16021(D)   - 0 DEC 2016

B. Tech 1st Semester Examination

Basic Mechanical Engineering (NS)

BE-102

Time : 3 Hours   Max. Marks : 100

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt five questions in all, selecting one question each from section A, B, C & D. Section-E is compulsory.

SECTION - A

1. (a) If Q is heat interaction and U is internal energy change in the process then show that polytrophic index 'n' for air expansion or compression process is given by the relation:

$$n = \frac{5Q - 7U}{5(Q - U)}$$

(10)

   (b) The gas space above the water in a closed storage tank contains nitrogen at 25°C, 100 kPa. Total tank volume is $4 m^3$, and there is 500 kg of water at 25°C. Additional 500 kg water is now forced into the tank. Assuming constant temperature throughout, find the final pressure of the nitrogen and the work done on the nitrogen in this process.

(10)

2. (a) A piston/cylinder in a car contains 0.2 litre of air at 90 kPa, 20°C. The air is compressed in a quasi-equilibrium polytropic process with polytropic exponent n=1.25 to a final volume six times smaller. Determine the final pressure, temperature, and the heat transfer for the process. R for air is 0.287 kJ/kg-K.

(10)

   (b) A thermodynamic process has same area under the curve when projected on V-axis and P-axis of P-V diagram. Name the process and derive the mathematical relation representing this area. Velocity and gravity effect may be neglected.

(10)

SECTION - B

3. (a) If two Carnot engines operate so that the exhaust of one is the intake of other then derive an expression of the intermediate temperature in terms of highest and lowest temperatures when both the engine have the (i) same thermal efficiency (ii) Same work output.

(10)

   (b) The temperature inside the engine of a helicopter is 2000°C; the temperature of the exhaust gases is 900°C. The mass of the helicopter is M = 2000 kg, the heat of combustion of gasoline is Q_{comb} = 47000 kJ/kg, and the density of gasoline is p= 0.8 g/cm^3. What is the maximum height that the helicopter can reach by burning V = 1 liter of gasoline? Assume that engine is working on Carnot cycle.

(10)

4. (a) Explain the terms (i) latent heat, (ii) sensible heat, (iii) total heat (iv) dryness fraction, (v) saturation temperature.

(10)

   (b) What is difference between separating and throttling calorimeter? Explain the working of separating calorimeter with neat sketch of and mention its limitations.

(10)

SECTION - C

5. (a) Write difference between petrol engine and diesel engine.

(5)

[P.T.O.]

(b) In an air standard Otto cycle, the compression ratio is 7 and the compression begins at 35°C and 0.1 MPa. The maximum temperature of the cycle is 1100°C.
Find (i) the temperature and the pressure at various points in the cycle, (ii) the heat supplied per kg of air, (iii) work done per kg of air, (iv) the cycle efficiency and (v) the MEP of the cycle. (15)

6. (a) Derive an expression for the air standard efficiency of Diesel cycle and show it on P-V and T-S diagram. (10)

(b) For the same compression ratio and heat input, which cycle is more efficient: Otto, Diesel or Dual cycle? Explain with P-V and T-S diagrams. (10)

SECTION - D

7. (a) Assume any suitable point on psychrometric chart. Then corresponding to this point show: DBT, WBT, DPT, Relative humidity, Humidity ratio. Also logically explain that how locating of DPT & WBT is done on the chart. (10)

(b) What is conduction mode of heat transfer? Derive an expression for the heat conduction through a hollow sphere of given material. (10)

8. (a) What is the role of psychrometry in air conditioning? Explain. (6)

(b) Explain Newton's law of viscosity. How will you justify its one-to-one correspondence with Hooke's law of elasticity? (7)

(c) What is pressure head? How pressure can be expressed in terms of height of a liquid column? (7)

SECTION - E

9. (a) Why heat is taken as boundary phenomenon?

(b) Steam is expanded through a turbine. Is this a process or a cycle? Justify.

(c) What is quasi-static process? Can we take it as reversible process?

(d) Write down the limitation overcome by second law of thermodynamics.

(e) What is the entropy principle of increase?

(f) What is wet steam? How it is described?

(g) What is brake horse power for reciprocating engines? Why it is named so?

(h) If some water is sprinkled in a room, how does it affect (i) the dew point and (ii) the relative humidity?

(i) Can liquid have coefficient of thermal conductivity? Explain.

(j) Why mercury is used in barometric tube to measure atmospheric pressure? (2×10=20)