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ABP/CCM-55/XIV
2015

MECHANICAL ENGINEERING

FIRST PAPER

Full Marks : 200

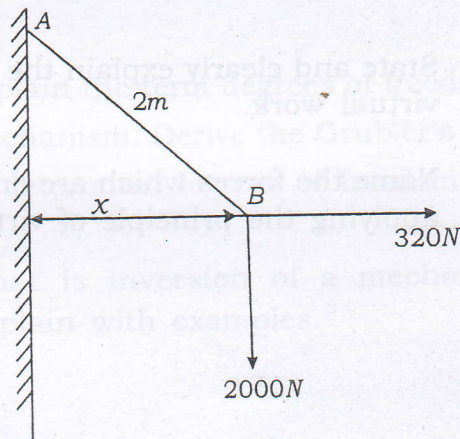
Time : 3 Hours

The figures in the margin indicate full marks for the questions.

Group-A

Answer **any ten** questions.

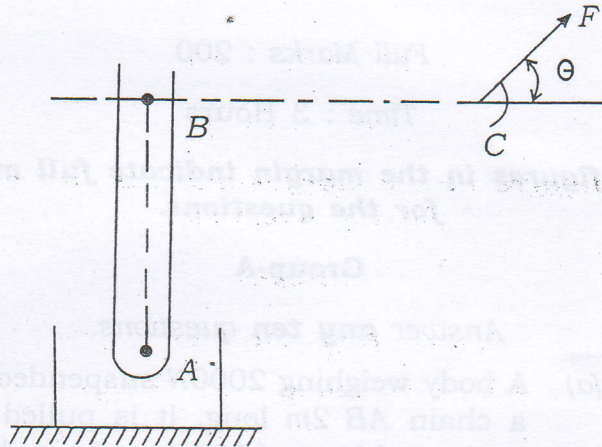
1. (a) A body weighing $2000N$ suspended with a chain AB $2m$ long. It is pulled by a horizontal force of $320N$ as shown below. Find the force in the chain and lateral displacement (ie., x) of the body.



10

Contd.

- (b) A L-shaped body ABC is hinged at A with a force F acting at its end C . Determine the angle θ which this force should make with the horizontal to keep the edge AB of the body vertical.



10

2. (a) State and clearly explain the principle of virtual work. 5
- (b) Name the forces which are omitted while applying the principle of virtual work. 5

(c) A beam AB of span $10m$ carries two point loads of $15kN$ and $20kN$ at $4m$ and $6m$ from the ends A respectively. Determine the beam reactions by the principle of virtual work. 10

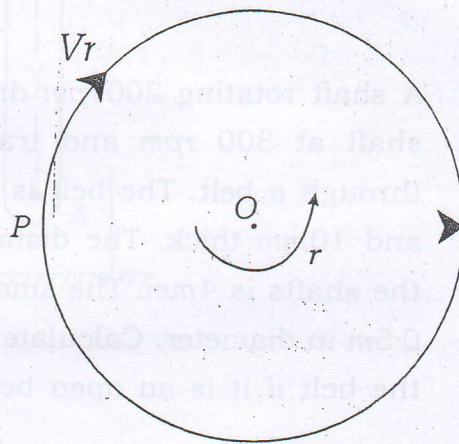
3. (a) Write the classification of kinematic pairs. 6

(b) A shaft rotating 200 rpm drives another shaft at 300 rpm and transmits $6kW$ through a belt. The belt is $100mm$ wide and $10mm$ thick. The distance between the shafts is $4m$. The smaller pulley is $0.5m$ in diameter. Calculate the stress in the belt if it is an open belt. 14

4. (a) Explain the term degrees of freedom of a mechanism. Derive the Grubler's criteria to determine degrees of freedom. 8

(b) What is inversion of a mechanism? Explain with examples. 4

- (c) A particle P moves with a constant relative velocity $V_r = 0.9 \text{ m/s}$, along the circumference of a circular disk of radius $r = 0.3 \text{ m}$, while the disk rotates with uniform angular velocity $\omega = 6 \text{ rad/s}$ in the opposite direction. Find the absolute acceleration 'a' of the particle. 8



5. (a) What do you understand by the terms Static and Dynamic balancing? Explain why a reciprocating mass cannot be balanced completely. 10

(b) The following data relate to a single cylinder reciprocating engine :

Mass of reciprocating parts = 40kg

Mass of revolving parts = 30kg at crank radius.

