

Total No. of Questions: 6

Total No. of Printed Pages: 3

Enrollment No.....



Faculty of Engineering / Science
End Sem Examination May-2023

EN3ES18 / BC3ES05 Basic Mechanical Engineering
Programme: B.Tech. / B.Sc. Branch/Specialisation: All

Duration: 3 Hrs.

Maximum Marks: 60

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

- Q.1 i. The effect of hardness of the work material- 1
(a) Has no effect on its machinability
(b) Increases its machinability
(c) Decreases its machinability
(d) Has negligible effect on the machinability
- ii. The permanent mode of deformation of a material known as- 1
(a) Elasticity (b) Plasticity
(c) Slip deformation (d) Twinning deformation
- iii. An ideal gas as compared to a real gas at very high pressure occupies- 1
(a) More volume (b) Less volume
(c) Same volume (d) Unpredictable correlation
- iv. Temperature of a gas is produced due to- 1
(a) Its heating Value
(b) Kinetic Energy of molecules
(c) Repulsion of molecules
(d) Attraction of molecules
- v. Which of the following does not relate to spark ignition engine? 1
(a) Spark Plug (b) Carburetor
(c) Fuel Injector (d) Ignition Coil
- vi. Which of the following factors affecting combustion in the CI engine? 1
(a) Intake temperature (b) Jacket water temperature
(c) Compression ratio (d) All of these

P.T.O.

[2]

- vii. A safety valve usually employed with stationary boilers is-
 (a) Lever safety valve
 (b) Dead weight safety valve
 (c) High steam and low water safety valve
 (d) All of these
- viii. Lancashire Boiler is-
 (a) Stationary fire tube boiler (b) Internally fired boiler
 (c) Horizontal boiler (d) All of these
- ix. Centroid of circle lies at-
 (a) Two diagonals intersect each other
 (b) Three medians meet each other
 (c) Centre
 (d) None of these
- x. Moment of Inertia of a circular disc of radius R and mass M about its diameter is-
 (a) MR^2 (b) $MR^2/2$
 (c) $MR^2/3$ (d) $MR^2/4$

Q.2

- Attempt any two:
- i. Discuss the composition, specific properties and main application of the stainless steel. 5
- ii. Draw the stress-strain curve for mild steel. Also discuss the various properties of mild steel related to this curve. 5
- iii. Describe the five types of mechanical properties of materials in short. 5

Q.3

- Attempt any two:
- i. Explain the first law of thermodynamics with suitable examples. 5
- ii. A cyclic heat engine operates between a source temperature of 800°C and a sink temperature of 30°C . What is the least rate of heat rejection per kW net output of the engine 5
- iii. A domestic food freezer maintains a temperature of -15°C . The ambient air is at 30°C . If the heat leaks into the freezer at a continuous rate of 1.75 kJ/s , what is the least power necessary to pump the heat out continuously? 5

- Q.4 i. Define swept volume, clearance volume and cut-off ratio. 3
 ii. With the help of PV & TS diagram, derive efficiency of Diesel cycle. 7

1

[3]

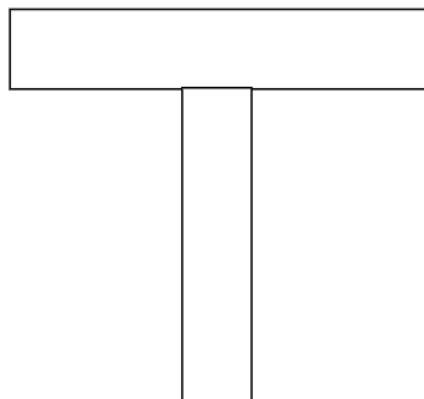
OR iii. An engine working on Otto cycle is supplied with air at 0.1 MPa and 35°C . The compression ratio is 8. Heat supplied is 2100 kJ/kg . Calculate the maximum pressure & temperature of the cycle and cycle efficiency. 7

Q.5 Attempt any two:

- i. Name boiler mountings and explain one of them. 5
- ii. Calculate the internal energy of 1 kg of steam at a pressure of 10 bar, when the steam is-
 (a) 0.9 dry (b) Super-heated to 250°C
- iii. Find the enthalpy & entropy of steam at 9 bar when it is dry saturated. 5

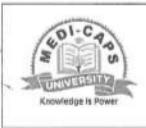
Q.6 Attempt any two:

- i. Difference between centroid and centre of gravity. 5
- ii. Derive an expression of centroid for rectangle. 5
- iii. Calculate the moment of inertia of given T section about centroidal axis. Top Flange = $20 * 100$, Web = $20 * 80$. Assume all dimension are in mm. 5



[4]

Scheme of Marking

	Faculty of Engineering End Sem Examination May-2023 EN3ES18 Basic Mechanical Engineering
Programme: B.Tech.	Branch/Specialisation:

Note: The Paper Setter should provide the answer wise splitting of the marks in the scheme below.

