

CBCS Scheme

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Third Semester B.E. Degree Examination, Dec.2016/Jan.2017
Engineering Thermodynamics

Time: 3 hrs.

Max. Marks: 80

Note: 1. Answer FIVE full questions, choosing one full question from each module.
2. Use of TD data handbook permitted.

Module-1

- 1 a. Define the following terms, with respect to thermodynamics : System, Property, State, Process, Cycle, Quasi static process. (06 Marks)
b. Differentiate : i) Intensive and Extensive properties ii) Cyclic and non – cyclic processes. (04 Marks)
c. State and explain Zeroth law of thermodynamics. (06 Marks)

OR

- 2 a. Define Work and heat. Write three important similarities between them. (05 Marks)
b. Derive an expression for work done during quasi static process. Explain its significance with the help of P-V diagram. (05 Marks)
c. The properties of a closed system change following the relation between pressure and volume as $P-V = 3.0$, where 'P' is in bar and 'V' is in m^3 . Calculate the work done when the pressure increases from 1.5 bar to 7.5 bar. (06 Marks)

Module-2

- 3 a. Write the statement of first law of thermodynamics for a system under going i) a cycle ii) a process. (04 Marks)
b. Applying first law of thermodynamics to steady flow process, derive steady flow energy equation. (05 Marks)
c. 10 kg of fluid per minute goes through a reversible steady flow process. The properties of fluid are : $P_1 = 1.5$ bar ; $\rho_1 = 26$ kg/ m^3 ; $V_1 = 110$ m/s and $u_1 = 910$ kJ/kg and at the exit are : $P_2 = 5.5$ bar , $\rho_2 = 5.5$ kg/ m^3 , $V_2 = 190$ m/s and $u_2 = 710$ kJ/kg. During the process, the fluid rejects 55kJ/s and rises through 55m. Determine i) the change in enthalpy and ii) work done during the process. (07 Marks)

OR

- 4 a. Write two statements of second law of thermodynamics. (04 Marks)
b. Prove that entropy is a property of a system. (06 Marks)
c. A heat engine receives half of its heat supply at 1000K and half at 500K while rejecting heat to a sink at 300K, What is the minimum possible thermal efficiency of this heat engine? (06 Marks)

Module-3

- 5 a. Distinguish between : i) Theoretical air and Actual air ii) Higher heating value and Lower heating value. (04 Marks)
b. Derive an expression for thermal efficiency of Otto cycle in terms of compression ratio. (07 Marks)
c. A diesel engine has a compression ratio of 15 and heat addition at constant pressure takes place at 6% of stroke. Find the air standard efficiency of the engine. (05 Marks)

OR

- 6 a. Define the following terms with respect to IC engine : i) Brake power ii) Indicated power iii) Mechanical efficiency iv) Specific fuel consumption v) Thermal efficiency. (05 Marks)

- b. Explain Morse test method of determining indicated power and hence the frictional power of IC engine. (05 Marks)
- c. A four cylinder, four stroke S.I engine has a compression ratio of 8 and bore of 100 mm, with stroke equal to the bore. The volumetric efficiency of each cylinder is equal to 75%. The engine operates at a speed of 4800 rpm with an air fuel ratio 15. Given that the calorific value of fuel as 42 MJ/kg, atmospheric air density = 1.12 kg/m^3 , Mean effective pressure = 10 bar and Mechanical efficiency of the engine = 80%, determine the indicated thermal efficiency and the brake power. (06 Marks)

Module-4

- 7 a. Explain steam jet refrigeration system with a neat sketch. Write its draw backs. (07 Marks)
- b. Write the desirable properties of a good refrigerant. (04 Marks)
- c. In a standard (dry compression) vapour compression refrigeration cycle, operating between an evaporator temperature of -10°C and a condenser temperature of 40°C , the enthalpy of the refrigerant, Freon – 12, at the end of compression is 220 KJ/kg. Represent the cycle on T-S diagram and calculate : i) the COP of the cycle ii) the refrigerating capacity and the compressor power assuming a refrigerant flow rate of 1kg/min. You may use the extract of Freon – 12 property table given below : (05 Marks)

$t^\circ\text{C}$	P (MPa)	h_f (kJ/kg)	h_g (kJ/kg)
-10	0.2191	26.85	183.1
40	0.9607	74.53	203.1

OR

- 8 a. Distinguish between : i) Specific humidity and Relative humidity ii) Dry bulb and wet bulb temperature iii) Dry air and atmospheric air. (06 Marks)
- b. With a neat sketch, describe the working of summer air – conditioning system for hot and dry weather. (05 Marks)
- c. The dry and wet bulb temperatures of atmospheric air at 1 atm pressure are measured with a Bling psychrometer and determined to be 25°C and 15°C respectively. Determine using psychrometric chart i) Specific humidity ii) Relative humidity iii) Enthalpy of air. (05 Marks)

Module-5

- 9 a. Derive the condition for minimum work input to a two – stage compressor with perfect inter – cooling between stages. (05 Marks)
- b. Explain the necessity of multi – stage compression using P-V diagram. (05 Marks)
- c. A single stage double acting air compressor is required to deliver 14m^3 of air per minute measured at 1.013 bar and 15°C . The delivery pressure is 7 bar and the speed is 300 rpm. Take the clearance volume as 5% of swept volume with a compression and reexpansion index $n = 1.3$. Calculate the swept volume of the cylinder, the delivery temperature and the indicated power. (06 Marks)

OR

- 10 a. Explain Open and Closed cycle gas turbine cycles. (04 Marks)
- b. Explain Turbo – jet with the help of a neat sketch. Write its advantages and disadvantages. (06 Marks)
- c. A gas turbine unit has a pressure ratio of 6:1 and maximum cycle temperature of 610°C . The isentropic efficiency of the compressor and turbine are 0.80 and 0.82 respectively. Calculate the power output in kilowatts when the air enters the compressor at 15°C at the rate of 16 kg/s. Take $C_p = 1.005 \text{ kJ/kg.K}$ and $\gamma = 1.4$ for the compression process and take $C_p = 1.11 \text{ kJ/kg.K}$ and $\gamma = 1.333$ for the expansion process. (06 Marks)

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