Model Answer: Winter - 2018

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

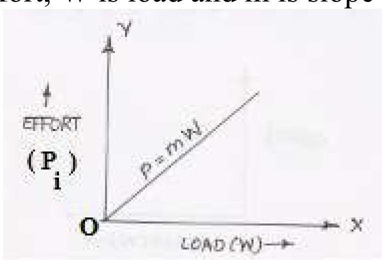
Important Instructions to examiners:

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.	**State characteristics of force.** i) Magnitude: The quantity of force e.g. 10 N, 100 kN etc. ii) Direction: It is the line along which the force acts. It is also called as line of action of the force. iii) Point of application: The point at which the force acts on the body. iv) Sense or Nature: ➢ Pull: If the arrow head is pointed away from the point of application, the nature of the force is pull. ➢ Push: If the arrow head is pointed towards the point of application, the nature of the force is push.	½ each	2
	b) Ans.	**Define Mechanical Advantage and Velocity Ratio.** **Mechanical Advantage:** It is the ratio of the load (W) lifted by the machine to the effort (P) applied to lift the load. $M.A. = \frac{W}{P}$ **Velocity Ratio**: It is the ratio of distance travelled by effort (y) to distance travelled by load (x). $V.R. = \frac{y}{x}$	1 1	2
	c) Ans.	**State law of Parallelogram of force.** **Law of Parallelogram of force:** It states that "if two forces acting at and away from point be represented in magnitude direction by the two adjacent sides of parallelogram, then the diagonal of the parallelogram passing through the point of intersection of the two forces represents the resultant in magnitude direction".	2	2

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1	d)	**State analytical conditions of equilibrium of concurrent force system.**		
	Ans.	1) $\Sigma Fx = 0$ i. e. Algebraic sum of all the forces along X-axis must be equal to zero.	1	2
		2) $\Sigma Fy = 0$ i. e. Algebraic sum of all the forces along Y-axis must be equal to zero.	1	
	e)	**Define coefficient of friction and angle of repose.**		
	Ans.	**Coefficient of friction:** It is the ratio of limiting friction (F) to the normal reaction (R) at the surface of contact. $F \alpha R$ $F = \mu R$ $\mu = \frac{F}{R}$	1	2
		Angle of repose: It is defined as the angle made by the inclined plane with the horizontal plane at which the body placed on an inclined plane is just on the point of moving down the plane, under the action of its own weight.	1	
	f)	**Define centroid and centre of gravity.**		
	Ans.	**Centroid:** It is defined as the point through which the entire area of a plane figure is assumed to act, for all positions of the lamina. e. g. Triangle, Square.	1	2
		Centre of Gravity: It is defined as the point through which the whole weight of the body is assumed to act, irrespective of the position of a body. e.g. Cone, Cylinder.	1	
	g)	**Write relation between resultant and equilibrant.**		
	Ans.	Equilibrant is always equal in magnitude, opposite in direction and collinear to the resultant.	2	2

