

2006

MECHANICAL ENGINEERING

Paper 1

*Time : 3 Hours ]*

*[ Maximum Marks : 300*

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INSTRUCTIONS

*Candidates should attempt **all** the questions in Parts A, B & C. However, they have to choose only **three** questions in Part D. The number of marks carried by each question is indicated at the end of the question.*

*Answers must be written in English.*

*This paper has four parts :*

- A**            20 marks
- B**            100 marks
- C**            90 marks
- D**            90 marks

*Marks allotted to each question are indicated in each part.*



**PART A**

1×5=20

*Answer each question in about 50 words. Each question carries 5 marks.*

1. (a) Explain the term kinematic link. Give the classification of kinematic link.
- (b) Explain briefly with a sketch the free and forced vibrations.
- (c) Define manufacturing process. What is meant by primary and secondary processes ? Give examples.
- (d) What is productivity ? What is its relationship with production ?

**PART B***10×10=100**Answer each question in about 100 words. Each question carries 10 marks.*

2. (a) Explain, with the help of a neat sketch, the body centrode. 3  
(b) Draw a neat sketch of universal joint and show its parts. 7
3. Explain with sketches the different types of cams and followers. 10
4. Establish an expression for the natural frequency of free transverse vibrations for a beam fixed at both ends and carrying uniformly distributed mass of  $m$  kg/unit length. 10
5. (a) Explain briefly the term 'factor of safety'. 4  
(b) Draw Mohr's circle diagram for two-dimensional state of stress. Show stresses involved. 6
6. (a) Distinguish between hot working and cold working. 4  
(b) What are the advantages and limitations of metal working process? 6
7. (a) What are the uses of Jigs and Fixtures? 5  
(b) Draw a neat sketch of Steady-Rest. 5
8. Derive specific Euler's equations for sizes of column having 10  
(a) Round cross-section  
(b) Rectangular cross-section
9. Explain the working principle of EDM with a neat sketch of schematic arrangement. 10
10. List out ten principles of value analysis. 10
11. (a) What are the objectives of plant-layout? 5  
(b) What are the factors considered in designing a work station? 5

[Turn over

## PART C

6×15=90

Answer each question in about 150 words. Each question carries 15 marks.

12. Four masses  $m_1$ ,  $m_2$ ,  $m_3$  and  $m_4$  are 200 kg, 300 kg, 240 kg, and 260 kg respectively. The corresponding radii of rotation are 0.2 mtr, 0.15 mtr, 0.25 mtr and 0.3 mtr respectively and corresponding angles between successive masses are  $45^\circ$ ,  $75^\circ$  and  $135^\circ$ . Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 mtr. 15
13. A belt drive consists of two V-belts in parallel, on grooved pulleys of the same size. The angle of the groove is  $30^\circ$ . The cross-sectional area of each belt is  $750 \text{ mm}^2$  and  $\mu = 0.12$ . The density of material is  $1200 \text{ kg/m}^3$  and maximum safe stress in the material is 7 MPa. Calculate the power that can be transmitted between the pulleys 300 mm diameter rotating at 1500 rpm. Find also the shaft speed at which the power transmitted would be maximum. 15
14. A compound tube is made by shrinking a thin steel tube on a thin brass tube. The cross-sectional area of these tubes are  $A_s$  and  $A_b$  respectively while Young's moduli are  $E_s$  and  $E_b$ . Show that for any tensile load, the extension of the compound tube is equal to that of a single tube of the same length and total cross-sectional area but having Young's modulus of 
$$\frac{E_s A_s + E_b A_b}{A_s + A_b}$$
. 15
15. With a neat sketch explain Electrolytic Grinding. 15
16. Explain briefly the different stages of Value Engineering. 15
17. (a) Define MRP, CRP and BOM. 6  
 (b) How does MRP differ from Inventory Control System ? 4  
 (c) What are the inputs to MRP ? 5

**PART D**

3×30=90

Answer any **three** of the following questions, each in about 300 words.  
Each question carries 30 marks.

18. The upper arms of a porter governor have lengths 350 mm and are pivoted on the axis of rotation. The lower arm have lengths 300 mm and are attached to a sleeve at a distance of 40 mm from the axis. Each ball has a mass of 4 kg and mass of the sleeve is 45 kg. Determine the equilibrium speed for a radius of rotation of 200 mm. Find also the effort power of the governor for 1% speed change. 20+10=30
19. (a) Explain the term “under damping”, “critical damping” and “over damping”. 4×3=12
- (b) Establish an expression for the amplitude of forced vibrations. 18
20. A hollow column, 400 mm external diameter and 300 mm internal diameter, is hinged at both ends. If the length of column is 5 mtr,  $E = 0.75 \times 10^5 \text{ N/mm}^2$ , factor of safety 5, Rankine constant  $\frac{1}{1600}$  and crushing stress  $587 \text{ N/mm}^2$ , find the safe load the column can carry without buckling. Use Euler’s and Rankine formulae. 30
21. (a) Explain explosive forming with neat sketch. 15
- (b) Describe the ‘ABC analysis’ in an Inventory Control. 15
22. The annual demand for a machine component is 24,000 units. The carrying cost is Rs. 1000/unit/year. Find the values of the following : 6×5=30
- (i) Economic order quantity
- (ii) Maximum inventory
- (iii) Maximum stockout
- (iv) Cycle time
- (v) Inventory period
- (vi) Shortage period

