Q1.) What is Axioms of mechanics? Enumerate. (3M)

Q2.) What are the characteristics of couple? (3M)

Q3.) State and explain Varignon’s Theorem. (3M)

Q4.) What do you understand by a ‘couple’? What is the unique property of couple? (3M)

Q5.) Explain Principle of Transmissibility of forces. (3M)

Q6.) Reduce the force system in single force and determine its position w.r.t. point B as shown in fig. (7M)

Q7.) Find Resultant and its location of the Force System, shown in Fig. -1. The grid is 1 Unit each along X and Y axes. (7M)
Q8.) In figure the x-component of F is 893N, find its Y-component.

Q9.) A rigid bar AB is subjected to a system of parallel forces as shown in Fig. 1. Reduce the given system of forces to an equivalent.

(i) Single resultant

(ii) Force system at D

(iii) Force system at A.

Q10.) Calculate resultant of the forces and its X and Y intercept shown in Fig.
Q11.) A dam is subjected to 3 forces, 50KN force on the upstream vertical face AB, 40KN force on the downstream inclined face and its own weight of 140KN as shown in figure. Determine the single equivalent force and locate its point of intersection with the base AD, assuming all the forces to lie in the same plane. (5M)

Q12.) If the resultant of the three forces acting on the block is horizontal. (7M)

(i) Determine the value of angle $\theta$.

(ii) What is the magnitude of resultant force

Q13.) Find the resultant force of the system as shown in the figure (2a) and locate the position of its line of action along OD. (5 M)
Q14.) The force system shown in Fig. produce a resultant of 600 N acting up to the right at an angle of 60° X-axis. Find the Values of F and θ to produce the resultant. (7M)

Q15.) Two forces are acting on a bracket as shown in Fig. Reduce the force system into a resultant force and a couple at point A. (5M)

Q16.) Three forces are shown in fig. Determine the resultant and position where it cuts X-axis. (4M)

Q17.) Determine the resultant of the force system and its location (5M)
Q1.) State Static Equilibrium Conditions of 3-D Non-Concurrent Force System. (3M)

Q2.) Explain the term wrench.

Q3.) ABCD are the points in space having the co-ordinates A (12, 0, 0), B (0, 4, -6), C (0, 0.7), D (0, -12, 0). The force \( F = 5.6 \) kN acts from A to B

Determine: Moment of a force \( F \) about the point C and moment about line CD. (7M)

Q4.) A force \( F, 70 \) N in magnitude passes through point A (−2, 1, 3) towards B (4,4,5) coordinates of point C and D are (−2, 0, 1) and (2, 0, -2) respectively. (6M)

Find:

i) Component of \( F \) along AC

ii) Moment of \( F \) about line BC

iii) Moment of \( F \) about line CD.

Q5.) Three forces \( F, P, Q \) act at point D as shown in figure \( F=90 \) N and \( P=149 \) N.

Determine the magnitude of force \( Q \); so that the resultant of the three forces is parallel to 'Y' axis. (5M)

Q6.) Determine the resultant of the force system shown in Fig. in which \( P = 560 \) N, \( T = 520 \) N and \( F = 630 \) N. (7M)
Q7.) Find:

(i) Component of Force P along Force Q and

(ii) Moment of P about Origin.

Force $\vec{P} = 3i - 2j + 4k$

Force $\vec{Q} = 7i - 4j - 8k$

Q8.) State Static Equilibrium Conditions of 3-D Non-Concurrent Force System.

Q9.) A force $\vec{F} = 70$ N in magnitude passes through point A (-2, 1, 3) towards B (4, 4, 5)

co-ordinates of point C and D are (-2, 0, 1) and (2, 0, -2) respectively

Find:

(i) Moment of F about line AC

(ii) Moment of F about line BC.

Q10.) A force $\vec{P} = 200$ N acts from A (0, 0, 10) to B (8, -4, 0) and force $\vec{T} = 134$ N acts from C (0, -4, 6) to D (7, 0, 0).

Find the force F to be applied at E (0, -10, 0) to reduce their resultant to a couple.

What is the resultant couple?

