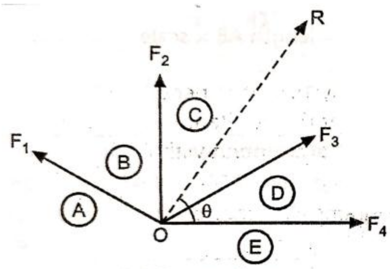
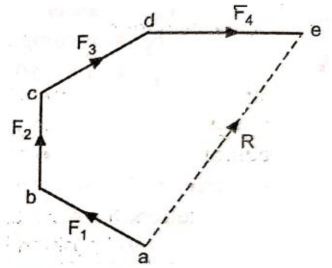
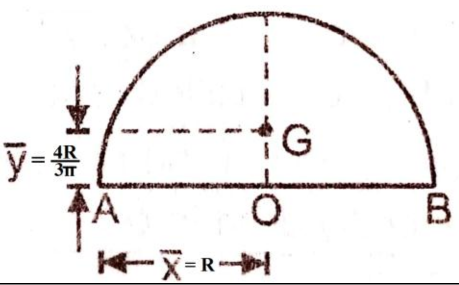
Model Answer: Winter - 2019

Subject: Applied Mechanics **Sub. Code: 22203**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills.)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by the candidate and those in the model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and the model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1		**Attempt any FIVE of the following:**		10
	a) Ans.	**Define Scalar and Vector quantity.** **Scalar Quantity:** A physical quantity having only magnitude but no direction is called as scalar quantity.	1	
		Vector Quantity: A physical quantity having both magnitude as well as direction is called as vector quantity.	1	2
	b) Ans.	**State VR of geared pulley block.** V.R. = $\frac{N_1}{N_2} \times \frac{N_3}{N_4}$	1	
		Where, N_1 = Number of cogs on effort wheel. N_2 = Number of teeth on pinion wheel. N_3 = Number of teeth on spur wheel. N_4 = Number of cogs on load wheel.	1	2
		OR V.R. = $\frac{D}{d} \times \frac{N_3}{N_2}$	1	
		Where, D = Diameter of effort wheel. D = Diameter of load wheel. N_2 = Number of teeth on pinion wheel. N_3 = Number of teeth on spur wheel.	1	2

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1	c) Ans.	**State Law of polygon of forces.** This law states that, "If number of coplanar concurrent forces acting simultaneously on a body, be represented in magnitude and direction by the sides of polygon taken in same order, then their resultant may be represented in magnitude and direction by the closing side of the polygon, taken in opposite order."  (a) Space diagram  (b) Vector diagram	1 1	2
	d) Ans.	**Define free body diagram.** When all active and reactive forces acting on the free body are shown and thus the diagram obtained is called as 'free body diagram'.	2	2
	e) Ans.	**State four laws of static friction.** 1. The frictional force is always acts tangential to the plane of contact and in the opposite direction of motion. 2. When the body is in limiting equilibrium, the ratio of limiting friction to normal reaction is constant. This ratio is called as 'coefficient of friction'. 3. The coefficient of friction depends upon the nature of surfaces in contact and is not dependent on surface areas in contact. 4. The static friction is more than dynamic friction. 5. Force of friction is a self-adjusting force and it increases as the applied force increases up to limiting friction.	½ each (any four)	2
	f) Ans.	**State the centroid of semi-circle and show it on the sketch.** Centroid of semi-circle : $\bar{X} = R$ $\bar{Y} = \frac{4R}{3\pi}$ (from base AB) 	½ ½ 1	2

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1	g) Ans.	**State two limitations of Lami's theorem.** 1. The theorem is applicable only if the body is in equilibrium. 2. The theorem is not applicable for parallel or non-concurrent force system. 3. The theorem is not applicable for more or less than three concurrent forces. 4. The theorem is not applicable for non-coplanar forces.	1 each (any two)	2

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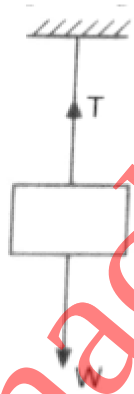
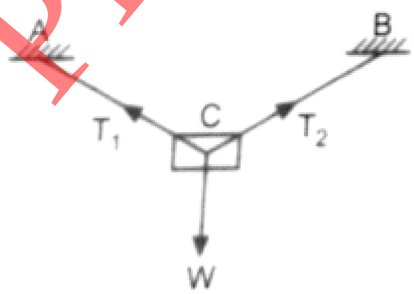
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2		**Attempt any <u>THREE</u> of the following:**		**12**
	a)	**Define force system. Explain three force systems with sketches.**		
	Ans.	When two or more forces acting on a body, they are said to form a system of forces or force system.	**1**	
		Force systems with sketches:		

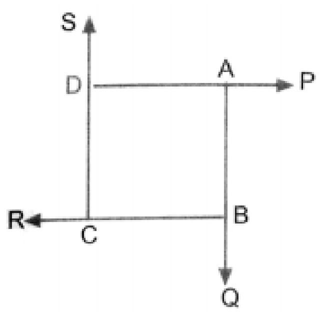
1. Coplanar Collinear force system: The force system in which forces lies on the same plane and act along the same line of action are known as Coplanar Collinear force system.

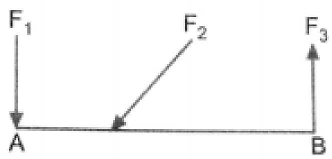


2. Coplanar Concurrent force system: The force system in which forces lies on the same plane and meet at a point are known as Coplanar Concurrent force system.



3. Coplanar Non-concurrent force system: The force system in which forces lies on the same plane but meet at different points are known as Coplanar Concurrent force system.

