SLOT: D2+TD2

REG. NO.:

VIT

Vellore Institute of Technology

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

SCHOOL OF MECHANICAL ENGINEERING
CONTINUOUS ASSESSMENT TEST - I
FALL SEMESTER 2025-2026

Programme Name & Branch	**: B-Tech (BMM, BMA and BME)**
Course Code	**: BMEE303L**
Course Name	**: Thermal Engineering Systems**
Faculty Name(s)	**: Dr. N. GOVINDHA RASU**
Class Number(s)	**: VL2025260102342**
Date of Examination	**: 20-08-2025**
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, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcomes Statements:
  CO1: Apply the thermodynamic laws to the working of IC engines.
  CO2: Analyze performance parameters of IC engines.
  CO3: Design a steam nozzle for a thermal power plant and analyze the performance of reciprocating air compressors.

Q. No.	Question	M	CO	BL
1.	Compare and interpret the normal and abnormal combustion in C.I. Engines with a detailed pressure-crank angle diagram.	10	CO1	BL3
2.	Explain the working principle of a simple carburettor with a neat sketch and list down its merits and demerits.	10	CO1	BL2
3.	A rope brake dynamometer measures the power output of an I.C. engine. The diameter of the brake pulley is 700 mm, and the rope diameter is 25 mm. The load on the rope is 50 kg mass, and the spring balance reads 50 N. The engine is running at 900 RPM, and the engine consumes fuel with a calorific value of 44,000 kJ/kg at a rate of 4 kg/h. Assume $g = 9.81\ m/s^2$. Calculate (i) brake specific fuel consumption, (ii) brake thermal efficiency.	10	CO2	BL3
4.	A 4-stroke SI engine has six cylinders, each with 8 cm bore and 10 cm stroke. The engine is coupled to a brake having a torque radius of 40 cm. At 3200 rpm, with all cylinders operating, the net brake load is 350 N. When each cylinder, in turn, is rendered inoperative, the average net brake load produced at the same speed by the remaining 5 cylinders is 250 N. Estimate the indicated mean effective pressure of the engine. With all cylinders operating, the fuel consumption is 0.33 kg/min. The calorific value of the fuel is 43 MJ/kg. The cooling water flow rate and temperature rise are 70 kg/min and 10°C, respectively. During testing, the engine is enclosed in a	10	CO2	BL4

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	thermally and acoustically insulated box, through which the output drive, water, fuel, and air connections pass. Ventilating air, blown up through the box at the rate of 15 kg/min, enters at 17 °C and leaves at 62 °C. Draw up a heat balance of the engine on a minute basis. (Take, specific heat of water as 4.18 kJ/kg-k and specific heat of air as 1.005 kJ/kg-k).			
5.	A single-stage, single-acting reciprocating air compressor of 250 mm bore and 350 mm stroke runs at 200 rpm. The suction and delivery pressures are 1 bar and 6 bar, respectively. Calculate the theoretical power required to run the compressor and isothermal efficiency under each of the following conditions of compression: (Neglect the effect of clearance) (a) Isothermal process (b) Polytropic process (n =1.3) and (c) Isentropic process (γ=1.4).	10	CO3	BL3

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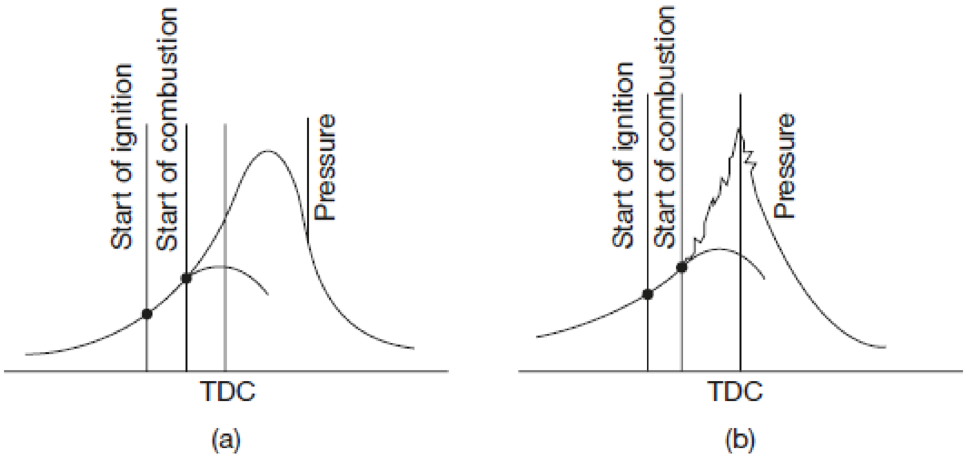
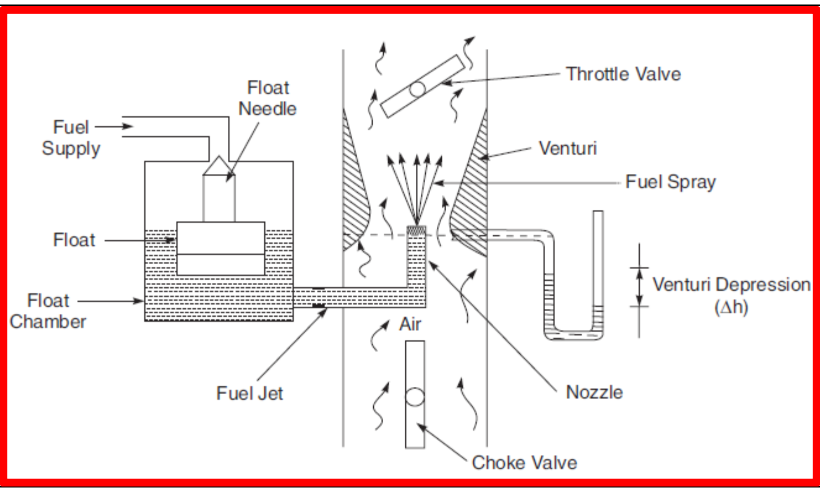
Key