Q11.) A vertical boom AE is supported by guy wires from A to B, C and D, if the tensile load in AD = 252N, find the forces AC and AB so that the resultant force on A will be vertical. (Fig.)

Q12.) A system consists of force $\vec{F} = (25 i + 40 j - 30k)$ N passing through point ‘A’ with a couple moment of 90 Nm in the direction of force F. The position vector of point ‘A’ is given by $\vec{r} = (2 i + j + k)$. Calculate the moment of the given system about the origin.
Q13.) A force 'F' of 2500N is acting from A (2, -1, 3) to B (5, 6, 2) 

Determine:

i) Moment of the force 'F' about point C (-3, 3, 3)

ii) Moment of the force 'F' about a line L = (-i+j-2k) passing through the point 'C'.

Q14.) Find the Component of Force P along Force Q and angle between two forces P and Q.

Force = -2i + 5j — 6k

Force = 3i-6j-2k

Q15.) Determine the resultant of two concurrent forces having the following magnitudes and passing through the origin and indicated points:

P = 140 N, (3, -6, 2)

T = 260 N, (-12, 4, -3)

Also find angles of the resultant with reference axes.

Q16.) Three forces F, P, Q acting at point D as shown in figure. F = 90 N, P = 150 N.

Determine the magnitude of force Q, so that the resultant of the three forces is Parallel to “y” axis. Point D is in plane x-y.

Q17.) The three forces in a system are given below with their points of application:

200i at (0,1.2,0) ; 300j (0,0,1) ; -150k; at (1.5 ,0, 0)

and a couple moment of 240i + 300j + 225k.

Replace this force system by a wrench passing through a point in Y-Z. plane.
State and explain Lami’s Theorom

Define free body diagram? Explain with example. (3M)

What is the physical meaning of the term "Equilibrium"? What are the equation of equilibrium? (3M)

Find the support reactions at A and B for the beam shown in fig. (7M)

A bar 12.0 m long is supported by two inclined plane as shown in figure. (5M)

Determine ‘x’ for the equilibrium of the bar. Assume smooth surfaces.

A bar All 8 m long is supported by an inclined plane and a vertical wall and loaded as shown in Fig. Determine the magnitude of force P for the equilibrium. (7M)

Assume smooth surfaces and weight of bar AB as negligible.
A uniform wheel weighing 200 kN and of 600 mm diameter rests against 150 mm thick rigid block as shown in Fig. 2. Find minimum $P$ required to pull the wheel over the block.

A uniform wheel of 80 cm diameter rests against a rectangular block as shown in Fig. Find least pull ‘$P$’ through centre of wheel to just turn the wheel over block. Assume all surfaces smooth. Weight of wheel 20 kN.

Two identical rollers each of weight 100N are supported by an inclined plane and a vertical wall as shown in fig. Assuming smooth surface, find the reactions at A, B and C.
Three bars mechanism is pinned at B and C and supported at hinges A and D as shown in the fig. (3b). Determine the value of 'P' that will prevent motion of the mechanism.

Determine the reactions at the supports for the given type of loads as shown in the fig. (5M)

Bar AB of negligible weight is subjected to a vertical force of 600 N and a horizontal force of 300 N applied as shown in Fig. 3(b). Find angle 'θ', with horizontal, at which equilibrium exists. Assume inclined surfaces as smooth. (7M)

A circular roller of weight 100 N and radius 10 cm hangs by a tie rod AB = 20 cm and rest against a smooth vertical wall at C. Determine the force F in the tie rod and the reaction R_C at point C. (4M)

Find the support at A & B as shown in Fig. A couple of 16 kN-m is acting at C. (7M)
What are the assumptions made in analysis of simple truss?  
(3M)
What are the type of trusses? Or Relation between member & joint.  
(3M)
Determine the forces in all the members of the truss as shown in fig.  
(10M)

For the truss shown in fig. compute the member forces BG, AC and HG.  
(10M)

Determine the forces in any five members of the truss shown in fig.  
(7M)
Find the force in the Truss members shown in Fig. 4. (5M)

A truss of 6 m span is carrying a central load of 10 kN as shown in Fig. 4. Find by any method, the magnitude and nature of forces in all members of the truss and tabulate the results. (7M)

Find the forces in all the members of a truss shown in fig. (5M)

Find the forces in all the members of given Truss, as shown in fig. (5M)
Determine support reaction and the force in members AC and BE, of a truss as shown in Fig. (5M)

Find the forces in all the members of a truss as shown in Fig. (7M)

Find the magnitude and nature of forces in all members of the truss and tabulated the results. (6M)
State and explain the principle of virtual work.