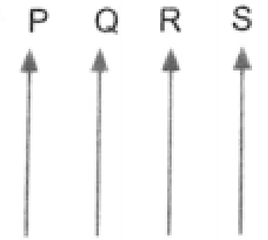




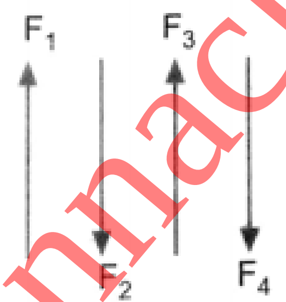
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2	a) Ans.			

4. Coplanar parallel force system:

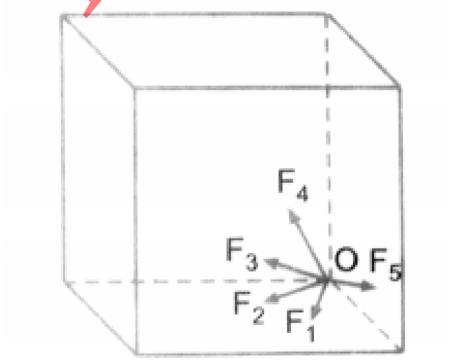
(i) Like parallel force system: The force system in which forces lies on the same plane and are parallel to each other acting in same direction are known as Coplanar Like parallel force system.

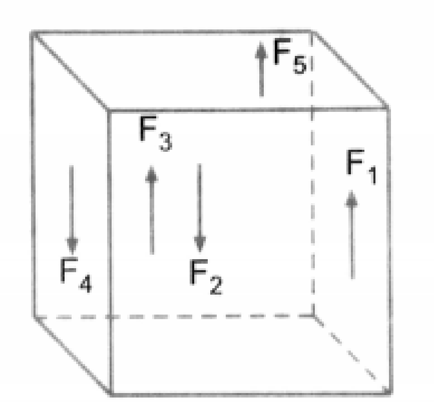
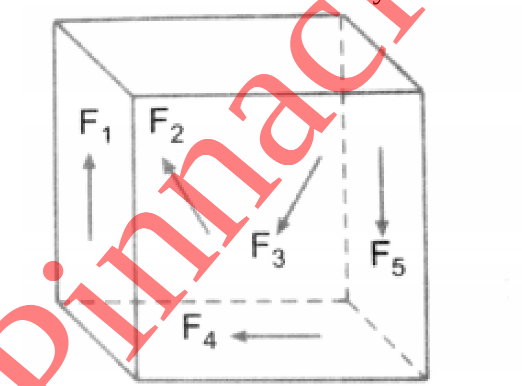


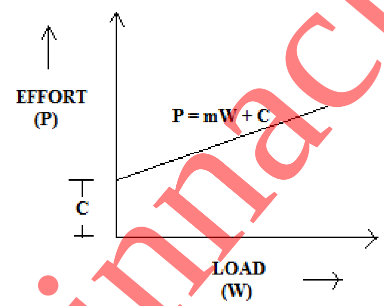
(ii) Unlike parallel force system: The force system in which forces lies on the same plane and are parallel to each other but acting in opposite direction are known as Coplanar Unlike parallel force system.

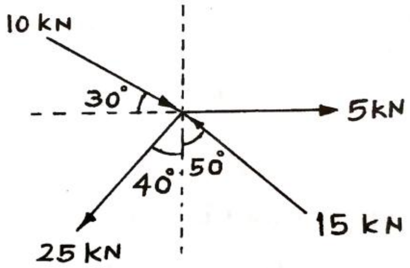
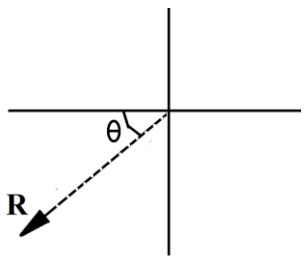


5. Non-coplanar concurrent force system: The force system in which forces lies in different planes but meet at a point are known as Non-coplanar Concurrent force system.



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2	a) Ans.	**6. Non-coplanar parallel force system:** The force system in which forces lies in different planes but are parallel to each other are known as Non-coplanar parallel force system.  **7. General force system:** The force system in which forces act in different planes and they do not possess one single point of concurrency are known as General force system.  *(Note: Definition 1 mark and any Three force system 1mark each).*	1 each (any three)	4
	b)	**For a certain machine, VR is 125. To lift a load of 11.90 kN, an effort of 190 N is required. Calculate the effort required to lift a load of 72 kN and identify the type of machine.**		
	Ans.	$MA = \frac{W}{P} = \frac{11.90\times10^3}{190} = \mathbf{62.63}$	1	
		$\eta = \frac{MA}{VR}\times100 = \frac{62.63}{125}\times100 = \mathbf{50.10\%}$	1	
		Since η of machine **is > 50%,** the machine is **reversible.**	1	
		Effort required to lift a load of 72 kN $\eta = \frac{MA}{VR}\times100 = \frac{W/P}{VR}\times100$		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2	b)	$50.10 = \dfrac{72\times10^3/P}{125}\times100$ **P = 1149.70 N**	1	4
	c)	**State law of machine and explain its significance.**		
	Ans.	**Law of machine:** The relation between the load lifted (W) and the effort applied (P) is known as the law of machine. This relationship, when plotted on a graph results in a straight line as shown below. The equation of this straight line is,	1	
		$P = (mW + C)\,N$	1	
		 	1	
		Where, m = Slope of line = constant c = Intercept on y axis = effort required to start the machine.		
		Significance of law of machine: With the help of law of machine one can find effort required to lift any given load and vice versa.	1	4
	d)	**State four laws of static friction.**		
	Ans.	1. The frictional force is always acts tangential to the plane of contact and in the opposite direction of motion. 2. When the body is in limiting equilibrium, the ratio of limiting friction to normal reaction is constant. This ratio is called as 'coefficient of friction'. 3. The coefficient of friction depends upon the nature of surfaces in contact and is not dependent on surface areas in contact. 4. The static friction is more than dynamic friction. 5. Force of friction is a self-adjusting force and it increases as the applied force increases up to limiting friction.	1 each (any four)	4

