VIT

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

REG.NO. 23BMA0029

SCHOOL OF MECHANICAL ENGINEERING
CONTINUOUS ASSESSMENT TEST - II
WINTER SEMESTER 2024-2025

SLOT: D2+TD2

Programme Name & Branch	: B.Tech (BMA/BME/BMM)
Course Code and Course Name	: BMEE303L (Thermal Engineering Systems)
Faculty Name(s)	: Dr. Senthil Kumar A, Dr. Senthur Prabu S, Dr. Prakash R, Dr. Dsilva Winfred Rufuss D
Class Number(s)	: VL2024250503542, 3541, 3540, 3539
Date of Examination	: 19/03/25
Exam Duration	: 90 minutes

Maximum Marks: 50

General instruction(s):

1. Use of approved Steam table and Mollier chart is permitted.
2. Missing data, if any, may suitably be assumed.

- M - Max mark; CO – Course Outcome; BL – Bloom's Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyze, 5 – Evaluate, 6 – Create)
- Course Outcomes (CO3 - Design a steam nozzle for thermal power plant and analyze the performance of Reciprocating air compressors, CO4 - Analyze the performance parameters of steam and gas power cycles)

Q. No	Answer all Questions	M	CO	BL
1.	A two-stage double acting air compressor operating at 200 rpm takes in air at 1.013 bar and 27°C. The diameter and stroke of L.P. cylinder are 35 cm and 38 cm respectively. The stroke of the H.P. cylinder is the same as that of the L.P. cylinder, and clearance of both cylinders is 4% of the stroke. The L.P. cylinder discharges air at a pressure of 4.052 bar. The air passes through the intercooler and enters the H.P. cylinder at 27°C and 3.85 bar. Finally, the air is discharged from the compressor at 15.4 bar. The compression and re-expansion in both cylinders follow the same law $pv^{1.3}$=constant. Determine (i) Shaft power required to run the compressor if mechanical efficiency is 80%. (ii) Diameter of H.P. cylinder (iii) Heat rejected by the intercooler. Take Cp = 1 kJ/kg-K and R = 287 J/kg-K for air.	10	3	3
2.	A single-stage single-acting air compressor is to deliver 8 kg of air per minute at 7 bar from suction conditions 1 bar and 15°C. Clearance volume may be taken as 4% of the stroke volume and the index for both compression and re-expansion as 1.3. The compressor runs at 2000 rpm. Assuming a stroke-bore ratio of 1.2 and a mechanical efficiency of 82%. Calculate the required cylinder dimensions and the shaft power.	10	3	3

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3.	A steam turbine develops 160 kW with a specific steam consumption of 19.4 kg/kWh. The pressure and temperature of the steam entering the nozzle are 12 bar and 220°C. The steam leaves the nozzles at 1.2 bar. If the diameter of the nozzle at the throat is 7 mm, find the number of nozzles required. If 8% of the total enthalpy drop is used up in frictional reheating in the diverging part of the nozzle. Determine the diameter at the exit of the nozzle and the quality of steam leaving the nozzle.	10	3	4
4.	A convergent-divergent nozzle is supplied with steam at a pressure of 1 MN/m^2 and 225°C. Super-saturated expansion occurs according to $pv^{1.3} = C$, in the nozzle down to an exit pressure of 0.32 MN/m^2. The exit diameter of the nozzle is 25 mm. If the flow through the nozzle is choked, determine (i) exit velocity, (ii) mass flow, and (iii) throat diameter.	10	3	4
5.	An open-cycle gas turbine power plant has a maximum pressure ratio of 8 and a temperature of 1080 K. The pressure and temperature of the air at the entry of the compressor are 1 bar and 300 K. If the airflow through the compressor is 500 kg/min. Find the gas turbine power plant capacity in kW and the thermal efficiency. Take the isentropic efficiency of the turbine and compressor as 80%. Take γ =1.4 and Cp = 1 kJ/kg °C for both air and gas. Neglect the pressure losses in the system.	10	4	3

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