

CBCS SCHEME

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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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