Speed = 150 rpm

Stroke = 350mm

If 60% of the reciprocating parts and all the revolving parts are to be balance, determine the

(i) balance mass required at a radius of 320 mm.

(ii) unbalanced force when the crank has turned 45° from the top-dead centre. 10

6. (a) A cantilever shaft 50mm diameter and 380mm long has a disc of mass 100kg at its free end. The Young's modulus for the shaft material is 200 GN/m^2 . Determine the frequency of longitudinal and transverse vibrations of the shaft.

12

- (b) A rectangular bar is subjected to a direct stress (σ) in one plane only. Prove that the normal and shear stresses on an oblique plane are given by

$$\sigma_n = \sigma \cos^2 \theta \text{ and } \sigma_t = \frac{\sigma}{2} \sin 2\theta, \text{ where}$$

θ = angle made by the oblique plane with the normal cross-section of the bar.

σ_n = Normal stresses, σ_t = shear stresses

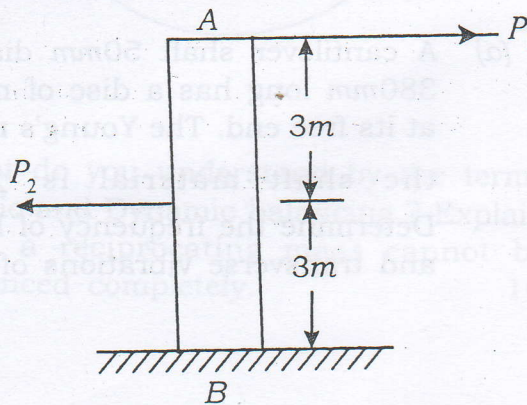
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7. (a) State and prove Cartigliano's Theorem

10

- (b) Horizontal pulls P_1 and P_2 are applied to a vertical pole AB which is 4cm in diameter. If the deflection at the top of the pole is to be zero, find the ratio of P_1 to P_2 .

10



8. Stating the assumptions made in developing the Merchant's circle diagram, deduce the expressions for (i) Shear force (ii) Normal force (iii) frictional force (iv) the back-up force in terms of F_c, F_t, ϕ and α ; where these symbols have their usual meaning. $5 \times 4 = 20$

9. With a neat sketch, explain the working principle of the following along with the applications :

(i) Electro-discharge Machining

(ii) Ultrasonic Machining. $10 \times 2 = 20$

10. (a) Explain stress-strain diagram for ductile materials. 10

(b) Explain the two forming processes

(i) Deep drawing

(ii) Forging $5 \times 2 = 10$

11. (a) What is high velocity forming and why is it used? 5

(b) Describe with neat sketches, the different types of techniques of explosive forming. 15

12. (a) What do you understand by the term "tool life" ? What are the methods by which tool life can be assessed ?

3+5=8

(b) Explain the term "Machinability". On what factors does machinability depend? Explain the term "Machinability Index".

2+4+2=8

(c) Explain in brief how tool life is affected by the rake angle and clearance angle.

4

13. (a) Write the concept and advantages of control charts.

5+3=8

(b) Write notes on :

4×3=12

(i) Line balancing

(ii) Factors affecting good work station

(iii) C-chart

14. (a) What is the relation between Primal and Dual problem ?

5

(b) Solve by dual simplex method the following problem : 15

$$\text{Maximize } Z = -3x_1 - 2x_2$$

$$\text{Subject to } x_1 + x_2 \geq 1$$

$$x_1 + x_2 \leq 7$$

$$x_1 + 2x_2 \geq 10$$

$$x_2 \leq 3$$

$$x_1, x_2 \geq 0$$

15. Five wagons are available at stations A, B, C, D and E. These are required at five stations I, II, III, IV and V. The mileages between various stations are given in table below. How should the wagons be transported so as to minimize the total mileage covered ? 20

	I	II	III	IV	V
A	10	5	9	18	11
B	13	9	6	12	14
C	3	2	4	4	5
D	18	9	12	17	15
E	11	6	14	19	10