Q.1	i)	The effect of hardness of the work material a) Has no effect on its machinability b) Increases its machinability c) Decreases its machinability d) Has negligible effect on the machinability	1
	ii)	The permanent mode of deformation of a material known as a) Elasticity b) Plasticity c) Slip Deformation d) Twinning Deformation	1
	iii)	An ideal gas as compared to a real gas at very high pressure occupies a) More Volume b) Less Volume c) Same Volume d) Unpredictable Correlation	1
	iv)	Temperature of a gas is produced due to a) Its heating Value b) Kinetic Energy of molecules c) Repulsion of molecules d) Attraction of molecules	1
	v)	Which of the following does not relate to spark ignition engine? a) Spark Plug b) Carburetor c) Fuel Injector d) Ignition Coil	1
	vi)	Which of the following factors affecting combustion in the CI engine?	1

[1]

	a) Intake Temperature b) Jacket Water Temperature c) Compression Ratio <input checked="" type="checkbox"/> d) All of the mentioned	1
vii)	A safety valve usually employed with stationary boilers is a) Lever Safety Valve b) Dead weight safety valve c) High steam and low water safety Valve. <input checked="" type="checkbox"/> d) All of these	1
viii)	Lancashire Boiler is a) Stationary fire tube boiler b) Internally fired boiler c) Horizontal Boiler <input checked="" type="checkbox"/> d) All of these	1
ix)	Centroid of circle lies at a) Two diagonals intersect each other b) Three medians meet each other c) Centre <input checked="" type="checkbox"/> d) None of these	1
x)	Moment of Inertia of a circular disc of radius R and mass M about its diameter is a) MR^2 b) $MR^2/2$ c) $MR^2/3$ <input checked="" type="checkbox"/> d) $MR^2/4$	1
Q.2	i.	Discuss the composition, specific properties and main application of the Stainless steel. 1 MARKS 2 MARKS
	ii.	Draw the stress-strain curve for mild steel. 2.5 MARKS Also discuss the various properties of mild steel related to this curve. 2.5 MARKS
OR	iii.	Describe the 5 types of mechanical properties of materials in short. EACH 1 MARKS
Q.3	i.	Explain the first law of thermodynamics with suitable examples. 1 MARKS FOR DIAGRAM 2 MARKS FOR STATEMENT 2 MARKS FOR EXAMPLES
	ii.	A cyclic heat engine operates between a source temperature of,

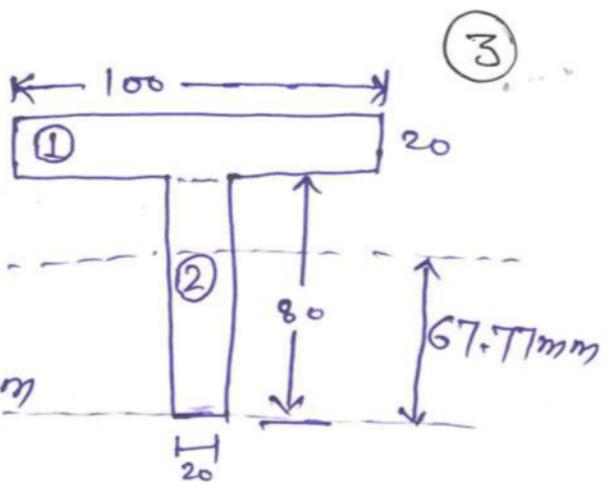
	[2]	800°C and a sink temperature of 30°C. What is the least rate of heat rejection per kW net output of the engine? PROCESS 2 MARKS FINAL ANSWER 3 MARKS
		$\eta = 0.72 \Rightarrow 2 \text{ marks}$ $h_{DB} = 1000 \text{ kJ/kg}$ $Q_c = 1388 \text{ kJ} \Rightarrow 2 \text{ marks}$
OR	iii.	A domestic food freezer maintains a temperature of -15°C. The ambient air is at 30°C. If the heat leaks into the freezer at a continuous rate of 1.75 KJ/s, what is the least power necessary to pump the heat out continuously? $COP = 2.58 \Rightarrow 5.733 \text{ (2 marks)}$ PROCESS 2 MARKS FINAL ANSWER 3 MARKS $5.733 = 1.75 \Rightarrow P = 0.305 \text{ kJ/s (3 marks)}$
Q4	ii.	Define swept volume, clearance volume & air/fuel ratio. (Each 1 mark)
Q4	iv.	With the help of PV & TS diagram derive efficiency of Diesel cycle, also find out the mean effective pressure. PV TS DIAGRAM 3 MARKS PROCESS 4 MARKS EFFICIENCY 1.5 MARKS MEP 1.5 MARKS
OR	iii.	An engine working on otto cycle is supplied with air at 0.1 MPa and 35°C. The compression ratio is 8. Heat supplied is 2100 kJ/kg. Calculate the maximum pressure and temperature of the cycle, cycle efficiency and mean effective pressure. MAXIMUM PRESSURE 3 MARKS MAXIMUM TEMPERATURE 3 MARKS MEP 4 MARKS $P_{max} = 9.43 \text{ MPa (2.5 marks)}$ $T_{max} = 3396 \text{ K (2.5 marks)}$
Q5	i.	Name boiler mountings and explain one of them. NAME BOILER MOUNTINGS 3 MARKS EXPLAIN ONE 2 MARKS
	ii.	Calculate the internal energy of 1 kg of steam at a pressure of 10 bar, when the steam is a) 0.9 dry b) Super heated to 250°C 0.9 DRY 2.5 MARKS SUPERHEATED 2.5 MARKS
OR	iii.	Find the enthalpy & entropy of steam at 9 bar when it is dry

