CBCS SCHEME

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18ME42

Fourth Semester B.E. Degree Examination, Feb./Mar. 2022
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Compare Otto, Diesel and Dual cycle based on:
i) Same compression ratio and heat rejection
ii) Same maximum pressure and temperature. **(10 Marks)**

b. An engine with 200mm cylinder diameter and 300mm stroke length, works on the theoretical diesel cycle. The initial pressure and temperature of air are 1 bar and 27°C. The cut off is at 8% of the stroke and compression ratio is 15. Determine: i) Pressure and temperature at all salient points of the cycle ii) Theoretical air standard efficiency iii) Power developed, if there are 400 working strokes/min. **(10 Marks)**

OR

2 a. With P-θ diagram explain the stages of combustion in C.I. engine. **(08 Marks)**

b. The following observations were made during a test on a two stroke oil engine: Room temperature = 22°C; Bore = 20cm; stroke = 25cm; speed = 350rpm; brake drum diameter = 1.2m; mean effective pressure = 2.8 bar; Net brake load = 450N; oil consumption = 3.6kg/h; calorific value of oil = 41800kJ/kg; quantity of jacket cooling water = 455kg/h; rise in temperature of jacket water = 28°C. Temperature of exhaust gases entering and leaving the exhaust gas calorimeter is 8kg/min. Temperature rise of calorimeter water = 9°C. Determine the indicated and brake power, mechanical efficiency and brake thermal efficiency. Draw the heat balance sheet on one minute basis. **(12 Marks)**

Module-2

3 a. With a neat sketch, explain gas turbine cycle with regenerator and derive the cycle efficiency. **(08 Marks)**

b. In a gas turbine plant, air enters the compressor at 15°C and it is compressed through a pressure ratio of 4 with isentropic efficiency of 85%. The air fuel ratio is 80 and the calorific value of fuel is 42000kJ/kg. The turbine inlet temperature is 1000K and the isentropic efficiency of the turbine is 82%. Calculate the overall efficiency and air intake for a power output of 260kW. Take the mass fuel in account. **(12 Marks)**

OR

4 a. With a neat sketch, explain the working of gas turbine cycle with intercooling and reheating with T-S diagram. **(12 Marks)**

b. With a neat sketch, explain working of turbojet. **(08 Marks)**

Module-3

5 a. Discuss the following on the performance of Rankine cycle: i) Effect of condenser pressure ii) Effect of boiler pressure iii) Superheat. **(10 Marks)**

b. A simple Rankine cycle works between the boiler pressure of 30 bar and condenser pressure of 0.04 bar. The supply steam to the turbine is dry saturated. Determine Rankine cycle efficiency. If the supply steam to the turbine is superheated by 66°C. What is the effect on Rankine efficiency? **(10 Marks)**

OR

6 a. With the help of schematic diagram and h-s diagram, explain regenerative vapor power cycle with one feed water heater and derive an expression for its thermal efficiency. **(08 Marks)**

b. In a reheat cycle, steam at 500°C expands in a H.P turbine till it is saturated vapor. It is then reheated at constant pressure to 400°C and then expanded in a L.P turbine to 40°C. If the maximum moisture content at the turbine exhaust is limited to 15%. Find: i) The reheat pressure ii) Pressure of steam at the inlet to the H.P turbine iii) the net specific work out put iv) the cycle efficiency. Assume all ideal processes. **(12 Marks)**

Module-4

7 a. With a neat sketch, describe the working of a Bell-Coleman cycle with P-V and T-S diagram. **(10 Marks)**

b. An ammonia vapour compression refrigeration works between an evaporator pressure of 1.2 bar and condenser pressure of 12 bar. The refrigerant leaves the evaporator at -20°C and leaves the condenser at +20°C. Determine the COP of the system and the power required in ton of refrigeration. **(10 Marks)**

OR

8 a. Define the terms: i) Dry bulb temperature ii) Wet bulb temperature iii) Relative humidity iv) Dew point temperature. **(08 Marks)**

b. It is required to design an air conditioning plant for a small office room for the following winter condition:
Outdoor conditions = 14°C DBT and 10°C WBT
Required conditions = 20°C DBT and 60°C RH
Amount of air circulation = 0.30m^3/min/person seating capacity of office = 60.
The required condition is achieved first by heating and then by adiabatic humidifying.
Determine the following:
i) Heating capacity of the coil in KW and surface temperature required if bypass factor of the coil is 0.4.
ii) Capacity of the humidifier. **(12 Marks)**

Module-5

9 a. Derive an expression for condition for minimum work input required for two stage compressor with perfect inter-cooling. **(12 Marks)**

b. A two stage air compressor with perfect inter-cooling takes in air at 1 bar and 27°C. The law of compression in both the stages is $PV^{1.3}$ = constant. The compressed air is delivered at 9 bar. Calculate for unit mass flow rate of air the minimum work done and heat rejected to inter-cooler. Compare the values if compression is carried out in single stage compressor with after-cooler. **(08 Marks)**

OR

10 a. What is critical pressure ratio? Derive an expression for pressure ratio which gives maximum discharge through the nozzle. **(10 Marks)**

b. Dry saturated steam at a pressure of 11 bar enters a convergent divergent nozzle and leaves at a pressure of 2 bar. If the flow is adiabatic and frictionless. Determine: i) Exit velocity of the steam ii) Ratio of cross section area at exit and at a throat. Assume the index of adiabatic expansion to be 1.135. **(10 Marks)**

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