Determine the reaction at supports for the beam shown in figure by virtual work method.

Using virtual work method determine reactions at supports A, B, and C for the beam shown in figure.

Two bars AB and AC each of length L and weighing 50 N are connected by smooth pin at A and ends B and C rest on a smooth horizontal surface. The midpoint D and E of the bars are connected by a light string of length L/2 as shown in figure. Determine the tension in the string by using the principle of virtual work, if the system carries a weight of 100 N at the point A.
The system consisting of two equal bars and a block C, is held in equilibrium by force P. The weight of each bar is 100N. Using virtual work method find the value of P to maintain the system in equilibrium. Refer fig. (6M)

![Diagram of two equal bars and block C held in equilibrium by force P.]

A simply supported beam of span 10 m carries point loads of 5KN, 2KN, 10KN and 15KN at 2m, 3m, 5m and 9m from left hand support using principle of virtual work. (5M)

The system consisting of two equal bars and a block C, is held in equilibrium by force P. The weight of each bar is 80N. Using virtual work method find the value of P to maintain the system in equilibrium. Shown in fig. (5M)

Using the method of virtual work, determine the values of angle θ1, θ2 and θ3 at the equilibrium position of three homogeneous links each weighing 200 N and 3m long. The mechanism is held in equilibrium by 300N horizontal force as shown in fig. (7M)
Using virtual work method determine reactions at supports A, B.

![Diagram showing forces and support A and B](image)

Using the method of virtual work, determine the values of angle $\theta_1$, $\theta_2$ and $\theta_3$ at the equilibrium position of three homogeneous links each weighing 100 N and 2m long. The mechanism is held in equilibrium by 150N horizontal force as shown in fig.

![Diagram showing three links and angles](image)

Find the reaction at support D using principle of virtual work.

![Diagram showing forces and support D](image)

Determine the reactions at supports for the beam shown fig. by virtual work method.

![Diagram showing beam with forces](image)
Static and explain parallel axis theorem of moment of inertia. \( (3M) \)

Determine the centroid of the I section shown in figure with respect to the axes shown. Also find moment of Inertia about x-axis. \( (7M) \)

Compute the product of inertia of the triangle shown in fig. with respect to given X & Y axis. \( (4M) \)

Determine the moment of inertia about its centroidal axis of given fig. \( (7M) \)
Compute:

i) Moment of inertia with respect to X and Y axis for the shaded area.

ii) Product of inertia with respect to X-Y axis for the shaded area shown in fig.

Determine centroid w.r.t X and Y axis of the fig. given below.

Determine MI w.r.t X and Y axis of the fig. given below.

Determine the moment of inertia of the shaded region as shown in fig. about the given X and Y references axes.
Determine co-ordinates of centroid of the area as shown in fig. Dimension are in cm. (5M)

Find moment of inertia for the shaded area as shown in fig. 5 (b) about the specified X and Y axis. (7M)

Determine the product of inertia as shown in fig. 6 (b) with respect to specified X and Y axis. (5M)

Determine the moment of inertia of the shaded region as shown in fig. about the given X and Y references axes. (8M)
Find moment of inertia about x-axis for the shaded area shown in fig. (5M)

Find centroid for the shaded area for above fig. (5M)

Locate the centroid of inertia of the plane lamina in fig. (5M)

Find moment of inertia of the plane lamina in fig. about the X and Y axis as shown in figure. (5M)
For the shaded area determine the coordinates of centroid w.r.t X and Y axis. (3M)

For the composite area shown in figure determine: (7M)

i) Find the moment of inertia X-axis & Y-axis.

ii) Product of inertia w.r.t indicated X-Y axis
Explain the term Elastic Impact. (3M)