2006

## MECHANICAL ENGINEERING

Paper 2

*Time : 3 Hours ]**[ Maximum Marks : 300*

## INSTRUCTIONS

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*Answers must be written in English.*

*This paper has four parts :*

- |          |           |
|----------|-----------|
| <b>A</b> | 20 marks  |
| <b>B</b> | 100 marks |
| <b>C</b> | 90 marks  |
| <b>D</b> | 90 marks  |

*Marks allotted to each question are indicated in each part.*

**SEAL**

**PART A**

4×5=20

*Answer each question in about 50 words. Each question carries 5 marks.*

1. (a) State Zeroth law and Second law of Thermodynamics.
- (b) Define 'Laminar' and 'Turbulent' flows.
- (c) Explain two types of process of condensation.
- (d) Classify the IC engines based on thermodynamic cycle.

**PART B**

10×10=100

Answer each question in about 100 words. Each question carries 10 marks.

2. (a) Derive an expression for efficiency of the reversible heat engine. 6  
(b) Define Carnot theorem. 4
3. State Bernoulli's theorem. Prove Bernoulli's equation for steady flow of an incompressible non-viscous liquid. 3+7=10
4. (a) What is Biot number ? 3  
(b) Using lumped system analysis, determine the time required for solid steel of diameter  $D = 5$  cm to cool from  $600^\circ\text{C}$  to  $200^\circ\text{C}$ , if it is exposed to air stream at  $50^\circ\text{C}$  having a heat transfer coefficient  $h = 100\text{ W/m}^2\text{ }^\circ\text{C}$ . Take  $\rho = 7833\text{ kg/m}^3$ ,  $C_p = 0.465\text{ kJ/kg }^\circ\text{C}$ ,  $K = 54\text{ W/m }^\circ\text{C}$ . 7
5. What is Fouling factor in case of heat exchangers ? List out types of fouling. Explain mechanism of fouling. 3+3+4=10
6. Explain working principle of steam turbines. 10
7. Explain different types of Ignition systems in IC engines. 10
8. What are the properties of a good refrigerant ? 10
9. Explain working principle of a typical nuclear power plant. 10
10. Draw a diagrammatic sketch of Cochran boiler and show its parts. 10
11. Draw a neat sketch of centrifugal pump and show its parts. 10

[Turn over



**PART C**

6×15=90

*Answer each question in about 150 words. Each question carries 15 marks.*

12. Steam at 7 bar and dryness fraction 0.95 expands in a cylinder behind a piston isothermally and reversibly to a pressure of 1.5 bar. The heat supplied during the process is found to be 420 kJ/kg. Calculate per kg the following : 5×3=15
- Change of internal energy
  - Change of enthalpy
  - Work done
13. The loss of pressure for a laminar flow in a pipe is a function of pipe length ' $l$ ', its diameter ' $d$ ', mean velocity ' $u$ ', and the dynamic viscosity ' $\mu$ '. Obtain an expression for the pressure loss. 15
14. A copper pin fin 0.25 cm in diameter protrudes from a wall at 95° C into ambient air at 25° C. The heat transfer is mainly by free convection with a coefficient equal to 10 W/m<sup>2</sup>-K. Calculate the heat loss, assuming that 8+7
- the fin is infinitely long. Assume  $K = 396$  W/m-K.
  - the fin is 2.5 cm long and coefficient is same as over the circumference.
15. A single cylinder four stroke engine has swept volume of 4.5 litre. The mean effective pressure is 0.65 MPa and the engine speed is 505 rpm. If there are 250 explosions per minute and the brake torque is 176 N-m, find Indicated power and Brake power of the engine. 10+5=15
16. Draw a neat sketch of a simple carburettor and explain how it works. 15
17. What do you understand by MHD systems ? Explain. 15

**PART D**

3×30=90

Answer any **three** of the following questions, each in about 300 words.  
Each question carries 30 marks.

18. Explain briefly the following : 6×5=30
- (a) Laminar and Turbulent flows
  - (b) Uniform and Non-uniform flows
  - (c) Steady and Unsteady flows
  - (d) Ideal and Real flows
  - (e) Rotational and Irrotational flows
  - (f) One and Two dimensional flows
19. (a) An oil of specific gravity 0.85 and viscosity 3.8 poise flow in 5 cm diameter pipe at a rate of 4 litres/sec. Comment whether the flow is laminar or turbulent. 15
- (b) An oil having kinematic viscosity of 21.4 stokes is flowing through a pipe of 300 mm diameter. Determine the type of flow if the discharge through the pipe is 15 litres/sec. 15
20. Explain the working principle of Four Stroke Petrol Engine with neat sketches. 30
21. (a) How are water turbines classified ? 10
- (b) Describe briefly with line diagram, the working principle of a Pelton wheel. 20
22. (a) Sketch and explain the working of a single stage air compressor. 20
- (b) Explain why multistage compression is required. 10