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

Question Paper Code : 72146

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Fourth/Sixth Semester

Mechanical Engineering

ME 6404 – THERMAL ENGINEERING

(Common to Mechanical Engineering (Sandwich))

(Regulations 2013)

Time : Three hours   Maximum : 100 marks

(Use of Refrigerant tables and steam tables are permitted)

1. Answer ALL questions.
2. Use of Approved Data Book is Permitted
3. Assume Missing Data Suitably

PART A — (10 × 2 = 20 marks)

1. Define Air Standard efficiency.
2. Draw Brayton cycle in TS and PV planes.
3. What are the advantages in MPFI system?
4. What is Octane number in I.C.Engines.
5. Define critical pressure ratio in steam flow through Nozzles.
6. If the enthalpy drop in a steam nozzle of efficiency 92% is 100 kJ/kg determine the exit velocity of steam.
7. Briefly explain the influence of pressure ratio on the volumetric efficiency of an air compressor.
8. What do you mean by Free Air delivered in a Reciprocating Air compressor?
9. Define Relative humidity of air.
10. What is the significance of RSHF in summer air conditioning?

PART B — ($5 \times 13 = 65$ marks)

11. (a) An engine with 200 mm cylinder diameter and 300 mm stroke works on theoretical Diesel cycle. The initial pressure and temperature of air used are 1 bar and 27°C. The cut-off is 8% of the stroke. Determine: (i) Pressures and temperatures at all salient points. (ii) Theoretical air standard efficiency. (iii) Mean effective pressure. Assume that compression ratio is 15 and working fluid is air. Consider all conditions to be ideal.

Or

(b) Derive an expression for Air standard efficiency and state the assumptions of an Otto Cycle.

12. (a) Explain a typical valve timing diagram and the significance of each angle in the valve timing diagram.

Or

(b) Following data relate to a 4-cylinder four-stroke petrol engine. Air-fuel ratio by weight = 16:1, calorific value of the fuel = 45200 kJ/kg, mechanical efficiency = 82%, air-standard efficiency = 52%, relative efficiency = 70%, volumetric efficiency = 78%, stroke/bore ratio = 1.25, suction conditions = 1 bar, 25°C. r.p.m. = 2400 and power at brakes = 72 kW. Calculate (i) Compression ratio. (ii) Indicated thermal efficiency (iii) Brake specific fuel consumption.

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 1.381m^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 single acting two stage compressor with complete inter cooling delivers 6 kg/min of air at 16 bar (1.6Mpa). Assuming an intake at 1 bar (100 kPa) and 15°C and compression and expansion with the law $pV^{1.3} = C$. Calculate: (i) Power required to run the compressor (ii) Isothermal efficiency (iii) Free air delivered per sec. (iv) If clearance ratios for LP and HP cylinder are 0.04 and 0.06, calculate volumetric efficiency and swept volume for each cylinder. Assume R = 0.287 kJ/kg °K C_v = 0.71 kJ/kg °K.

Or

(b) Derive an expression for equation of work in terms of clearance factor in a single stage compressor with n as the index of expansion and compression.

15. (a) A refrigeration system of 10.5 tonnes capacity at an evaporator temperature —12°C and a condenser temperature of 27°C is needed in a food storage locker. The refrigerant ammonia NH_3 is sub-cooled by 6°C before entering the expansion valve. The vapour is 0.95 dry as it (NH_3) leaves the evaporator coil. If the compression is adiabatic, find: (i) Condition of vapour at outlet of the compressor (ii) Power required in kW.

Or

(b) A building has the following calculated cooling loads: RSH gain = 310 kW RLH gain = 100kW. The space is maintained at the following conditions: Room DBT =25°C Room RH =50% Outdoor air temperature: is at 38°C and 50% RH. And 10% by mass of air supplied to the building is outdoor air. If the air supplied to the space is not to be at a temperature lower than 18°C, find: (i) Minimum amount of air supplied to space in m^3/s. (ii) Volume flow rate of return (recirculated room) air, exhaust air, and outdoor air.

PART C — (1 × 15 = 15 marks)

16. (a) Analyse the effect of Octane and Cetane number on the I.C.Engine cycle and performance.

Or

(b) Analyse the implications of high latent heat load on the design of Air conditioning systems and on the energy efficiency of the overall system.