Define coefficient of restitution. (2 or 3M)

A 10N ball traverses a frictionless tube as shown in figure falling through a height of 2m. It then strikes a 20N ball hung from a rope 1.2 m long. Determine the height to which the hanging ball will rise if the collision is perfectly elastic. (7M)

A bullet of weight 30 gms moving with velocity of 100 m/sec hits a 5kg bob of a simple pendulum horizontally. Determine the maximum angle through which the pendulum string 0.5m long may swing if.

a) The bullet gets embedded in bob.
b) The bullet escapes from the other end at 20m/sec.
c) The bullet is rebounded from the surface of bob at 20m/sec. (10M)
A spherical ball A of weight 100N is released from rest slides down the surface of a smooth bowl and strikes another spherical ball B of weight 25N resting at the bottom of bowl. Determine the height from which the ball A should be released so that after impact the ball B just leaves the bowl. The coefficient of restitution may have assumed to be 0.8. (10M)

![Diagram](image1.png)

The 50N block A has velocity 3m/s when it strikes 100N ball B. If coefficient of restitution is 0.8, find the position of block A, maximum and minimum tension in the string, refer fig. The coefficient of friction between the block and the surface is 0.2. (8M)

![Diagram](image2.png)

A sphere of weight 20N is released from rest and strikes a block of weight 25N resting on a horizontal surface. How far the block will move after impact? Also find the maximum angle through which the sphere swings after impact. Assume $e=0.75$ and the coefficient of friction between the block and the floor is 0.25. (7M)

![Diagram](image3.png)
Bullet 'A' of mass 0.01 kg moving with a velocity of 150 m/s hits a bob 'B' of a simple pendulum horizontally. Consider the mass of the bob as 1 kg and length of pendulum 1.50 m as shown in fig. (8b). Determine the maximum angle through which the pendulum swings when:

a) the bullet gets embedded into the bob.

b) the bullet rebounds from the surface of the bob with a velocity of 30 m/s.

c) the bullet escapes from the other end of the bob with a velocity of 30 m/s

Two blocks A and B, each of 1 kg mass and resting on a rough inclined plane are released from the position as shown in Fig. 11. The static friction between block A and surface of incline is 0.12, and that between block B and surface of incline is 0.3. Make calculations. Find the time at which impact would occur, and the velocity of blocks immediately after impact. Coefficient of restitution equal to 0.75.

Find the displacement of block A for fig. after 5 secs starting from rest. Take $\mu = 0.1$
A bullet of weight 20 gm moving horizontally with a velocity of 800 m/s strikes a block of wood of mass 5 kg through its centre. The block is suspended by a vertical wire from a point 2 m above its centre. To what angle, with the vertical, will the block and the embedded bullet will swing?

The spheres ‘A’ and ‘B’ as shown in fig. are attached to stiff rods of negligible weight. The sphere ‘A’ is released from rest and allowed to strike sphere ‘B’, kept in vertical position, if the coefficient of restitution \( e = 0.6 \). Determine the maximum angle \( \theta \) through which sphere ‘B’ will swing. What is minimum and maximum tension in the rod attached to sphere ‘B’? If the impact lasts for 0.01 second, find average impact force. Weight of ‘A’ = 45N and ‘B’ = 40N.
The balls A and B are attached to stiff rods of negligible weights. Ball ‘B’ is released from rest as shown in the fig and allowed to strike ball ‘A’. If $e=0.65$, determine the maximum angle ‘$\theta$’ through which the ball ‘A’ will swing. What is max and min. tension in the rod attached to the ball ‘A’? If the impact lasts for 0.01 seconds, also find the average impact force.

\begin{align*}
\text{MAX TENSION:} & \quad T_{\text{max}} = \frac{mgL(1-e^2)}{\cos \theta} \\
\text{MIN TENSION:} & \quad T_{\text{min}} = \frac{mgL(1+e^2)}{\cos \theta}
\end{align*}

\text{AVG I mpact Force:} \quad F_{\text{avg}} = \frac{mv^2}{t}

\text{(8M)}

\text{ALL THE BEST}