CBC M

USN

15ME43

Fourth Semester B.E. Degree Examination, Det4019. aa'n .2020
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Thermodynamics data handbook is permitted.

Module-1

1 a. With suitable assumptions, P-V and T-S diagrams, derive an expression for the air standard efficiency of a diesel cycle in terms of compression ratio and cut off ratio. (10 **Marks)**

b. A certain quantity of air at a pressure of 1 bar and temperature of 70°C is compressed isentropically until the pressure is 7 bar in an Otto cycle engine. 465 k.T of heat per kg of air is now added at constant volume. Determine: (i) Compression ratio of the engine (ii) Temperature at the end of compression (iii) Temperature at the end of heat addition. **(06 Marks)**

OR

2 a. Derive an expression for optimum pressure ratio for maximum specific work output for an ideal gas turbine cycle. **(06 Marks)**

b. A gas turbine unit has a pressure ratio of 6:1. The maximum cycle temperature is 610°C. The isentropic efficiencies of compressor and turbine are 0.8 and 0.82 respectively. Calculate the power output in KW of an electric generator geared to the turbine when the air enters the compressor at 15°C at the rate of 16 kg/s. Take C_p = 1.005 k.1/kgK and y = 1.4 for compression, combustion and expansion processes. **Marks)**

Module-2

3 a. With a neat schematic diagram, P-V and T-S diagrams, explain the working of Rankine cycle. Derive the thermal efficiency expression for the same. **(08 Marks)**

b. A 40 MW steam power plant working on Rankine cycle operates between boiler pressure of 40 bar and condenser pressure of 01 bar. The steam leaves the boiler and enters the steam turbine at 400°C. The isentropic efficiency of the turbine is 85%. Determine: (i) The cycle efficiency (ii) The quality of exhaust steam from the turbine (iii) Steam flow rate in kg/hr considering pump work. **(08 Marks)**

OR

4 a. With a schematic diagram and T-S diagram, explain the working of regenerative vapour cycle with open feed water heaters. Derive the thermal efficiency expression for the same. **(08 Marks)**

b. A steam paWer plant operates on a reheat cycle. Steam in boiler at 150 bar, 550°C expands through high pressure turbine. It is reheated at a constant pressure of 40 bar to 550°C and expands through low pressure turbine to a condenser at 0.1 bar. Find: (i) Quality of steam at turbine exhaust (ii) Cycle efficiency (iii) Steam rate in kg/KWhr **(08 Marks)**

Module-3

5 a. Define the following:
i) Stoichiometric air ii) Excess air iii) Enthalpy of formation
iv) Internal energy of combustion v) Combustion efficiency (10 **Marks)**

b. Find the stoichiometric air fuel ratio for the combustion of Propane (C_3H_8) on molar and mass basis. **(06 Marks)**

OR

6 a. Explain how the frictional power of a multi cylinder engine is determined using Morse Test. **(06 Marks)**

b. During a test on a single cylinder 4-stroke cycle oil engine, the following observations were made: Bore = 30 cm, Stroke = 45 cm, duration of trial = 1 hour, total fuel consumption = 7.6 kg/hr, Speed = 200 rpm, Calorific value of fuel = 45000 kJ/kg, MFP = 6 bar, Net brake load = 1470 N, Brake drum diameter = 1.8 m, Rope diameter = 3 cm, Mass of cooling water circulated — 550 kg/hr, water enters at 15°C and leaves at 60°C, exhaust gas temperature = 300°C, ambient temperature = 20°C. Calculate: (i) indicated power and brake power (ii) Mechanical efficiency. Draw the heat balance sheet on minute basis. Take mass of air = 360 kg/hr, Cpg = 1.1 kJ/kgK. **(10 Marks)**

Module-4

7 a. With a neat sketch, explain the working of a vapour absorption refrigeration system. **(06 Marks)**

b. An air refrigeration plant is to be designed according to the following specifications: Pressure of air at compressor inlet = 101 kPa, pressure of air at compressor outlet = 404 kPa, pressure loss in the inter cooler = 12 kPa, pressure loss in the cold chamber = 3 kPa, temperature of air at compressor inlet = 6°C, temperature of air at turbine inlet = 27°C, compressor and turbine efficiency = 0.85. Determine: (i) COP (ii) Power required t(; produce one TR (iii) Air circulation rate/TR.. (10 **Marks)**

OR

8 a. Define the following terms:
(i) Specific humidity (ii) Relative humidity
(iii) Degree of saturation (iv) Dry bulb temperature. **(08 Marks)**

b. Following data refers to an air conditioning system to be designed for an industrial process for hot and wet climate:
Outside conditions = 30°C DBT, 75% RH
Required inside conditions = 20°C DBT, 60% RH
Amount of free air circulated = 20m^3/min
The required condition is to be achieved first by cooling and dehumidifying and then by heating. Find: (i) Capacity of the cooling coil in TR (ii) Capacity of the heating coil in KW (iii) Amount of water vapour removed per hour. **(08 Marks)**

Module-5

9 a. Derive an expression for the volumetric efficiency of a reciprocating air compressor. (08 **Marks)**

b. A single stage single acting compressor delivers 0.6 kg/min of air at 6 bar. The temperature and pressure at the end of suction stroke of the compressor are 100 mm and 150 mm respectively. The clearance is 3% of the swept volume. Assuming the index of compression and expansion to be 1.3, find: (i) Volumetric efficiency of the compressor (ii) power required if the efficiency of the motor is 0.85 (iii) speed of the compressor. **(08 Marks)**

OR

10 a. Explain the following types of flows in a nozzle: (i) Frictionless adiabatic flow (ii) Frictional adiabatic flow (iii) Super saturated flow **(06 Marks)**

b. The inlet condition to a steam nozzle is 10 bar and 250°C. The exit pressure is 2 bar. Assuming isentropic expansion and negligible inlet velocity, determine: (i) throat area (ii) exit velocity (iii) exit area of the nozzle. Assume the index of expansion for super heated steam at inlet = 1.3 and mass flow rate of steam = 0.2 kg/s. (10 **Marks)**