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17ME43

Fourth Semester B.E. Degree Examination, July/August 2021 Applied Thermodynamics

Time: 3 hrs.

Max. Marks: 100

*Note: 1. Answer any FIVE full questions.
2. Use of Thermodynamics data hand book is permitted.*

1.
 - a. With the help of P-V and T-S diagrams, derive an expression for the air standard efficiency of a diesel cycle. (10 Marks)
 - b. An engine of 250mm bore and 375mm stroke works on otto cycle. The clearance volume is 0.00263m^3 . The initial pressure and temperature are 1 bar and 50°C . If maximum pressure is 25 bar find: i) Air standard efficiency of the cycle ii) Mean effective pressure. (10 Marks)

2.
 - a. Derive an expression for the optimum pressure ratio for the maximum network output in an Brayton cycle. (08 Marks)
 - b. What are methods of improving the efficiency of Brayton cycle? (02 Marks)
 - c. The following data refers to an open cycle gas turbine. Pressure ratio = 5, Maximum temperature = 1075K, Minimum temperature = 290K, C_p for gas = 1.15kJ/kg.K, γ for air = 1.4 and γ for gas = 1.33, calorific value of the fuel = 45000kJ/kg, Efficiency of the compressor = 0.85, Efficiency of the turbine = 0.9, Efficiency of combustion = 0.95, Mass flow rate = 5kg/sec, Find: i) Thermal efficiency of the plant ii) Power output of the plant iii) Air to fuel ratio. (10 Marks)

3.
 - a. Discuss the effect of i) Boiler pressure ii) Condenser pressure iii) Superheat on the performance of Rankine cycle. with the help of T-S diagram. (09 Marks)
 - b. With a schematic diagram and its P-V and T-S diagrams explain the Rankine cycle and also derive its thermal efficiency. (11 Marks)

4.
 - a. With a schematic diagram and its T-S diagram, explain the working of reheat vapour cycle of deduce an expression for cycle efficiency. (10 Marks)
 - b. A steam turbine working of a Rankine cycle is supplied with dry saturated steam at 25 bar and the exhaust takes place at 0.2 bar. For a steam flow rate of 10 kg/s, determine,
 - i) Quality of steam at the end of expansion
 - ii) Turbine shaft work
 - iii) Power required to operate the pump
 - iv) Work ratio. (10 Marks)

5.
 - a. Explain the following terms with reference to a combustion process:
 - i) Stoichiometric air ii) Enthalpy of formation iii) Enthalpy of combustion
 - iv) Adiabatic flame temperature v) Enthalpy of reaction. (10 Marks)
 - b. The products of combustion of an unknown hydrocarbon C_xH_y have the following composition as measured by an Orsat apparatus. $\text{CO}_2 = 8\%$, $\text{CO} = 0.9\%$, $\text{O}_2 = 8.8\%$, $\text{N}_2 = 82.3\%$. Determine: i) The composition of fuel ii) The air-fuel ratio iii) The percentage of excess air used. (10 Marks)

- 6 a. Define indicated power. Explain briefly how the frictional power of a multicylinder engine is determined using Morse test. State the assumptions made. (10 Marks)
- b. A two stroke diesel engine was motored when meter reading was 1.5kW. Test on the engine was carried out for one hour and data observed were, brake torque = 120N-m, rpm = 600, fuel used = 2.5kg, cooling water = 818kg, CV of fuel = 40.3MJ/kg, Rise in temperature of cooling water = 10°C, room temperature = 27°C, A:F used = 32:1, exhaust gas temperature = 347°C, C_p for exhaust gases = 1.05kJ/kg.K. Determine, brake power, indicated power, mechanical efficiency and thermal efficiency. Draw heat balance sheet on minute and percentage basis. (10 Marks)
- 7 a. With a neat sketch, explain the working of vapour absorption refrigeration system. (10 Marks)
- b. A food storage chamber requires a refrigeration system of 10 Ton capacity with an evaporator temperature of -10°C and condenser temperature of 30°C. The refrigerant F-12 is sub cooled by 5°C before entering the throttle valve and the vapour is superheated by 6°C before entering the compressor. The specific heats of vapour and liquid are 0.7327 and 1.235 respectively. Determine: i) The refrigerating capacity per kg ii) Mass of refrigerant circulated per minute iii) COP. (10 Marks)
- 8 a. Define the following: i) Dry bulb temperature ii) Wet bulb temperature iii) Specific humidity iv) Saturated air v) Degree of saturation. (10 Marks)
- b. Represent the following processes on a psychrometric chart i) Sensible heating ii) Dehumidification. (04 Marks)
- c. Atmospheric air at 101.325kPa has 30°C DBT and 15°C DPT, without using the psychrometric chart using the property values from the tables, calculate:
i) Partial pressure of air ii) Specific humidity iii) Relative humidity. (06 Marks)
- 9 a. Derive an expression for volumetric efficiency of a single stage air compressor in terms of pressure ratio, clearance ratio and the index of expansion and compression. (10 Marks)
- b. A single stage double acting reciprocating compressor delivers 0.25m³/s. of air measured at 1.013 bar and 27°C. The delivery pressure is 7bar. At the beginning of compression, air is at 0.98 bar and 40°C. The clearance volume is 4% of swept volume. The stroke to bore ratio is 1:3. Compressor runs at 300rpm. Calculate, the volumetric efficiency cylinder dimensions and indicated power if the index of compression and expansion is 1.3. (10 Marks)
- 10 a. Show that the optimum intermediate pressure of a two stage reciprocating air compressor for minimum work is the geometric mean of the suction and discharge pressures. (10 Marks)
- b. Mention the types of nozzles. Explain any one. (04 Marks)
- c. A two stage reciprocating air compressor works between pressure limits of 1 bar and 8 bar and draw in air at 15°C at the rate of 467 litres per minute. The compression in both stages is isentropic and inter cooling is perfect. Estimate minimum power supplied. (06 Marks)

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