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2		**Attempt any <u>THREE</u> of the following :**		12
	a)	**Define force and state its effects.**		
	Ans.	**Force:** It is an external agency either push or pull which changes or tends to change the state of rest or of uniform motion of a body, upon which it acts.	2	
		Effects of force : i) It may change the state of a body i.e. the state of rest or state of motion. ii) It may accelerate or retard the motion of a body. iii) It may turn or rotate the body on which it acts. iv) It may deform the body on which it acts.	1 each (any two)	4
	b)	**The law of certain machine is P = W/50 + 8 N and VR 100. Find the maximum possible M.A. and maximum possible efficiency in %. While lifting a load of 600 N, what will be the efficiency?**		
	Ans.	$P=\frac{W}{50}+8\,N,\ VR=100,\ W=600N$ $Max.M.A.=?,\ \ Max\,\eta=?$		
		$Max.M.A.=\frac{1}{m}=\frac{1}{\left(\frac{1}{50}\right)}=50$ $\boxed{Max.M.A.=50}$	1	
		$Max\,\eta=\frac{Max.\ M.A.}{VR}\times100=\frac{50}{100}\times100=50\%$ $\boxed{Max\,\eta=50\%}$	1	4
		Using relation, $P=\frac{W}{50}+8\,N=\frac{600}{50}+8=20N$	1	
		$\%\eta=\frac{M.A.}{V.R.}\times100=\frac{\left(\frac{W}{P}\right)}{V.R.}\times100=\frac{\left(\frac{600}{20}\right)}{100}\times100$ $\boxed{\%\eta=30\%}$	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2	c)	**Define ideal machine and state law of machine for it with help of sketch.**		
	Ans.	**Ideal Machine:** It is the machine whose efficiency is 100 %. i.e. output is equal to input. This machine is absolutely free from frictional loss. i.e. frictional loss is zero.	2	4
		Law of machine for ideal machine: The relation between the load lifted (W) and the effort applied (Pi) is known as law of ideal machine. P = mW Where, P_i is ideal effort, W is load and m is slope of line.	1	
			1	
	d)	**Write two advantages and two disadvantages of friction.**		
	Ans.	**Advantages of friction:** 1) One can walk easily on rough surface than smooth surface. 2) Moving vehicle on road can be stopped suddenly by applying brakes. 3) One can hammer nail into wall. 4) One can easily hold pen, pencil and can write on paper.	1 each (any two)	4
		Disadvantages of friction: 1) Energy is lost due to friction. 2) It causes wear and tear in machine parts. 3) More effort is required to lift any load on a machine. 4) There is more consumption of fuel due to friction. ***(Note: Any other appropriate advantages and disadvantages should be considered)***	1 each (any two)	

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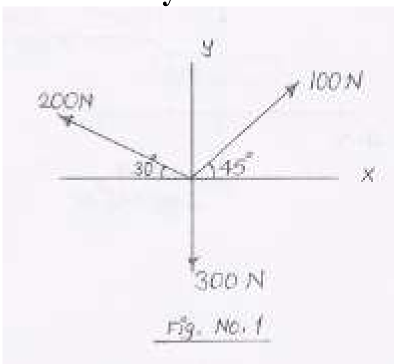
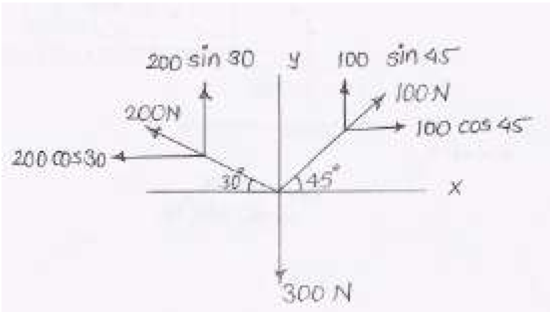
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 3		**Attempt any THREE of the following :**		12
	a)	**Calculate resultant of a force system as shown in Figure No. 1.**		



Ans.



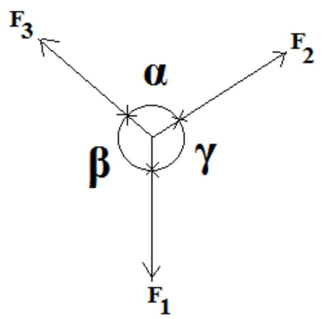
Model Answers	Marks	Total Marks
Resolving all forces		
$\sum F_x = +(100 \times \cos 45) - (200 \times \cos 30) = -102.494$ N	1	
$\sum F_y = +(100 \times \sin 45) + (200 \times \sin 30) - (300) = -129.289$ N	1	4
$R = \sqrt{\left(\sum F_x\right)^2 + \left(\sum F_y\right)^2} = \sqrt{(102.494)^2 + (129.289)^2}$	1	
$\boxed{R = 164.986 N}$	1	

b) State and explain Lami's theorem with sketch.

