CBCS SCHEME

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18ME42

Fourth Semester B.E. Degree Examination, June/July 2025
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 steam tables and Mollier chart permitted.

Module-1

1 a. Derive an expression of air standard efficiency of otto cycle with neat sketch of P-V and T-S diagrams. **(10 Marks)**

b. The compression ratio of a compression ignition engine working on the ideal diesel cycle is 16. The temperature of air at the beginning of compression is 300 K and the temperature of air at the end of expansion is 900 K. Determine : i) Cut off ratio ii) Cycle efficiency. **(10 Marks)**

OR

2 a. How Morse test will be carried on a 3 cylinder IC engine? **(04 Marks)**

b. Explain the Willian's line method of determining the frictional power of an IC engine. **(04 Marks)**

c. In a test on 3-cylinder, 4 stroke IC engine with 22 cm bore and 26 cm stroke, the following were the observations during a trial period of one hour. Fuel consumption 8 kg, calorific value 45000 kJ/kg, total revolutions of the crank shaft 12000, mean effective pressure 6 bar, net load on brake 1.5 kN, brake drum diameter 1.8 m, rope diameter 3 cm, mass of cooling water 550 kg, inlet temperature of water 27°C, exit temperature of water 55°C, air consumed 300 kg, ambient temperature 30°C, exhaust gas temperature 310°C, specific heat of gases = 1.1 KJ/kg K. Calculate : i) Indicated and brake power ii) Mechanical efficiency iii) Indicated thermal efficiency. Also draw a heat balance sheet in KJ/min. **(12 Marks)**

Module-2

3 a. Derive an expression for optimum pressure ratio for maximum work output incase of an ideal Brayton cycle in terms of maximum and minimum temperature of the cycle. **(10 Marks)**

b. Air enters the compressor of a turbine plant operating on Brayton cycle at 101.325 kPa, 27°C and the pressure ratio in the cycle being 6. If the turbine work equals 2.5 times the compressor work, determine the maximum temperature in the cycle and the cycle efficiency. Take Cp = 1.005 kJ/kg K and $\gamma = 1.4$. **(10 Marks)**

OR

4 a. With a neat sketch, explain the working of Ramjet engine. **(10 Marks)**

b. A gas turbine plant works between the temperature limits of 300 K and 1000 K and pressure 1 bar and 16 bar. The compression is carried out in 2-stages with perfect intercooling between low pressure and high pressure compressors. Calculate the net power of the plant per kg of air circulation. Take Cp = 1 KJ/kg K and $\gamma = 1.4$ of air and mass flow rate air = 1 kg/sec. **(10 Marks)**

Module-3

5 a. With a schematic diagram and T-S diagram derive an expression for thermal efficiency of Rankine cycle. **(10 Marks)**

b. A simple ideal Rankine cycle works between the pressure of 30 bar and 0.04 bar, the initial condition of steam being dry saturated. Calculated the cycle efficiency and work ratio. **(10 Marks)**

OR

6 a. With a neat schematic diagram and T-S diagram briefly explain the regenerative vapour power cycle with single open feed water heater. Derive an expression for its thermal efficiency. **(10 Marks)**

b. A steam power plant operates on a reheat cycle. Steam in boiler at 150 bar, 550°C expands through high pressure turbine. It is reheated at 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 exit ii) Cycle efficiency iii) Steam rate in Kg/Kw-hr. **(10 Marks)**

Module-4

7 a. With a neat sketch, explain the working principle of an ammonia vapour absorption refrigeration system. **(10 Marks)**

b. A cold storage is to be maintained at -5°C (268 K) while the surroundings are at 35°C. The heat leakage from the surroundings into cold storage is estimated to be 29 KW. The actual cop of the refrigeration plant is one third that of an ideal plant working between the same temperatures. Find the power required to drive the plant. **(10 Marks)**

OR

8 a. Define the following terms with respect to air conditioning:
- i) Dry bulb temperature
- ii) Wet bulb temperature
- iii) Dew point temperature
- iv) Specific humidity
- v) Relative humidity. **(10 Marks)**

b. A sling psychrometer reads 40°C DBT and 28°C WBT calculate the following:
- i) Specific humidity
- ii) Relative humidity
- iii) Vapour density in air
- iv) Dew point temperature
- v) Enthalpy of mixture per kg of dry air. **(10 Marks)**

Module-5

9 a. Define the following with respect to a reciprocating air compressor.
- i) Isothermal efficiency
- ii) Adiabatic efficiency
- iii) Mechanical efficiency
- iv) Overall efficiency
- v) Volumetric efficiency. **(10 Marks)**

b. A single stage double acting air compressor is required to deliver 14 m^3 of air per minute at 1.013 bar and 15°C. The delivery pressure is 7 bar and the speed 300 rpm. Take the clearance volume as 5% of the swept volume with the compression and expansion index n = 1.3, calculate: i) Swept volume of cylinder ii) Indicated power. **(10 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. Steam at a pressure 6.5 bar and 0.9 dry discharges through a nozzle having throat area of 0.004 m^2. The back pressure is 1 bar. Calculate the weight of discharge per minute and necessary diameter of the mouth of the nozzle, so that discharge shall be maximum. What is final velocity of steam? Take n = 1.113 for wet steam. **(10 Marks)**

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