



CBCS SCHEME

15ME43

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024

Applied Thermodynamics

Time: 3 hrs.

Max. Marks : 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- Compare the otto, diesel and dual cycles on P-V diagram and T-S diagrams, when heat is supplied to each cycle is same. (08 Marks)
 - Derive air standard efficiency expression for dual combustion cycle. (08 Marks)

OR

- With a schematic diagram, explain a closed cycle gas turbine. (04 Marks)
 - With the help of neat diagram, explain a Rocket engine. (04 Marks)
 - The air enters the compressor of an open cycle constant pressure gas turbine at a pressure of 1 bar and temperature 20°C. The pressure of the air after the compression is 4 bar. The isentropic efficiencies of the compressor and turbine are 80% and 85% respectively. The air fuel ratio is 90 : 1. If flow rate of air is 3 kg/sec. Find (i) Power developed (ii) Thermal efficiency of the cycle.
Assume $C_p = 1.0$ kJ/kgK and $\gamma = 1.4$ for air and gases. Take calorific value of the fuel as 41800 KJ/kg. (08 Marks)

Module-2

- With a schematic diagram, explain the working of regenerative Rankine cycle. Show the process on T-S and H-S diagram. (08 Marks)
 - 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

- What are the advantages and disadvantages of binary vapour power cycle? (06 Marks)
 - 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:
 - Reheat pressure
 - Cycle efficiency
 - Steam rate, steam is reheated to 550°C. (10 Marks)

Module-3

- With neat sketch, explain the Orsat's apparatus used for exhaust gas analysis. (06 Marks)
 - The products of combustion of an unknown hydrocarbon C_xH_y have the following composition as measured by an Orsat apparatus: $CO_2 = 8.0\%$, $CO = 0.9\%$, $O_2 = 8.8\%$ and rest is N_2 . Determine:
 - Composition of the fuel
 - The air-fuel ratio
 - Percentage of excess air
 - Dew point temperature of the products if the total pressure is 1.0 bar. (10 Marks)

OR

- 6 a. Explain the principle of conducting Morse test on IC engines for determining frictional power. (04 Marks)
- b. List the factors affecting the detonation. (02 Marks)
- c. A 4-cylinder 2-stroke petrol engine has a bore of 57 mm and stroke of 90 mm. Its rated speed is 2800 rpm and is tested at this speed against a brake, which has a torque arm of 0.356 m. The net brake load is 155 N and the fuel consumption is 6.74 lit/h. The specific gravity of the petrol is 0.735 and it has a calorific value of 44200 kJ/kg. A Morse test is carried out and the cylinders are cut-out in order 1, 2, 3, 4 with corresponding brake loads 111, 106.5, 104.2 and 111.3 N respectively. Calculate for this speed :
- The engine torque
 - Brake mean effective pressure
 - Brake thermal efficiency
 - BSFC
 - Mechanical efficiency
 - Indicated thermal efficiency.
- (10 Marks)

Module-4

- 7 a. With the help of a neat sketch, explain a simple vapour absorption cycle. (05 Marks)
- b. Explain the various factors affecting the performance of a vapour compression system. (04 Marks)
- c. A vapour compression refrigerator uses methyl chloride (R-40) and operates between temperature limits of -10°C and 45°C . At the entry to the compressor, the refrigerant is dry and after compression it acquires a temperature of 60°C . Find the C.O.P of the refrigerator. (07 Marks)

OR

- 8 a. Define the following terms:
- Dry bulb temperature (DBT).
 - Wet bulb temperature (WBT)
 - Specific humidity.
 - Relative humidity.
- (08 Marks)
- b. Atmospheric air at 101.325 KPa has 30°C DBT and 15°C DPT. Without using the psychrometric chart, using the property values from the tables. Calculate
- Partial pressure of air and water vapour.
 - Specific humidity
 - Relative humidity.
 - Vapour density and enthalpy of moist air.
- (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)