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15ME43

**Fourth Semester B.E. Degree Examination, June/July 2017**  
**Applied Thermodynamics**

Time: 3 hrs.

Max. Marks: 80

**Note: 1. Answer FIVE full questions, choosing one full question from each module.**  
**2. Use of thermodynamic data book is permitted.**

**Module-1**

- 1** a. Obtain air standard efficiency expression for diesel cycle. (08 Marks)  
 b. The compression ratio of an air standard Otto cycle is 8. At the beginning of compression process the pressure is 1 bar and the temperature is 300 K. The heat transfer to the air per cycle is 1900 kJ/kg of air. Calculate:  
 i) Pressure and temperature at the end of each process of the cycle.  
 ii) Thermal efficiency. (08 Marks)

**OR**

- 2** a. With a neat sketch, explain the working of Ram jet. (06 Marks)  
 b. In a constant pressure open cycle gas turbine air enters at 1 bar and 20°C, leaves the compressor at 5 bar. Using the following data, temperature of gases entering the turbine = 680°C, pressure loss in the combustion chamber = 0.1 bar, compressor and turbine efficiency = 0.85 and 0.80,  $\gamma = 1.4$ ,  $C_p = 1.024$  kJ/kgK for air and gas, combustion chamber efficiency = 85%, find:  
 i) The quantity of air circulation if the plant develops 1065 kW.  
 ii) Heat supplied /kg of air circulation.  
 iii) The thermal efficiency of the cycle. Mass of the fuel may be neglected. (10 Marks)

**Module-2**

- 3** a. With a schematic diagram, explain the working of regenerative Rankine cycle. Show the process on T-S and H-S diagram. (08 Marks)  
 b. In a steam power plant operating on ideal Rankine cycle steam enters the turbine at 20 bar with an enthalpy of 3248 kJ/kg and an entropy of 7.127 kJ/kgK. The condenser pressure is 0.1 bar. Find the cycle efficiency and specific steam consumption in kg/kWh. Do not neglect pump work. (08 Marks)

**OR**

- 4** a. What are the advantages and disadvantages of binary vapour power cycle? (06 Marks)  
 b. In a reheat cycle, the initial steam pressure and the maximum temperature are 150 bar and 550°C. If the condenser pressure is 0.1 bar and the moisture at the condenser inlet is 5% and assuming ideal processes, determine: (i) Reheat pressure, (ii) Cycle efficiency, (iii) Steam rate, steam is reheated to 550°C. (10 Marks)

**Module-3**

- 5** a. Define the following:  
 i) Stoichiometric air  
 ii) Enthalpy of formation  
 iii) Combustion efficiency. (06 Marks)

- b. During a test on a diesel engine the following observations were made. The power developed by the engine is used for driving a DC generator. The output of the generator was, 210 A at 200 V, the efficiency of generator being 82%. The quantity of fuel supplied to the engine was 11.2 kg/h. Calorific value of fuel being 42600 kJ/kg. The air fuel ratio was 18:1. The exhaust gases were passed through an exhaust gas calorimeter for which the observations were as follows, water circulated through exhaust gas calorimeter = 580 lit/h, temperature rise of water through calorimeter = 36°C. Temperature of exhaust gases at exit from calorimeter = 98°C, Ambient temperature = 20°C. Heat lost to jacket cooling water = 32% total heat supplied. Specific heat of exhaust gases = 1.05 kJ/kgK. Calculate BP of the engine,  $\eta_{br}$  and draw up heat balance sheet on minute basis. (10 Marks)

**OR**

- 6 a. With a P- $\theta$  diagram, explain the stages of combustion in CI engine. (08 Marks)  
 b. Benzene  $C_6H_6$  is burnt in air and the analysis of the products of combustion yielded the following results:  
 $CO_2 = 10.96\%$ ,  $CO = 0.5\%$ ,  $O_2 = 7.5\%$ ,  $N_2 = 81.04\%$ .  
 Determine: i) Actual air-fuel ratio on mole basis ; ii) Actual air-fuel ratio on mass basis;  
 iii) Percentage excess air. (08 Marks)

**Module-4**

- 7 a. With a schematic diagram, explain the working of vapour absorption refrigeration system. Show the processes on T-S diagram. (08 Marks)  
 b. An air conditioning plant is required to supply 60 m<sup>3</sup> of air/minute at a DBT of 21°C and 55% RH. The outside air is at DBT of 28°C and 60% RH. Determine the mass of water drained and capacity of the cooling coil. Assume the air conditioning plant first to dehumidify and then to cool the air. (08 Marks)

**OR**

- 8 a. With a neat sketch explain the working of winter air conditioning system. Show the processes on psychrometric chart. (08 Marks)  
 b. An air refrigeration system working on Bell-Coleman cycle with 15 TOR capacity has its pressure range 1 bar to 10 bar. Air enters the compressor at -5°C and enters the expander at 25°C. Assuming isentropic expansion and compression, find COP, air flow rate and power required. (08 Marks)

**Module-5**

- 9 a. Show that for perfect intercooling, stage pressure ratio remains the same in multistage air compressor and hence prove that  $Z = \left( \frac{p_{x+1}}{p_1} \right)^{1/x}$  where  $z$  = stage pressure ratio,  $p_1$  = initial pressure,  $x$  = number of stages. (09 Marks)  
 b. Steam expands from 17 bar and 284°C to 0.7 bar in a convergent-divergent nozzle. Assuming that the expansion is frictionless and the steam discharged is 0.25 kg/s, calculate the diameter of the nozzle, (i) at a point where the pressure is 9.5 bar, (ii) at exit, using H-S chart. (07 Marks)

**OR**

- 10 a. Briefly explain the different types of flows in a steam nozzle. (09 Marks)  
 b. Determine the size of the cylinder of a double acting air compressor of 45kW in which air is taken at 1 atmosphere and compressed to 16 atmospheric pressure according to the law  $PV^{1.25} = C$ . Assume speed of the crank as 300 rpm, piston speed = 180 m/min. (07 Marks)

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