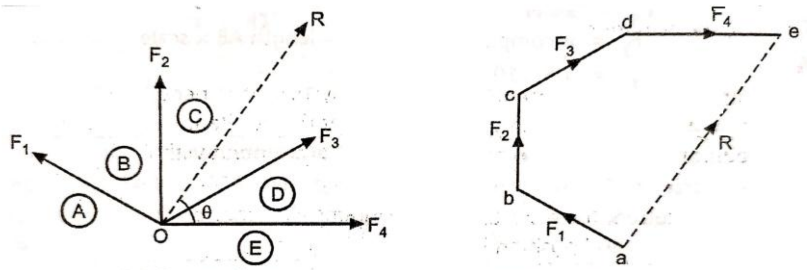
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 3		**Attempt any <u>THREE</u> of the following:**		**12**
	a)	**Calculate the magnitude and direction of resultant for the concurrent force system as shown in figure No. 1. Show it on the sketch. Use analytical method only.**  **<u>Fig. No. 1</u>**		
	Ans.	1) Resolving all forces ΣFx = +(10cos30°) – (25cos50°) – (15cos40°) + 5 **= - 13.90 kN.** ΣFy = -(10sin30°) – (25sin50°) + (15sin40°) **= - 14.51 kN.**	**1**	
		2) Magnitude of Resultant $R=\sqrt{(\Sigma Fx)^2+(\Sigma Fy)^2}=\sqrt{(-13.90)^2+(-14.51)^2}$ **R = 20.09 kN.**	**1**	
		3) Direction of Resultant $\theta=\tan^{-1}\left\|\frac{\Sigma Fy}{\Sigma Fx}\right\|=\tan^{-1}\left\|\frac{14.51}{13.90}\right\|$ **θ = 46.23°**	**1**	
		4) Position of Resultant Since ∑ Fx is –ve and ∑ Fy is -ve, Resultant lies in **Third quadrant.** 	**1**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks

Q. 3 **b)**

State law of polygon of forces and explain it with sketch.

Ans. This law states that, "If number of coplanar concurrent forces acting simultaneously on a body, be represented in magnitude and direction by the sides of polygon taken in same order, then their resultant may be represented in magnitude and direction by the closing side of the polygon, taken in opposite order." **1**



(a) Space diagram (b) Vector diagram

1

Consider four forces F1 = AB, F2 = BC, F3 = CD, and F4 = DE acting at a point 'O' as shown in space diagram. Label all the forces by Bow's notation.

Considering suitable scale for vector diagram and find vector length for different forces.

Draw vector ab // AB, bc // BC, cd // CD, and de // DE as shown in the vector diagram to represent the forces F1, F2, F3, and F4 respectively. abcde is an open polygon. Join the first point 'a' and last point 'e'. The closing side 'ae' of the polygon represents the resultant of all the forces in magnitude and direction. In space diagram, through 'O' draw line parallel to 'ae' to locate the position of the resultant. Measure angle 'θ', which gives the direction of resultant with the horizontal. **2** **4**

c)

In a worm and worm wheel, the number of teeth on the worm wheel is 120. The diameter of effort wheel is 100mm and that of loading drum is 150mm. This worm and worm wheel lifts a load of 2.5 kN by applying 100 N effort. Calculate efficiency and effort lost in friction.

Ans.

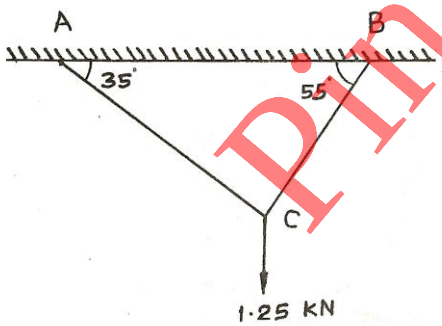
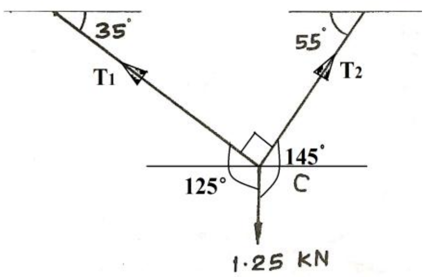
Number of teeth on worm wheel (T) = 120.

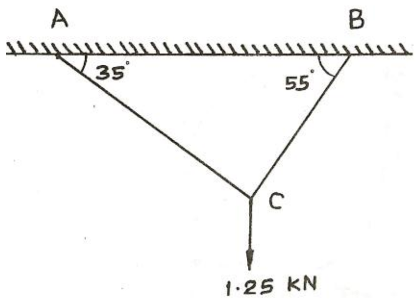
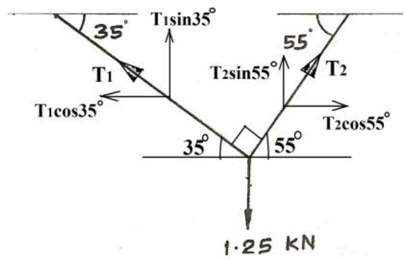
Radius of effort wheel (R) = $\frac{D}{2} = \frac{100}{2} = 50\,\text{mm}$

