

Time : 3 hours

Full Marks : 200

Instructions :

- (1) Answer any **ten** questions following directions.
- (2) The figures in the margin indicate full marks for the questions.
- (3) Use of programmable devices or graphical calculator is **NOT** allowed.

1. (a) State the Lami's theorem for the equilibrium of a rigid body under the action of three coplanar forces. A simple stone-crushing mechanism consists of a piston on which a force of 15 kN acts and three rigid weightless links OA , OB and OC hinged at O , A , B and C as shown in Fig. 1. At the given orientation, what is the force exerted on the stone S trapped between the jaw and the fixed wall? 2+6=8

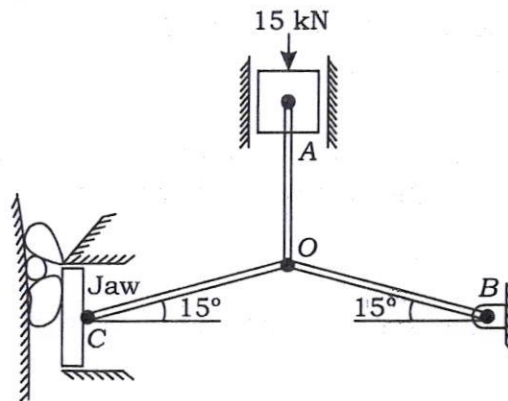


Fig. 1

- (b) What are statically determinate and statically indeterminate systems? Give one example of each such system. 2+2=4

- (c) A string carrying a weight of 15 kg is tied to a ceiling and passed over three pulleys A , B and C as arranged in Fig. 2 (a). Find the acceleration of the 25 kg mass suspended from the pulley A as shown in Fig. 2 (a). If the 15 kg mass is removed and a tension of (15×9.81) N is applied to the string as shown in Fig. 2 (b), will the acceleration

of the 25 kg mass be changed? If it is so then by how much the acceleration is changed?

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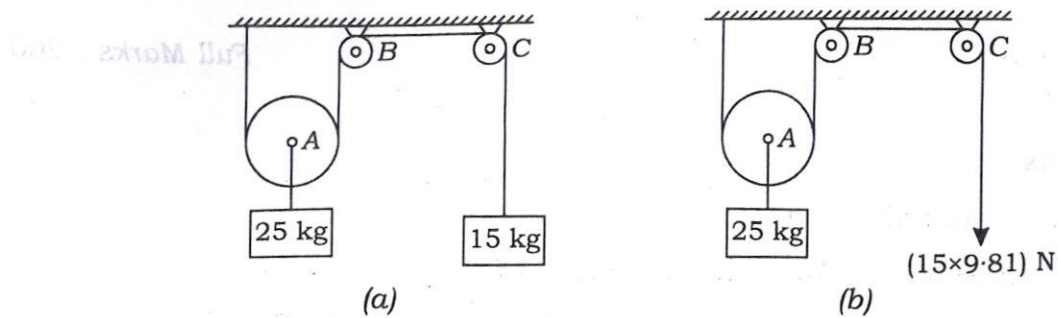


Fig. 2

2. (a) What is a mechanism and a machine? Give examples of each. $2+2=4$
 - (b) What do you mean by inversion of a mechanism? Describe various inversions of a slider-crank mechanism giving examples. $2+8=10$
 - (c) State the fundamental law of gearing. Name two common forms of teeth that satisfy the law of gearing. $2+2=4$
 - (d) A standard gear has outside diameter of 100 mm and module 4 mm. Evaluate the number of teeth on the gear. 2
3. (a) What is the function of a governor? How does it differ from that of a flywheel? $2+2=4$
 - (b) What are inertia governors? How do they differ from centrifugal governors? $2+2=4$
 - (c) What is the condition of isochronism in governors? In what type of governors can it be achieved? Find the required condition of isochronism in case of a Hartnell governor. $2+2+4=8$
 - (d) What do you understand by balancing of machines? What is the condition for dynamic balancing of a shaft-rotor system? $2+2=4$

4. (a) What is vibration? Write down the constitutive law for the following basic elements of a vibratory system : 2+4=6

Linear spring, Linear viscous damper

- (b) What do you mean by degrees of freedom of a vibratory system? In a three-dimensional space, what are the degrees of freedom of a particle and that of a rigid body? 2+2=4

- (c) What are the causes of vibration? How does it affect the performance of a machine? Discuss different remedial measures to reduce vibration. 4+2+4=10

5. (a) The Mohr's circle for a plane stress is a circle of radius R with its origin at $+3R$ on σ axis. Sketch the Mohr's circle and determine σ_{\max} , σ_{\min} and $(\tau_{xy})_{\max}$ for this situation. 5

- (b) Write the generalized Hooke's law for a stressed body as shown in Fig. 3 : 3

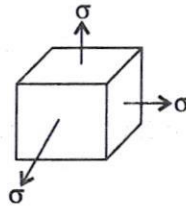


Fig. 3

- (c) A solid shaft and a hollow shaft of same material have the same length and same outer radius R . The inner radius of the hollow shaft is $0.7R$. If both the shafts are subjected to the same torque, then compare their shear stresses, angle of twist and weights. Also, find the strength to weight ratio for both shafts. 3+3+3=9

- (d) Define section modulus. What is its physical significance? 1+2=3

6. (a) Represent the basic machining operation with the help of a schematic diagram showing all important parameters. 6