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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Industrial and Production Engineering

Semester End Examination; June - 2017

Engineering Thermodynamics

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. Distinguish between;
i) Microscopic and macroscopic point of view ii) Intensive and extensive properties. 8

b. With a suitable example, explain Quasi static process. 6

c. The e.m.f. in a thermocouple with the test junction at t° C on gas thermometer scale and reference junction at ice point is given by e = 0.20 t - $5x10^{-4}t^2$ mV. The thermometer is calibrated at ice and steam points. What will this thermometer read in a place where the gas thermometer reads 50°C? 6

2a. What are the similarities between heat and work? 6

b. Derive an expression for displacement work if the system undergoes isothermal process. 6

c. Show that for a Vander Waal's gas whose equation of state is described by the equation $\left(p+\frac{a}{v^2}\right)(v-b)=RT$. The isothermal work per unit mass is given by
$RT\log\left(\frac{v_2-b}{v_1-b}\right)-a\left(\frac{1}{v_1}-\frac{1}{v_2}\right)$ where v_1 and v_2 are the initial and final specific volumes. 8

UNIT - II

3 a. Explain Joule's experiment for a closed system undergoing a cycle. Show that the internal energy is a property of the system. 8

b. A fluid is confined in a cylinder by a spring-loaded, frictionless piston so that the pressure in the fluid is a linear function of the volume (p = a+bv). The internal energy of the fluid is given by following equation U = 34+3.15pv, where U is in kJ, p in kPa, and V in m^3. If the fluid changes from an initial state of 170 kPa, 0.03 m^3 to a final state of 400 kPa, 0.06 m^3, with no work other than that done on their piston, find the direction and magnitude of the work and heat transfer. 8

c. Define specific heats at constant volume and constant pressure. 4

4 a. Write Kelvin Planck and Clausius statements of second law of thermodynamics. 6

b. Briefly explain the important factors that render processes irreversible. 6

c. A system receiver 200 kJ of heat at constant volume and rejects 220 kJ of heat at constant pressure during which 40 kJ of work is done on the system. The system is brought back to its original state by an adeabatic process. Calculate adeabatic work. If the initial internal energy is 240 kJ. Then calculate the value of internal energy at all states. 8

UNIT - III

5 a. Draw the P-T diagram of water with relevant points. 6

b. Define the following :
i) Pure Substance ii) Dryness Fraction iii) Sensible Heat
iv) Degree of super Heat v) Latent Heat vi) Triple Point. 6

Contd…2

c. Two Boilers one with super heater and other without superheater are delivering equal quantities of steam of steam into a common main. The pressure in the boiler and main is 20 bar. The temperature of steam from a boiler with a superheater is 350ºC and temperature of the steam in the main is 250ºC. Determine the quanlity of steam supplied by the other boiler. Take C_{PS} = 2.25 kJ/kg. 8

6 a. Derive the relationship between the two principal specific heats and characteristic gas constant for a perfect gas. 8

b. A vessel of capacity 3 m^3 contains 1kg mole of N_2 at 90ºC 8

i) Calculate pressure and specific volume of the gas

ii) If the ratio of specific heats is 1.4 evaluate the values of C_p and C_v.

iii) Subsequently, the gas cools to the atmospheric temperature of 20ºC. Evaluate pressure of gas.

c. Differentiate between an ideal and a perfect gas. 4

UNIT - IV

7 a. With the help of a PV and T.S. diagram, derive an expression for the efficiency of a Rankine cycle. 10

b. Steam at 20 bar, 360ºC is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feedback the water into the boiler. 10

i) Assuming ideal processes, find per kg of steam the network and the cycle efficiency

ii) If the turbine and the pump have each 80% efficiency, find the percentage reduction in the network and cycle efficiency.

8 a. Derive an expression for the air standard efficiency of a diesel cycle. 10

b. A air standard dual cycle has a compression ratio of 16, and compression begins at 1 bar, 50ºC. The maximum pressure is 70 bar. The heat transfer to air at constant pressure is equal to that at constant volume. Estimate; 10

i) the pressure and temperatures at the cardinal points of the cycle

ii) the cycle efficiency

iii) the m.e.p. of the cycle, C_v =0.718 kJ/kgK, C_p = 1.005 kJ/kgK.

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UNIT - V

9 a. Discuss the methods employed for increasing thermal efficiency and specific output of open cycle Gas turbine. 10

b. A Gas turbine plant has temperature limits of 1000º C and 10º C compression in the compressor and the expansion in the turbine are iscentropic. Determine, 10

i) The pressure ratio which will give the maximum network output

ii) The maximum net specific work output

iii) The thermal efficiency at maximum workoutput Take γ = 1.4, C_p = 1.005 kJ/kgK.

10 a. Derive an expression for the volumetric efficiency of reciprocating air compressor. 6

b. What are the advantages of multi stage air compressor over single stage air compressor? 6

c. Find the power required to compress and delivers 2 kg of air per minute from 1 bar and 20ºC to a delivery pressure 7 bar when the compression is carried out in, 8

i) single stage compressor ii) two stage compressor

The compression of air follows the law $PV^{1.4}$ = C. Take; R = 0.287 kJ/kgK.

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