Radius of load drum (r) = $\frac{d}{2} = \frac{150}{2} = 75\,\text{mm}$

1) Efficiency of worm and worm wheel

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 3	c)	Mechanical Advantage (MA) = $\frac{W}{P}=\frac{2.5\times10^{3}}{100}$ **= 25**	1	
		Velocity Ratio (VR) = $\frac{RT}{r}=\frac{50\times120}{75}$ **= 80**	1	
		η = $\frac{MA}{VR}\times100=\frac{25}{80}\times100$ **= 31.25%**	1	
		2) Effort lost in friction $P_f = P - P_i$ $= P - \frac{W}{VR}=100-\frac{2.5\times10^{3}}{80}$ **P_f = 68.75 N**	1	4
	d)	**A machine lifts a load of 19kN and 29kN by efforts of 700N and 900N respectively. Calculate the law of machine and efficiency of a load of 50kN if VR is 50.**		
	Ans.	1) Law of machine Law of machine is $P=mW+C$ 700 = m(19000) + C ……………………(i) 900 = m(29000) + C …………………… (ii) Subtracting equation (1) from (2) **m = 0.02**	½	
		Putting value of m in equation (1), 700 = (0.02 x 19000) + C **C = 320 N**	½	
		Hence, law of machine is**, P = (0.02)W + 320 N**	1	
		2) Efficiency at load of 50kN P = 0.02 x 50000 + 320 **= 1320 N**	1	
		$\eta=\frac{MA}{VR}\times100=\frac{W/P}{VR}\times100$ $=\frac{50000/1320}{50}\times100$ **= 75.76%**	1	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4		**Attempt any THREE of the following:**		12
	a)	**Calculate the resultant of two concurrent forces of magnitudes of 25 kN and 50 kN with included angle of 55°.**		
	Ans.	**1)** Magnitude of Resultant		
		R = $\sqrt{P^2+Q^2+2PQ\times\cos\theta}$	1	
		$=\sqrt{25^2+50^2+2\times25\times50\times\cos55°}$		
		$=\sqrt{625+2500+1433.94}$		
		R = 67.52 kN	1	
		2) Direction of Resultant		
		$\alpha=\tan^{-1}\left(\dfrac{Q\sin\theta}{P+Q\cos\theta}\right)=\tan^{-1}\left(\dfrac{50\sin55°}{25+50\cos55°}\right)$	1	
		α = 37.34°	1	4
		(Note: Considering the forces P and Q of same nature).		
	b)	**A weight of 1.25 kN is attached by two ropes as shown in figure No.2. Calculate the tension in the ropes.**		
		**Fig. No. 2** **F.B.D.**		
	Ans.		1	
		Applying Lami's Theorem at 'C'		
		$\dfrac{T_1}{\sin145°}=\dfrac{T_2}{\sin125°}=\dfrac{1.25}{\sin90°}$	1	
		$T_1=\sin145°\text{x}\dfrac{1.25}{\sin90°}=$ **0.717 kN**	1	
		$T_2=\sin125°\text{x}\dfrac{1.25}{\sin90°}=$ **1.024 kN**	1	4
		OR		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4	b)	 Fig. No. 2  F.B.D.	1	
		Using the conditions of equilibrium for concurrent force system and resolving all forces: $\Sigma Fx = 0$ $T_2 \cos 55° - T_1 \cos 35° = 0$ $0.57\ T_2 – 0.82 T_1 = 0$ ………………. (i)	1	
		$\Sigma Fy = 0$ $T_2 \sin 55° + T_1 \sin 35° - 1.25 = 0$ $0.82\ T_2 + 0.57 T_1 – 1.25 = 0$ ………………. (ii)	1	
		Solving equation (i) and (ii) simultaneously T_1 = **0.717 kN** T_2 = **1.024 kN**	1	4

