Printed Pages : 7

EME-303

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 901303

Roll No. | | | | | | | | | |

B. Tech.

(SEM. III) (ODD SEM.) THEORY EXAMINATION, 2014-15

THERMODYNAMICS

Time : **3** Hours] [Total Marks : **100**

SECTION - A

1 Attempt **all** questions parts : **10×2=20**

a. An apple "weighs" 60 g and has a volume of 75 cm^3 in a refrigerator at 8°C. What is the apple's density? List three intensive and two extensive properties of the apple.

b. Explain Zeroth law of thermodynamics. What is the advantage of thermocouple in temperature measurement?

c. Explain quasi-equilibrium process with an example.

d. Why is it incorrect to say that a system contains heat? In the differential form of the closed system energy balance, $dE = \delta Q - \delta, W$ why is d and not δ used for the differential on the left?

e. What do understand by steady flow process? Write the steady flow energy equation for boiler.

f. Write the statements of Carnot principles. Draw P-v and T-S diagram for Carnot cycle.

g. What is saturation pressure and saturation temperature.

h. State Kelvin – Plank and Clausius statement of second law of thermodynamics with neat sketches.

i. Explain stroke, compression ratio, cut-off ratio and swept volume.

j. How does reversible work and actual work differ from useful work?

SECTION - B

2 Answer any three parts of the following : **3×10=30**

a. Determine the heat transfer and its direction for a system in which a perfect gas having molecular weight of 16 is compressed from 101.3 kPa, 20°C to a pressure of 600 kPa following the law $PV^{1.3}$ = constant. Take specific heat at constant pressure of gas as 1.7 kJ/kg.K.

b. Air enters a compressor operating at steady state. Between the inlet and exit of the nozzle, the relevant data regarding the working fluid is given in the table. Heat transfer from the compressor to its surroundings occurs at a rate of 180 kJ/min. Employing the ideal gas model, calculate the power input to the compressor, in kW. Given that: C_p = 1.005 kJ/kg-K, C_v = 0.718 kJ/kg-K, R = 0.287 kJ/kg-k.

Parameter	Inlet	Exit
Pressure	1 bar	7 bar
Temperature	290 K	450 K
Velocity	6 m/s	2 m/s
Area	0.1 m^2	-
Specific Volume	0.832 m^3/ kg	-

c. A heat engine working on Carnot cycle is shown in figure.

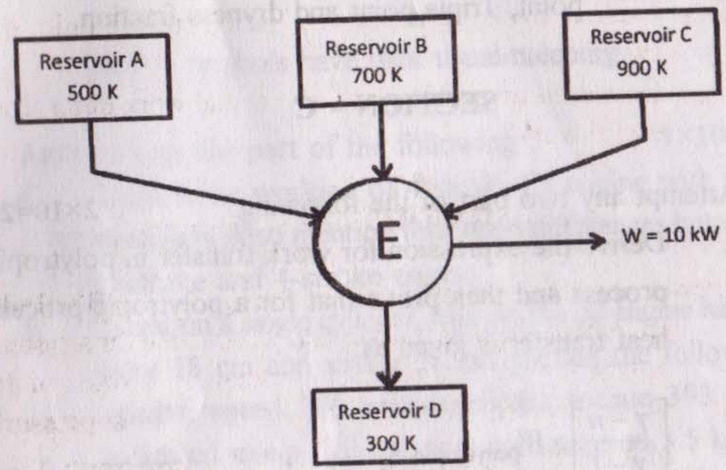

Fig. 1

The engine rejects 600 kJ/ min of heat to a sink at 300 K. The heat supplied to the reservoir at 900 K is 50% of the heat supplied by the reservoir at 500 K. Calculate the thermal efficiency of the engine and the heat supplied by each reservoir.

d. Prove thatfor a polytropic process the entropy change is given by

$$S_2 - S_1 = \left(\frac{n-\gamma}{n-1}\right) mc_v \ln\left(\frac{T_2}{T_1}\right)$$

e. Attempt all parts:

i. What do you understand by second law efficiency? How does it differ from first law efficiency?

ii. Define Sensible heating, Latent heating, Critical point, Triple point and dryness fraction.

SECTION - C

3 Attempt any two part of the following : 2×10=20

a. Derive the expression for work transfer in polytropic process and then prove that for a polytropic process heat transfer is given as:

$$\left[\frac{\gamma-n}{\gamma-1}\right]\times W_{polytropic}$$

b. A gas contained in a cylinder is compressed from 1 MPa and 0.05 m^3 to 2 MPa. Compression is governed by $PV^{1.4}$ = constant. Internal energy of gas is given by; U = 7.5 PV − 425 kJ.where P is pressure in kPa and V is volume in m^3.Determine heat, work and change in internal energy assuming compression process to be quasistatic.Also find out work interaction, if the 180 kJ of heat is transferred to system between same states.Also explain, why is it different from above.

c. Derive S.F.E.E. with suitable assumptions. Prove that for an adiabatic frictionless nozzle with ideal gas as working fluid

$$\text{Exit velocity } (C_2) = \sqrt{2C_P T_1\left[1-\left(\frac{P_2}{P_1}\right)^{\left(\frac{\gamma-1}{\gamma}\right)}\right]}$$

Where symbols have their usual meaning.

4 Attempt any one part of the following : 1×10=10

a. Explain the working of 4-stroke CI engine with neat diagrams. Also mention four main differences between 2-stroke and 4-stroke engine.

b. A test on a single cylinder, four stroke oil engine having bore 18 cm and stroke 36 cm yielded the following results; speed 285 rev/min; brake torque 393 Nm; indicated m.e.p. 7.2 bar; fuel consumption 3.5 kg/hr; cooling water flow 4.5 kg/min; cooling water temperature rise 36°C; air fuel ratio by mass 25; exhaust gas temperature 415°C; barometric pressure 1.013 bar; room temperature 21°C. The fuel has a calorific value of 45200 kJ/kg and contains 15% by mass of hydrogen. Determine:

i. The indicated thermal efficiency,

ii. The volumetric efficiency based on atmospheric conditions.

Draw up a heat balance in terms of kJ/min explaining clearly the content of such term.

Take R = 0.287 kJ/kgK, C_V for dry exhaust gases = 1.005 kJ/kgK and for superheated steam C_P = 2.05 kJ/kgK.

5 Attempt any one part of the following : 1×10=10

a. In a Rankine cycle, condition of the steam at inlet to turbine is 300°C at a pressure of 30 bar and the exhaust pressure is 0.2 bar. Draw the T-S diagram and determine:

i. The dryness at the end of expansion

ii. The pump work

iii. The turbine work,

iv. The Rankine efficiency

v. The condenser heat flow,

b. A vessel of volume $0.04m^3$ contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9kg. Find the mass, specific volume, enthalpy, entropy and the internal energy of mixture.

6 Attempt any one part of the following : 1×10=10

a. Prove that maximum work obtainable from an engine working between a finite body (T) and a thermal energy reservoir (T_O) is given by

$$W_{max} = C_P\left[(T - T_O) - T_O \ln\left(\frac{T}{T_O}\right)\right]$$

b. A tank holds 1 kg of air at 100 kPa, 40°C, and another tank holds 1 kg of air at 200 kPa, 40°C. The atmosphere is at 100 kPa, 20°C. In which tank is the stored energy greater? Determine the availability of the air in each tank.
