

# Faculty of Engineering / Science

## End Semester Examination May 2025

### EN3ES18 / BC3ES05 Basic Mechanical Engineering

<b>Programme</b>	:	B.Tech. / B. Sc.	<b>Branch/Specialisation</b>	:	All
<b>Duration</b>	:	3 hours	<b>Maximum Marks</b>	:	60

**Note:** All questions are compulsory. Internal choices, if any, are indicated. Assume suitable data if necessary.  
 Notations and symbols have their usual meaning.

#### Section 1 (Answer all question(s))

**Q1.** Which metal is known for its excellent corrosion resistance?

**Marks CO BL**  
1 1 1

<b>Rubric</b>	<b>Marks</b>
Stainless steel	1

- Iron       Copper  
 Aluminum       Stainless steel

**Q2.** The ratio of stress to strain within the elastic limit is known as-

1 1 1

<b>Rubric</b>	<b>Marks</b>
b) Modulus of elasticity	1

- Yield strength       Modulus of elasticity  
 Ductility       Toughness

**Q3.** A heat engine is supplied with 250 kJ/s of heat at a constant fixed temperature of 227 °C. The heat is rejected at 27 °C. The cycle is reversible, determine the amount of heat rejected.

1 2 2

<b>Rubric</b>	<b>Marks</b>
150 kJ/s	1

- 273 kJ/s       150 kJ/s  
 180 kJ/s       200 kJ/s

**Q4.** Which of the following is not a thermodynamic property?

1 2 2

<b>Rubric</b>	<b>Marks</b>
c) Heat	1

- Temperature       Pressure  
 Heat       Volume

**Q5.** What is the function of the piston rings?

1 2 1

<b>Rubric</b>	<b>Marks</b>
b) To seal the combustion chamber and control oil consumption	1

- To provide cooling to the piston       To seal the combustion chamber and control oil consumption  
 To lubricate the cylinder walls       To increase power output

**Q6.** If the stroke length of an engine is 100 mm and the bore is 80 mm, what is the engine's swept volume (displacement volume)? 1 3 2

<b>Rubric</b>	<b>Marks</b>
c) 502 cc	1

- 400 cc       480 cc  
 502 cc       800 cc

**Q7.** If a boiler has an efficiency of 80% and generates 2000 kW, what is the heat input? 1 3 2

<b>Rubric</b>	<b>Marks</b>
a) 2500 kW	1

- 2500 kW       2400 kW  
 2600 kW       2800 kW

**Q8.** Which type of steam has the highest enthalpy? 1 2 1

<b>Rubric</b>	<b>Marks</b>
d) Superheated steam	1

- Wet steam       Saturated steam  
 Dry steam       Superheated steam

**Q9.** The centroid of a uniform triangle is located at- 1 2 2

<b>Rubric</b>	<b>Marks</b>
b) One-third height from the base	1

- Midpoint of the base       One-third height from the base  
 Half the height from the base       Two-thirds height from the base

**Q10.** The SI unit of moment of inertia is- 1 1 1

<b>Rubric</b>	<b>Marks</b>
c) kg.m <sup>2</sup>	1

- kg       kg.m  
 kg.m<sup>2</sup>       kg/m<sup>2</sup>

### Section 2 (Answer all question(s))

**Q11.** Define hardness. Explain any one hardness test with suitable diagram. Marks CO BL

4 2 2

<b>Rubric</b>	<b>Marks</b>
Define hardness = 1 mark Explain any one hardness test with suitable diagram. = 3 marks	4

**Q12. (a)** Define the following mechanical properties, providing an example for each:

6 1 1

- Strength
- Hardness
- Toughness
- Ductility
- Creep
- Elasticity

<b>Rubric</b>	<b>Marks</b>
one marks for each define with example	6

**(OR)**

- (b)** A 10 mm diameter tensile specimen has a 50 mm gauge length. The load corresponding to the 0.2% offset is 55 kN and the maximum load is 70 kN. Fracture occurs at 60kN. The diameter after fracture is 8 mm and the gauge length at fracture is 65 mm. Calculate the following properties of the material from the tension test.
- Elongation in %
  - Reduction of Area (RA) in %
  - Tensile strength or ultimate tensile strength (UTS).

<b>Rubric</b>	<b>Marks</b>
Elongation 30 % = 2 marks Reduction of Area (RA) 36 % = 2 marks Tensile strength or ultimate tensile strength (UTS) 891 MPa = 2 marks	6

### Section 3 (Answer all question(s))

**Marks CO BL**

- Q13.** A gas is compressed in a cylinder by a piston. The initial volume of the gas is  $0.1 \text{ m}^3$ , and it is compressed to  $0.05 \text{ m}^3$ . The pressure of the gas remains constant at 100 kPa during the compression. If the change in internal energy is 1000 J, calculate the heat absorbed or released by the gas.