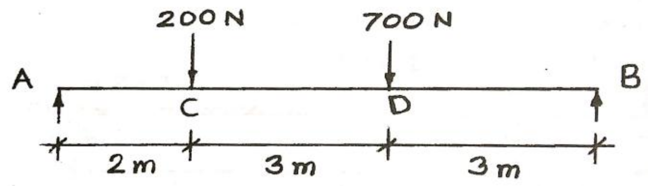
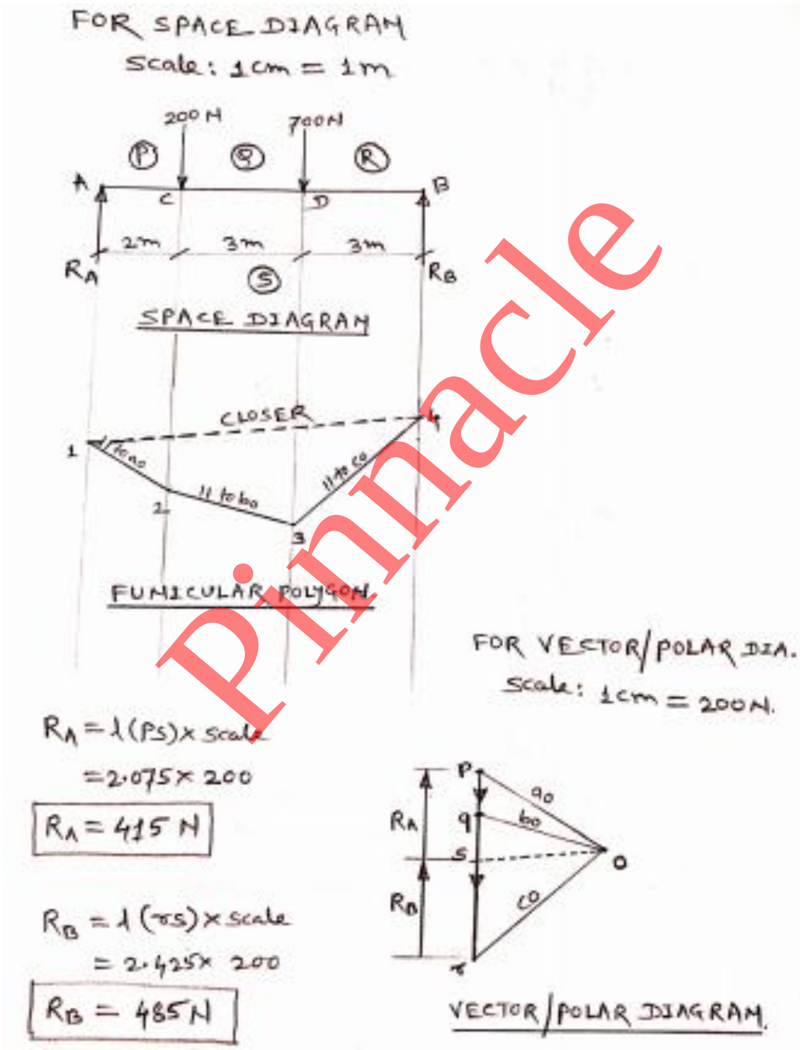
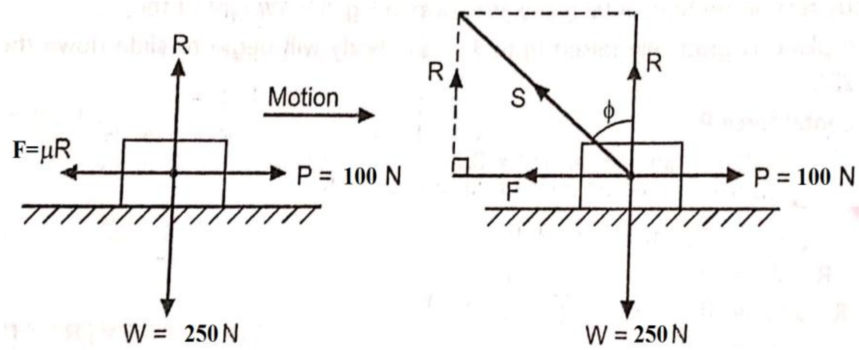
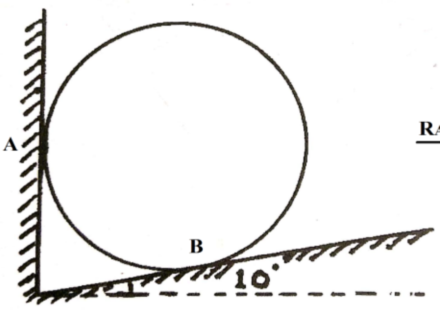
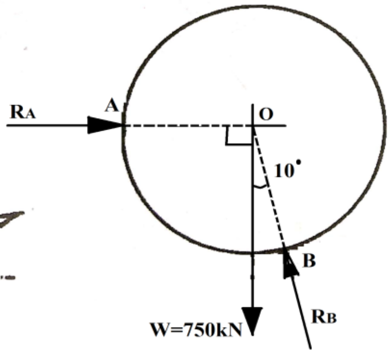
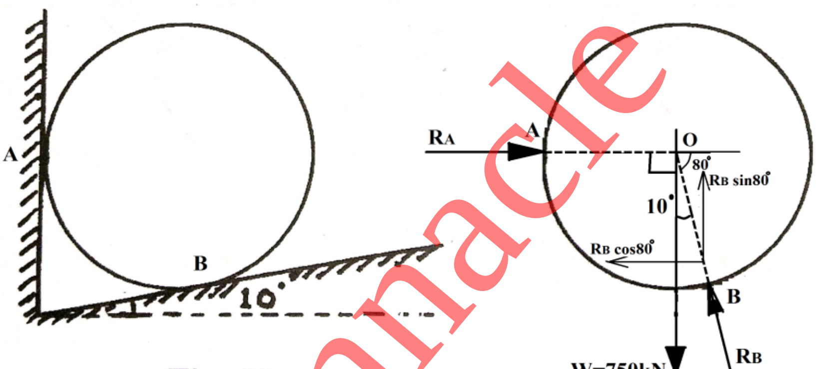
<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td></td><td>c)</td><td>A beam is loaded as shown in figure No. 3. Calculate its support reactions using graphical method only.


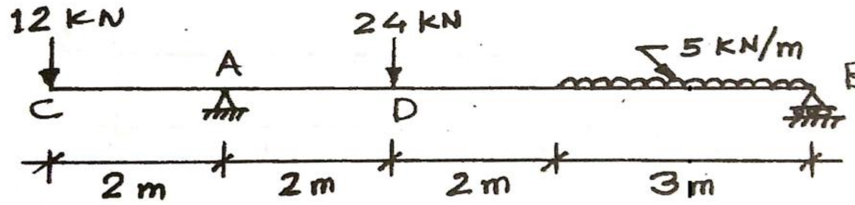
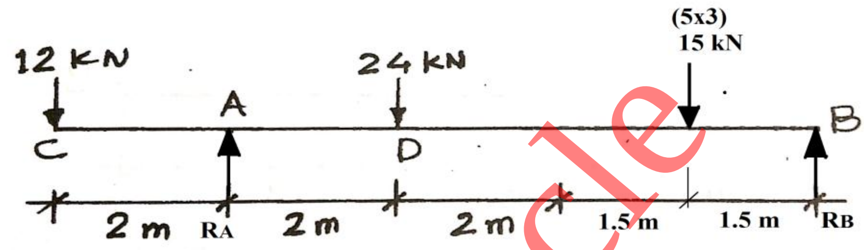
Fig. No. 3</td><td></td><td></td></tr>
<tr><td></td><td>Ans.</td><td>