Q. No.	Question	M
1.		10
2.		10

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3. (10)

Given data :

$D_b = 700\,mm = 0.7\,m$

$d_{rope} = 25\,mm = 0.025\,m$

$W = 50\,kg$

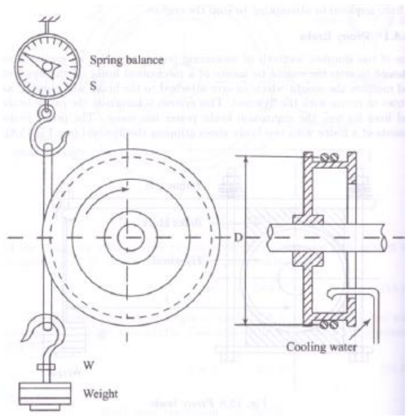
$S = 50\,N$

$N = 900\,r.p.m.$

$C.V. = 44{,}000\,kJ/kg$

$m_f = 4\,kg/h = 0.00111\,kg/s$

Find : (i) bsfc (ii) η_{bth}



Solution :

$$(i)\,bp = \frac{(W-S)\pi(D_b+d)\times N}{60{,}000} = \frac{(50\times 9.81-50)\times\pi(0.7+0.025)\times 900}{60{,}000} = 15.05\,kW$$

$$bsfc = \frac{m_f}{bp} = \frac{4}{15.05} = 0.266\ (kg/kW-hr)$$

$$(ii)\eta_{bth} = \frac{bp}{Q_s} = \frac{bp}{m_f\times C.V.} = \frac{15.05}{0.00111\times 44{,}000} = 30.78\%$$

4. (10)

Solution:

BP_K = 46.91 kW, BP_{K-1} = 33.51 kW

IP_K = IP1+IP2+IP3+IP4 = IP1× 4 = 80.4 kW

imep = 10 bar

Heat balance on minute basis:

(i) Heat supplied by fuel = **14190 kJ/min (100 %)**

(ii) Heat converted into BP = **2814.6 kJ/min (19.8 %)**

(iii) Heat lost to cooling water = **2926 kJ/min (20.6 %)**

(iv) Heat lost to ventilating air = **678.4 kJ/min (4.8 %)**

(v) Unaccounted loss = **7771 kJ/min (54.8 %)**

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5.	$Given\,data:$ $\qquad$ $To\,Find:$ $d = 250\,mm = 0.25\,m$ $\quad$ $(i)\,Theoritical\ power\ required\ to\ run\ the\ compressor,$ $L = 350\,mm = 0.35m$ $\quad$ $(a)\,Isothermal\ compression,$ $P_1 = 1\,bar = 100\,kPa$ $\quad$ $(b)\,Polytropic\ compression,$ $P_2 = 6\,bar = 600\,kPa$ $\quad$ $(c)\,Isentropic\ compression.$ $N = 200\,rpm$ $\quad$ $(ii)\,Isothermal\ efficency\ in\ each\ case$ $Solution:$ $Theoritical\ power\ required:$ $(i)\,Isothermal\ compression\ process$ $W_{iso} = p_1 V_1 \ln\left(\frac{p_2}{p_1}\right) = 100 \times 0.0572 \times \ln\left(\frac{6}{1}\right) = 10.261\ kJ/s\,(or)\,kW$ $where, V_1 = V_s = \frac{\pi}{4} d^2 \times L \times \frac{N}{60} = 0.0572 (m^3/s)$ $\qquad$ $why, V_1\ in\ m^3/s$ $(ii)\,Polytropic\ compression\ process$ $W_{poly} = \frac{n}{n-1} p_1 V_1 \left[\left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}} - 1\right] = \frac{1.3}{1.3-1} \times 100 \times 0.0572 \left[\left(\frac{6}{1}\right)^{\frac{1.3-1}{1.3}} - 1\right] = 12.7\,kW$ $(iii)\,Isentropic\ compression\ process$ $W_{Isen} = \frac{\gamma}{\gamma-1} p_1 V_1 \left[\left(\frac{p_2}{p_1}\right)^{\frac{\gamma-1}{\gamma}} - 1\right] = \frac{1.4}{1.4-1} \times 100 \times 0.0572 \left[\left(\frac{6}{1}\right)^{\frac{1.4-1}{1.4}} - 1\right] = 13.38\,kW$ $(ii)\,Isothermal\ efficency$ $\eta_{iso} = \frac{W_{iso}}{W_{actual}} \times 100$ $\qquad$ $(a)\,For\ isothermal\ compression,$ $\eta_{iso} = \frac{W_{iso}}{W_{iso}} \times 100 = \frac{10.26}{10.26} \times 100 = 100\%$ $(b)\,For\ polytropic\ compression,$ $\eta_{iso} = \frac{W_{iso}}{W_{poly}} \times 100 = \frac{10.26}{12.70} \times 100 = 80.8\%$ $(c)\,For\ isentropic\ compression,$ $\eta_{iso} = \frac{W_{iso}}{W_{isen}} \times 100 = \frac{10.26}{13.38} \times 100 = 76.67\%$	10

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