred to the working fluid per cycle is 1800 kJ/kg. At the beginning of compression stroke, the pressure is 1 bar and the temperature is 300K Calculate :
i) The thermal efficiency,
ii) The mean effective pressure.

(OR)

b) A gas engine operating on the ideal Otto cycle has a compression ratio of 6. The pressure and temperature at the commencement of compression are 1 bar and 27°C. Heat added during the constant volume combustion process is 1170 kJ/kg. Determine the peak pressure and temperature, work output per kg of air and air standard efficiency. Assume Cv = 0.717 kJ.kg and γ = 1.4 for air.

12. a) Discuss the difference between theoretical and actual valve timing diagrams of a diesel engine.

(OR)

b) Explain the phenomena of knocking in diesel engines. What are the different factors which influence the knocking ?

13. a) In a test on a steam nozzle, the issuing steam jet impinges on a stationary flat plate which is perpendicular to the direction of flow and the force on the plate is measured. With convergent-divergent nozzle supplied with steam at 10 bar dry saturated and discharging at 1 bar; the force is experimentally measured to be 600 N. The area of the nozzle at throat measures 5 cm^2 and the exit area is such that complete expansion is achieved under these conditions. Determine : (i) flow rate of the steam, and (ii) the efficiency of the nozzle assuming that all losses occur after the throat. Assume n = 1.135 for isentropic expansion.

(OR)

b) A 50% reaction turbine (with symmetrical velocity triangles) running at 400 r.p.m. has the exit angle of the blades as 20° and the velocity of steam relative to the blades at the exit is 1.35 times the mean blade speed. The steam flow rate is 8.33 kg/s and at a particular stage the specific volume is 1.381 m^3/kg. Calculate for this stage :
A suitable blade height, assuming the rotor mean diameter to be 12 times the blade height.

14. a) A two stage air compressor consists of three cylinders having the same bore and stroke. The delivery pressure is 7 bar and the free air delivery is 4.3 m^3/min. Air is drawn in at 1.013 bar, 15°C and an intercooler cools the air to 38° C. The index of compression is 1.3 for all the three cylinders. Neglecting clearance calculate : (i) The intermediate pressure (ii) The power required to drive the compressor (iii) The isothermal efficiency.

(OR)

b) With a neat sketch, describe the construction and working of a single-stage acting reciprocating air compressor. Also derive the equation for work done with clearance and without clearance.

15. a) Fuel supplied to an SI engine has a calorific value 42000 kJ/kg. The pressure in the cylinder at 30% and 70% of the compression stroke are 1.3 bar and 2.6 bar respectively. Assuming that the compression follows the law $pV^{1.3}$ = constant. Find the compression ratio. If the relative efficiency of the engine compared with the air-standard efficiency is 50%. Calculate the fuel consumption in kg/k Wh.

(OR)

b) An air standard Dual cycle has a compression ratio of 10. The pressure and temperature at the beginning of compression are 1 bar and 27°C. The maximum pressure reached is 42 bar and the maximum temperature is 1500°C. Determine (i) the temperature at the end of constant volume heat addition (ii) cut-off ratio (iii) work done per kg of air and (iv) the cycle efficiency. Assume Cp =1.004 kJ/kg K and Cv = 0.717 kJ/kg K for air.

PART – C **(1×15=15 Marks)**

16. a) Air is used as the working fluid in a simple ideal Brayton cycle that has a pressure ratio of 12, a compressor inlet temperature of 300 K, and a turbine temperature of 1000 K. Determine the required mass flow rate of air for a net power output of 70 MW, assuming both the compressor and the turbine have an isentropic efficiency of 85%.

(OR)

b) A multistage air compressor compresses air from 1 bar to 40 bar. The maximum temperature in any stage is not to exceed 400K.

i) If the law of compression for all the stages is $PV^{1.3}$ = C, and the initial temperature is 300 K, find the number of stages for the minimum power input.

ii) Find the intermediate pressures for optimum compression as well as the power needed.

iii) What is the heat transfer in each of the intercooler ?

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