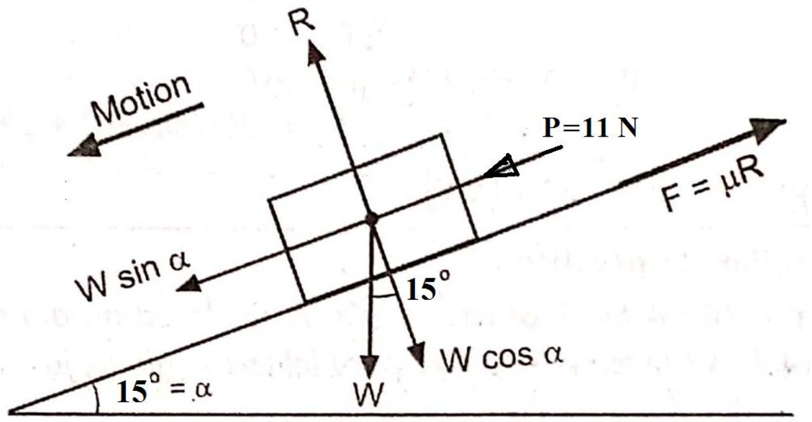
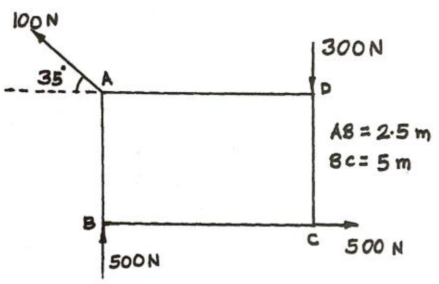
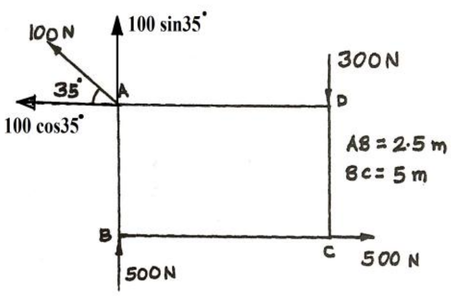
(Note: Answer may vary by ± 2 N)</td><td>1
1
1
1</td><td>4</td></tr>
<tr><td></td><td>d)

Ans.</td><td>A body weighing 250N is resting on a rough horizontal plane and is just moved by a horizontal force of 100 N. Calculate coefficient of friction. Also calculate magnitude and direction of the resultant reaction.
For limiting equilibrium
$\Sigma Fx = 0$
$100 - F = 0$</td><td></td><td></td></tr>
</table>

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4	d)			
		F = 100 N ………… (i)	½	
		$\Sigma Fy = 0$		
		R – W = 0		
		R – 250 = 0		
		R = 250 N ……….. (ii)	½	
		F = 100		
		μ x R = 100		
		μ x 250 = 100		
		μ = 0.4	1	
		Resultant reaction		
		$S = \sqrt{R^2 + F^2} = \sqrt{250^2 + 100^2}$ = **269.26 N**	1	
		Direction of resultant reaction		
		$\phi = \tan^{-1}(\mu)$		
		$= \tan^{-1}(0.4)$		
		= 21.80°	1	4
	e)	**A sphere having diameter 350mm and 750 kN as weight is placed as shown in figure No. 4. Calculate the reaction at point of contacts.**		
	Ans.	 Fig. No. 4  F.B.D.	1	