<b>Rubric</b>	<b>Marks</b>
$W = -5000 \text{ J}$ , 2 marks $Q = -4000 \text{ J}$ , 1 mark	3

- Q14. (a)** Write Kelvin-Planck and Clausius statements of the second law of thermodynamics with the help of a diagram.

7 2 1

<b>Rubric</b>	<b>Marks</b>
Write Kelvin-Planck statements with the help of diagram = 3.5 marks Write Clausius statements with the help of diagram. = 3.5 marks	7

**(OR)**

- (b)** A domestic food freezer maintains a temperature of  $-15^\circ\text{C}$ . The ambient air temperature is  $30^\circ\text{C}$ . If heat leaks into the freezer at continuous rate 1.75 kJ/s, what is the least power to pump this heat out continuously?

<b>Rubric</b>	<b>Marks</b>
$(COP)_{\text{Ref}} = 5.733$ , 4 marks $W = 0.3052 \text{ kW}$ , 3 marks	7

### Section 4 (Answer all question(s))

**Marks CO BL**

**Q15.** Compare the key differences between petrol engines and diesel engines.

3 2 2

Rubric	Marks
one marks for each difference (1x3)	3

**Q16. (a)** An engine working on air standard otto cycle has a cylinder diameter of 10 cm and stroke length of 15 cm. The ratio of specific heats for air is 1.4. If the clearance volume is 196.3 cc and the heat supplied per kg of air per cycle is 1800 kJ/kg. Determine the work output per cycle per kg of air.

7 3 2

Rubric	Marks
Swept Volume (Vs): 1178.09 cc, 2 marks Compression ratio = 7 , 1 mark efficiency 54.08%, 2 marks work output 973.5 kJ, 2 marks	7

(OR)

**(b)** A diesel engine works on diesel cycle with a compression ratio of 15 and cut off ratio of 1.75. Calculate the air standard efficiency. Assume adiabatic index as 1.4.

Rubric	Marks
p-v or t-s Diagram , 1 mark Formula, 2 marks air standard efficiency 61.63%, 4 marks	7

### Section 5 (Answer all question(s))

Marks CO BL

4 2 2

**Q17.** Define dryness fraction of steam. Also explain the function of three important boiler accessories.

Rubric	Marks
Define dryness fraction , 1 mark function of three important boiler accessories, 3 marks	4

**Q18. (a)** Derive an expression for the height of a boiler chimney in terms of water column, considering the difference in density between hot gases and atmospheric air.

6 4 1

Rubric	Marks
Diagram of boiler chimney with necessary assumptions and variables , 2 marks Derivation for the height of a boiler chimney , 4 marks	6

(OR)

**(b)** A boiler working at a pressure of 14 bar evaporates 9 kg of water per kg of coal fired from feed water entering at 35° C. The steam at outlet is 0.9 dry. The calorific value of coal is 35000 kJ/kg. Calculate equivalent evaporation from and at 100 °C and thermal efficiency of the boiler.

Rubric	Marks
E = 9.75 Kg/kg of coal , 3 marks Boiler efficiency = 62.88%, 3 marks	6

### Section 6 (Answer all question(s))

Marks CO BL

3 1 1

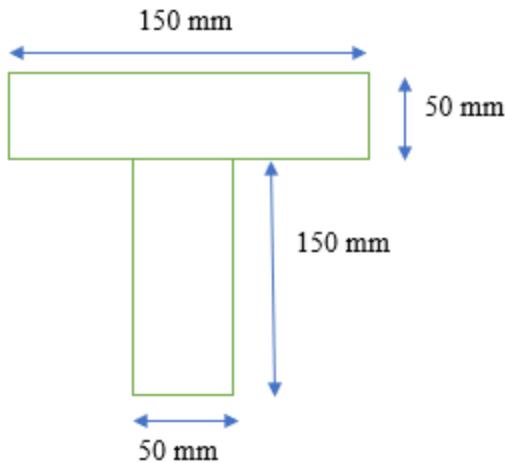
**Q19.** Differentiate between centre of gravity and centroid.

Rubric	Marks
one marks for each difference (1x3)	3

Rubric	Marks
Statement and diagram , 3 marks	7
Derivation , 4 marks	

(OR)

- (b) Find the moment of inertia of a T-section as shown in the figure with flange as 150 mm x 50 mm and web as 150 mm x 50 mm about X-X and Y-Y axes through the centre of gravity of the section.



Rubric	Marks
Centroid location $Y(\bar{y}) = 125 \text{ mm}$ , 1 mark	7
$I_{xx} = 53.125 \times 106 \text{ mm}^4$ , 3 marks	
$I_{yy} = 15.625 \times 106 \text{ mm}^4$ , 3 marks	

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