	[3]	saturated. (2)
		$h_g = 2773.9 \text{ kJ/kg}$ $s_g = 6.623 \text{ kJ/kg}$ (2 marks each)
Q.6		
	i.	Difference between Centroid and Centre of Gravity. MINIMUM FIVE DIFFERENCE, EACH ONE MARKS
	ii.	Derive an expression of Centroid for rectangle. PROCESS 3 MARKS FINAL EXPRESSION 2 MARKS $X = 2.5 \text{ marks}$ $Y = 2.5 \text{ marks}$
OR	iii.	Calculate the moment of inertia of given T section about centroidal axis. Top Flange = 20*100, Web = 20*80 all dimension are in mm PROCESS 2 MARKS FORMULA 2 MARKS FINAL ANSWER 1 MARKS $I_{xx} = 314221.5 \text{ mm}^4$ (2 marks) $I_{yy} = 252000 \text{ mm}^4$ (2 marks)

Q6] iii]

$$\bar{x} = \frac{2000 \times 50 + 1600 \times 50}{3600} \Rightarrow 50\text{mm}$$

$$\bar{y} = \frac{2000 \times 90 + 1600 \times 40}{3600} = 67.77\text{mm}$$



$$I_{xx} = (I_{xx})_1 + (I_{xx})_2$$

$$\Rightarrow \left[\frac{100 \times (20)^3}{12} + 2000 \times (90 - 67.77) \right]^2 + \left[\frac{20 \times (80)^3}{12} + \left(67.77 - \frac{50}{1600} \right)^2 \right]$$

$$\Rightarrow 1055012.47 + 2087209.7$$

$$\underline{\underline{314221.5 \text{ mm}^4}}$$

$$I_{yy} = I_{yy_1} + I_{yy_2}$$

$$= \frac{20 \times (100)^3}{12} + \frac{20 \times (80)^3}{12}$$

$$\underline{\underline{2520000 \text{ mm}^4}}$$

Solution BME (EN3ES18)

Q5 iii) from Steam Table at Loher

(4)

$$T_{sat} = 179.9, \quad h_f = 762.8 \text{ kJ/kg}, \quad h_{fg} = 2015.3 \text{ kJ/kg}$$

$$h_g = 2778.1 \text{ kJ/kg}$$

$$v_f = 761.7 \text{ m}^3/\text{kg} \quad v_g = 2583.6 \text{ m}^3/\text{kg}$$

$$v_f = 0.194 \text{ m}^3/\text{kg}$$

a) at 0.9 dry

$$v_s = v_f + \alpha v_{fg} \Rightarrow 761.7 + 0.9(2583.6 - 761.7) \\ \Rightarrow 2401.4 \text{ m}^3/\text{kg}$$

b) at 250°C

$$v_{sup} = h_{sup} - Pv_{sup}$$

$$\frac{v_{sup}}{T_{sup}} = \frac{v_{sat}}{T_{sat}} \Rightarrow \frac{v_{sup}}{523} = \frac{0.194}{452.9} \Rightarrow v_{sup} = 0.224 \frac{\text{m}^3}{\text{kg}}$$

$$P = 1000 \text{ kPa}, \quad h_{sup} = h_g + 2.1(250 - 179.9) \Rightarrow 2925.31 \text{ kJ/kg}$$

$$v_{sup} = 2925.31 - 1000 \times 0.224 \Rightarrow 2701.31 \text{ m}^3/\text{kg}$$