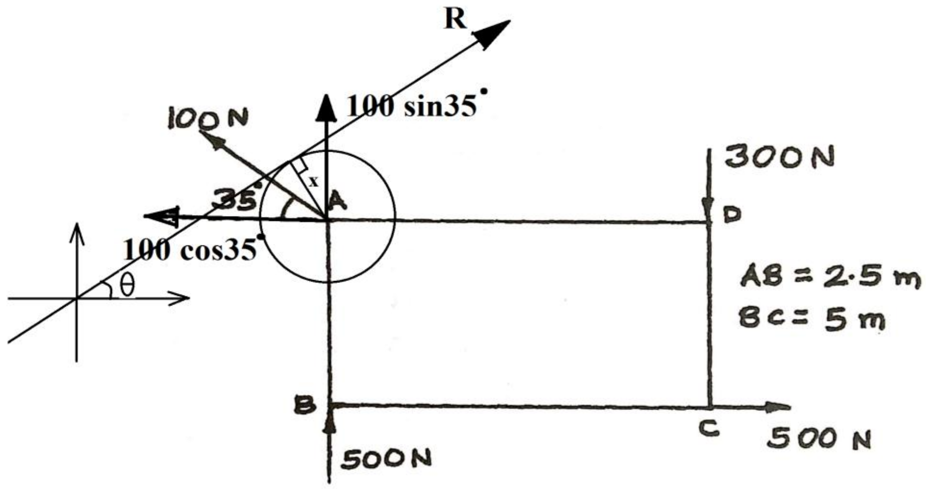
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4	e)	Applying Lami's theorem at 'O'		
		$$\frac{R_A}{\sin 10^\circ} = \frac{R_B}{\sin 90^\circ} = \frac{750}{\sin 100^\circ}$$	1	
		$R_A = \sin 10^\circ \times \dfrac{750}{\sin 100^\circ}$ = **132.25 kN**	1	
		$R_B = \sin 90^\circ \times \dfrac{750}{\sin 100^\circ}$ = **761.57 kN**	1	4
		OR		
		 Fig. No. 4 F.B.D.	1	
		Using the conditions of equilibrium for concurrent force system and resolving all forces –		
		$\Sigma Fx = 0$ $R_A - R_B \cos 80^\circ = 0$ $R_A - 0.174\, R_B = 0$ ………………. (i)	1	
		$\Sigma Fy = 0$ $R_B \sin 80^\circ - 750 = 0$ $\mathbf{R_B = 761.57\ kN}$	1	
		Put this value in equation no.(i)		
		$R_A - 0.174 \times 761.57 = 0$ $\mathbf{R_A = 132.51\ kN}$	1	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 5		**Attempt any <u>TWO</u> of the following:**		12
	a)	**Calculate the support reactions of beam loaded as shown in figure No.5. Use analytical method only.**		
	Ans.	 Fig. No. 5		
			1	
		1) Equivalent point load and it's position Equivalent point load = Intensity of udl x span of udl = 5 x 3 = 15 kN Position from equivalent point load from R_A = 2 m + 2 m+ Span of udl / 2 = 4 + (3/2) = 5.5 m	1	
		2) Applying equilibrium conditions $\Sigma M_A = 0$ (↻+ve , ↺−ve) and $\Sigma F_y = 0$ (↑+ve , ↓−ve)		
		$\Sigma M_A = 0$ Taking moment of all forces @ point A	1	
		$-(12 \times 2) + (R_A \times 0) + (24 \times 2) + (15 \times 5.5) - (R_B \times 7) = 0$	1	
		R_B = 15.214 kN	1	
		$\Sigma F_y = 0$ $R_A - 12 - 24 - 15 + R_B = 0$ $R_A - 51 + 15.214 = = 0$ **R_A = 35.786 kN**	1	6
	b)	**A block is resting on a rough inclined plane whose inclination to the horizontal is 15°. A force of 11 N is applied parallel to the plane on which block is resting will just move it down. If the coefficient of friction between the block and the plane is 0.40, estimate the weight of the block.**		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 5	b) Ans.		2	
		For limiting equilibrium $\Sigma Fy = 0$ $R - W\cos\alpha = 0$ $R = W\cos 15°$ $R = 0.966W$ …………… (i)	1	
		$\Sigma Fx = 0$ $F - P - W\sin\alpha = 0$	1	
		$\mu R - P – W\sin 15° = 0$ $(0.40 \times 0.966W) - 11 – 0.259W = 0$ $0.3864W - 11 – 0.259W = 0$ ………… (ii)	1	
		W = 86.34 N	1	6
	c)	**Calculate the magnitude and direction of a resultant force for a force system as shown in figure No. 6. Locate it with respect to point A.**		
	Ans.	 Fig. No. 6 		

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>Q. 5</td><td>c)</td><td>
Resolution of Forces
ΣFx = - (100cos35°) + 500 = **+ 418.08 N**
ΣFy = + (100sin35°) + 500 – 300 = **+ 257.36 N**

Magnitude of resultant
$R = \sqrt{(\Sigma Fx)^2 + (\Sigma Fy)^2} = \sqrt{(418.08)^2 + (257.36)^2}$
R = 490.94 N.

Direction of Resultant
$\theta = \tan^{-1}\left|\frac{\Sigma Fy}{\Sigma Fx}\right| = \tan^{-1}\left|\frac{257.36}{418.08}\right|$
θ = 31.62° with the positive X-axis in First quadrant.
Position of Resultant (from A)
According to the Varignon's theorem
ΣMFA = MRA
Let resultant lies at ' x ' perpendicular distance from point 'A'
+(300 x 5) – (500 x 2.5) = R x x
250 = 490.94 x
x **= 0.51 m**
As the value of **ΣMFA is +ve,** therefore resultant should produce 'clockwise moment' about 'A' point at a perpendicular distance of x = 0.51 m as shown in figure below.


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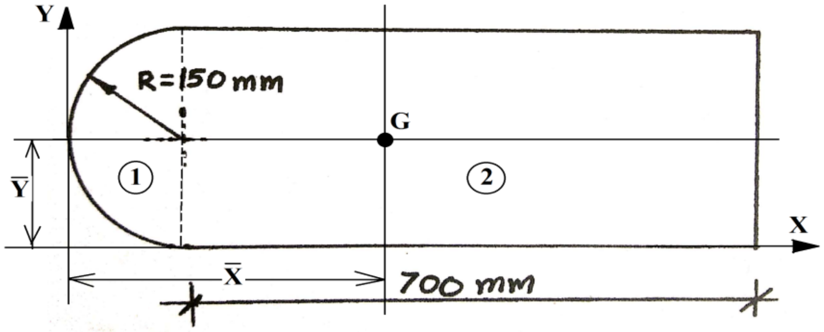
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		**Attempt any TWO of the following:**		12
	a)	**Locate the centroid of a lamina as shown in Figure No.7.**		
	Ans.	 **Fig. No. 7**	1	
		(1) Area calculation		
		a_1 = Area of semi-circle		
		$= \frac{\pi R^2}{2} = \frac{\pi \times 150^2}{2} =$ **35.34 x 10^3 mm^2**	1	
		a_2 = Area of rectangle		
		= (b x d) = (700 x 300) = **210 x 10^3 mm^2**		
		A = a_1 + a_2 = (35.34 x 10^3) + (210 x 10^3) = **245.34 x 10^3 mm^2**	1	
		(2) $\overline{X}$ calculation		
		x_1 = R - $\frac{4R}{3\pi} = 150 - \frac{4 \times 150}{3\pi} =$ **86.34 mm**		
		$x_2 = \frac{b}{2} + R = \frac{700}{2} + 150 =$ **500 mm**	1	
		$\overline{X} = \frac{a_1x_1 + a_2x_2}{A} = \frac{(35.34 \times 10^3 \times 86.34) + (210 \times 10^3 \times 500)}{245.34 \times 10^3}$		
		$\overline{X}$ = **440.41 mm**	1	
		(3) $\overline{Y}$ calculation		
		As the given composite section symmetric about x-x axis, therefore C.G. lies on the axis of symmetry.		
		$\overline{Y} = \frac{d}{2} = \frac{300}{2} =$ **150 mm**	1	6

