SLOT: C2+TC2

REG. NO.: 24BME

VIT®

Vellore Institute of Technology

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

SCHOOL OF MECHANICAL ENGINEERING
CONTINUOUS ASSESSMENT TEST - II
WINTER SEMESTER 2025-2026

Programme Name & Branch : B.Tech. & BME/ BMV

Course Code : BMEE303L

Course Name : Thermal Engineering Systems

Faculty Name(s) : Dr. Senthil Kumar M/ Dr. Senthur Prabu S/ Dr. Bibhuti B. Sahoo/Dr. Asokan M.A/ Dr. Gaurav Gupta/ Dr. Govindha Ra

Class Number(s) : VL2025260502936/ VL2025260502939/VL202526050294 VL2025260502941/ VL2025260502765/ VL20252605055

Date of Examination : 17/03/2026

Exam Duration : 90 minutes

Maximum Marks: 50

General instruction(s):

- Answer All Questions
- M - Max mark; CO – Course Outcome; BL – Bloom's Taxonomy Level (1 - Remember Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcome Statements:

CO3: Design a steam nozzle for a thermal power plant and analyze the performance o reciprocating air compressors

CO4: Analyze the performance parameters of steam and gas power cycles

- *Use of approved Steam Table and Mollier chart is permitted.*
- *Missing data, if any, may be suitably assumed and mentioned clearly on the answer sc*

Q. No	Question	M	CO	BL
1.	A two-stage, single-acting reciprocating compressor takes in Propane gas at the rate of 0.2 kg/s at 1 bar and 293K and delivers it at 20 bar. Clearance volumes for low- and high-pressure cylinders are 4% and 7% of the stroke volume, respectively. Assuming perfect intercooling and optimum intermediate pressure, calculate (i) The shaft power required with a mechanical efficiency of 85% (ii) Isothermal efficiency, (iii) Heat rejection in the intercooler, (iv) Volumetric efficiency of each stage and the free delivered and (v) The ratio of the diameters for the same stroke for both cylinders. For propane gas, Take Cp = 1.679 kJ/ kg K, Cv = 1.490 kJ/ kg K.	10	3	4
2.	The dry saturated steam enters a Convergent-Divergent nozzle at 20 bar with a velocity of 150 m/s and expands to a pressure of 2 bar. There is an isentropic flow across the nozzle with a rate of 2 kg/s.	10	3	5

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	Assuming the case of maximum flow inside a nozzle, determine the following: (a) Throat pressure. (b) Mach number at the divergent section. Give its significance relating to the area, velocity, and pressure of the nozzle. Represent the nozzle process in the h-s diagram.			
3.	The dry saturated steam is expanded in a nozzle from a pressure of 10 bar to 5 bar. If the expansion is supersaturated, find the following: 1. The degree of undercooling; 2. The degree of supersaturation; and 3. Draw and represent the process in a h-s diagram.	10	3	4
4.	A gas turbine power plant of 800 kW capacity takes the air at 1.01bar and 15°C. The pressure ratio of the cycle is 6, and the maximum temperature is limited to 700°C. A regenerator of 75% effectiveness is added to the plant to increase the overall efficiency of the plant. The pressure drop in the combustion chamber as well as the regenerator is 0.15 bar. Assume The isentropic efficiency of the compressor = 80% The isentropic efficiency of the turbine = 85% Determine the plant thermal efficiency. Neglect the mass of the fuel.	10	4	4
5.	A gas turbine power plant of 5 MW capacity is supplied with air at 15°C. The pressure ratio is 6. The maximum temperature is limited to 750°C. The compression is carried out in one stage, while the expansion is carried out in two stages with reheating to the original temperature. The suction and exhaust pressures are 1bar. Take C_p = 1.005 kJ/kg-K and γ = 1.4 for air, and for gases C_p = 1.15 kJ/kg-K and γ = 1.33. η_c = 80%, $\eta_{t1} = \eta_{t2}$ = 85%, C.V. of fuel used = 18,500 kJ/kg. Determine the thermal efficiency of the plant by considering the mass of fuel burnt.	10	4	4