

CBCS SCHEME

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18ME42

Fourth Semester B.E. Degree Examination, July/August 2022

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 Thermodynamics data hand book is permitted.

Module-1

- 1 a. Derive an expression of air standard efficiency of diesel cycle with neat PV and T-S diagrams. (10 Marks)
- b. An engine with 200mm cylinder diameter and 300mm Stroke length works on diesel cycle. The initial pressure and temperature of air are 0.1 MPa and 27°C. The cutoff is 8% of Stroke volume and compression ratio is 15. Determine :
- i) Pressure and temperature at all salient points ii) Air standard efficiency. (10 Marks)

OR

- 2 a. Explain any two methods of deeming frictional power. (08 Marks)
- b. The following observations were made during one hour test on a single Stroke oil engine.
Bore = 300mm ; Stroke = 450mm ; mass of fuel used = 8.8Kg ;
Calorific value = 41800kJ/Kg ;
Average speed = 200rpm, Mean effective pressure = 5.8 bar, Brake load = 1860N, Mass of cooling water = 650Kg, Temperature rise = 22°C, Diameter of Brake drum = 1.22 m.
Calculate: i) Mechanical efficiency ii) Brake thermal efficiency iii) Draw heat balance sheet on kJ/hr basis. (12 Marks)

Module-2

- 3 a. Derive an expression of optimum pressure ratio for maximum workout put in case of actual Brayton cycle. (10 Marks)
- b. Air enters the compressor of a gas turbine plant operating on Brayton cycle at 101.325KPa, 27°C. The pressure ratio in the cycle is 6. Calculate the maximum temperature in the cycle and cycle efficiency. Assume $W_T = 2.5W_C$. Where W_T and W_C are the turbine and compressor work respectively. Take $r = 1.4$. (10 Marks)

OR

- 4 a. With a neat block diagram and T-S diagram, explain how 'regeneration' increases thermal efficiency of gas turbine plant. (08 Marks)
- b. Air is drawn in a gas turbine unit at 15°C and 1.01bar and pressure ratio is 7. The compressor is driven by the high pressure turbine and low pressure turbine drives a separate shaft. The isentropic efficiencies of compressor and HP and LP turbines are 0.82, 0.85 and 0.85 respectively. If the maximum cycle temperature is 610°C, find :
- i) The pressure and temperature of the gases entering the power turbine
ii) The net power developed by the unit per Kg/sec mass flow.
iii) Work ratio
iv) Thermal efficiency of the unit

Neglect the mass of the fuel and assume the following :

For compression process, $C_{Pa} = 1.005$ kJ/Kg.K and $r = 1.4$.

For combustion and expansion process : $C_{Pg} = 1.15$ kJ/Kg.K and $r = 1.33$. (12 Marks)

Module-3

- 5 a. Discuss the effect of i) Boiler pressure ii) Condenser pressure iii) Super heat on the performance of a Rankine cycle. (10 Marks)

5. b. Steam at 1 bar and 350°C is expanded in a steam turbine to 0.08 bar. It then enters the condenser, where it is condensed to saturated liquid water. Assume the turbine and feed pump efficiencies as 80% and 90% respectively. Determine per kg of steam the network, the heat transferred to the working fluid and Rankine efficiency. (10 Marks)

OR

- 6 a. Sketch and explain the flow diagram and corresponding T-S diagram of practical regenerative Rankine cycle. (10 Marks)
- b. A reheat cycle has the first stage supply conditions of 70 bar and 500°C. The reheat is at 3 bar and to the same temperature.
- Given that the efficiency of the first stage turbine is 80%, how much energy is added per kg of steam in the reheat coils?
 - Assume that the same expansion efficiency exists in the second turbine. What is the thermal efficiency, if the condenser pressure is 0.03 bars? (10 Marks)

Module-4

- 7 a. Explain the effect of super heating and under cooling the refrigerant on the performance of vapour compression refrigeration cycle. (06 Marks)
- b. What are the properties of refrigerants? (04 Marks)
- c. A vapour compression refrigerator uses methyl Chloride (R - 40) and operates between the temperature limits of -10°C and 45°C. At the entry to the compressor the refrigerant is dry saturated and after the compression it acquires a temperature of 60°C. Find COP of the refrigerator. The relevant properties of R - 40 are as follows :

Saturation temperature	Enthalpy		Entropy	
	Liquid	Vapour	Liquid	Vapour
-10°C	45.4	460.7	0.183	1.637
45°C	133	483.6	0.485	1.587

Also find mass of methyl chloride and power required for a capacity of 15 TOR. (10 Marks)

OR

- 8 a. Define : i) Wet bulb temperature ii) Dew point temperature iii) Relative humidity iv) Specific humidity v) Degree of saturation. (10 Marks)
- b. Air is to be conditioned from 40°C (DBT) and 50% RH to a final temperature of 20°C (DBT) and 40% RH, by de-humidification process, followed by a reheat process. Assuming that the entire process is at constant pressure of 101.325 KPa, determine :
- The amount of water to be removed from air
 - The temperature of air leaving the dehumidifier
 - Refrigeration in tons for air flow rate of 0.47 m³/sec
 - Heating required in kW. (10 Marks)

Module-5

- 9 a. Derive an expression for minimum work input by two stage compressor with intercooler. (10 Marks)
- b. A single stage single acting reciprocating air compressor has a bore of 200 mm and Stroke of 300 mm. It receives air at 1 bar and 20°C and delivers it at 5.5 bar. If the compression follows the law $PV^{1.3} = C$ and clearance volume is 5% of the Stroke volume, determine :
- Mean effective pressure
 - Power required to drive the compressor if it runs at 500 rpm. (10 Marks)

OR

- 10 a. Derive an expression of critical pressure ratio which gives maximum discharge through the nozzle. (10 Marks)
- b. Steam at 15 bar and 250°C is expanded in a nozzle to 1 bar. For a discharge of 0.5 kg/sec find throat and exit diameter for maximum discharge conditions. Assume the nozzle efficiency as 90%. (10 Marks)