Model Answer: Winter - 2019

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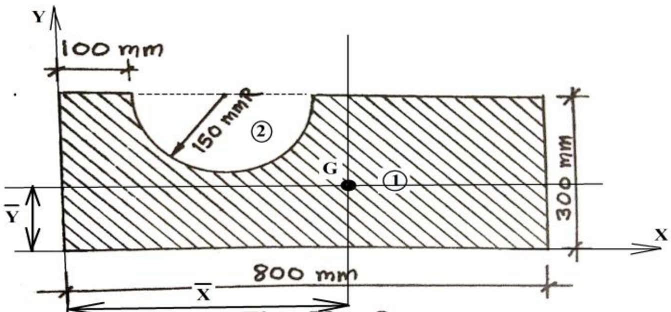
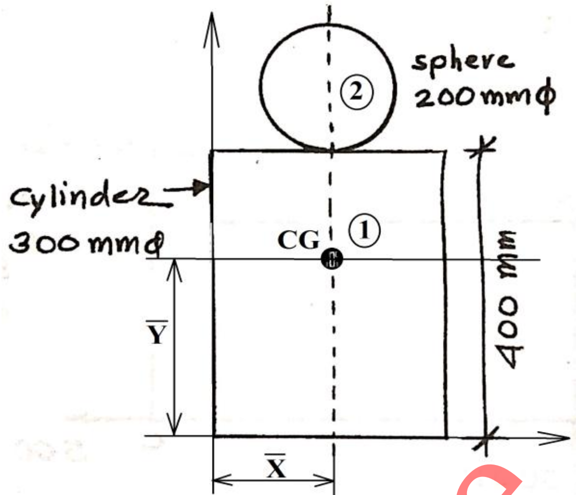
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6	b) Ans.	**Locate the centroid of a shaded portion of a lamina as shown in Figure No.8.**  **Fig. No. 8**	1	
		Let, Fig. 1 – Rectangle AND Fig. 2 – Semicircle 1) Area Calculation a_1 = Area of rectangle $= (b \times d) = (800 \times 300) = \mathbf{240 \times 10^3\ mm^2}$ a_2 = Area of semi-circle $= \frac{\pi R^2}{2} = \frac{\pi \times 150^2}{2} = \mathbf{35.34 \times 10^3\ mm^2}$ $A = a_1 - a_2 = (240 \times 10^3) - (35.34 \times 10^3) = \mathbf{204.66 \times 10^3\ mm^2}$	1	
		2) $\overline{X}$ calculation $x_1 = \frac{b}{2} = \frac{800}{2} = 400mm$ $x_2 = 100 + R = 100 + 150 = \mathbf{250\ mm}$	1	
		$\overline{X} = \frac{a_1 x_1 - a_2 x_2}{A} = \frac{(240 \times 10^3 \times 400) - (35.34 \times 10^3 \times 250)}{204.66 \times 10^3}$ $\overline{X}$ **= 425.90 mm**	1	
		(3) $\overline{Y}$ calculation $y_1 = \frac{d}{2} = \frac{300}{2} = 150mm$ $y_2 = 300 - \frac{4R}{3\pi} = 300 - \frac{4 \times 150}{3\pi} = 236.34$ mm	1	
		$\overline{Y} = \frac{a_1 y_1 - a_2 y_2}{A} = \frac{(240 \times 10^3 \times 150) - (35.34 \times 10^3 \times 236.34)}{204.66 \times 10^3}$ $\overline{Y}$ **= 135.09 mm**	1	6

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6	c)	**Locate the center of gravity for the solid as shown in Figure No. 9.**		
	Ans.	 **Fig. No. 9**	1	
		Let, Fig. 1 = Cylinder and Fig. 2 = Sphere. 1) Volume calculations V_1 = Volume of Cylinder $= \pi R^2 h = \pi (150)^2 \times 400$ $= \mathbf{28.274 \times 10^6\ mm^3}$	1	
		V_2 = Volume of Sphere $= \frac{4}{3}\pi R^3 = \frac{4}{3}\pi (100)^3 = \mathbf{4.188 \times 10^6\ mm^3}$	1	
		$V = V_1 + V_2 = 28.274 \times 10^6 + 4.188 \times 10^6 = \mathbf{32.462 \times 10^6\ mm^3}$ 2) $\bar{X}$ calculation As the given composite solid is symmetric about Y-Y axis, CG lies on the axis of symmetry. $\bar{X} = \frac{D}{2} = \frac{300}{2} = \mathbf{150\ mm}$	1	
		(3) $\bar{Y}$ calculation $y_1 = \frac{h}{2} = \frac{400}{2} = 200 mm$ y_2 = 400 + radius of sphere = 400 + 100 = **500 mm**	1	
		$\bar{Y} = \frac{V_1 y_1 + V_2 y_2}{V} = \frac{(28.274 \times 10^6 \times 200) + (4.188 \times 10^6 \times 500)}{32.462 \times 10^6}$ $\bar{Y}$ = **238.703 mm**	1	6