Ans. Lami's theorem states that, if three forces acting at a point on a body keep it at rest, then each force is proportional to the sin of the angle between the other two forces. (2)

Total Marks: 4

Here,
F_1, F_2, F_3 = Three concurrent forces
α = Angle made by force F_2, F_3
β = Angle made by force F_1, F_3
γ = Angle made by force F_1, F_2

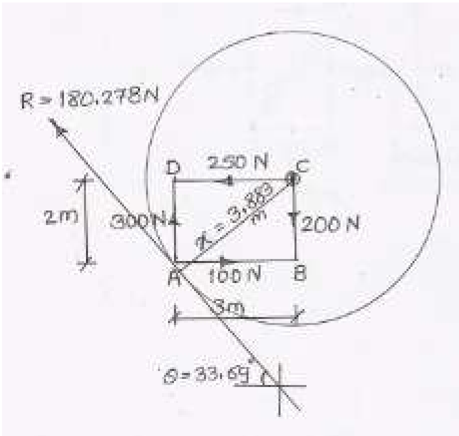


(2)

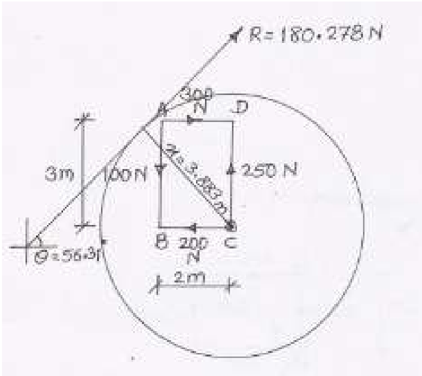
As per Lami's Theorem

$$\frac{F_1}{\sin\alpha} = \frac{F_2}{\sin\beta} = \frac{F_3}{\sin\gamma}$$

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 3	c)	**A screw jack having 5 mm pitch and has 300 mm as diameter of effort wheel is used to lift a load of 80 kN. Find V.R. and effort required if efficiency of machine is 40%.**		
	Ans.	$p=5\,mm, D=300\,mm, W=80\,kN=80\times10^3\,N, \%\eta=40\%,$		
		V.R.=?, P=?		
		$V.R.=\frac{\pi\times D}{p}=\frac{\pi\times300}{5}$	1	
		$\boxed{V.R.=188.496}$	1	
		$\%\eta=\frac{M.A.}{V.R.}\times100$	1	
		$40=\frac{M.A.}{188.496}\times100$		4
		$M.A.=75.398$		
		But $M.A.=\frac{W}{P}$		
		$75.398=\frac{80\times10^3}{P}$	1	
		$\boxed{P=1061.036\,N}$ OR $\boxed{P=1.061\,kN}$		
	d)	**In a machine load of 500 N was lifted by an effort 50 N. Another load of 750 N was lifted by an effort of 60 N. Obtain law of machine.**		
	Ans.	$W_1=500\,N,\ P_1=50\,N, W_2=750\,N,\ P_2=60\,N,$		
		Law of machine =?		
		Using eqation, $P=mW+C$		
		In above equation putting values of load and effort,		
		$50=m(500)+C$ ----(1)	1	
		$60=m(750)+C$ ----(2)		
		Solving equation (1) and (2),	1	
		$m=0.04$		
		Using equation (1) and putting value of m		4
		$50=m(500)+C$		
		$50=0.04\times(500)+C$		
		$C=30\,N$	1	
		$\boxed{\text{Law of machine}=P=(0.04)\,W+30\ \ N}$	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4		**Attempt any THREE of the following :**		12
	a)	**ABCD is a rectangle such that AB = 3 m and BC = 2 m. Along side AB, CB, CD and AD, the forces of 100 N, 200 N, 250 N, 300 N are acting respectively. Find magnitude, direction and position of the resultant force from C. Use analytical method only.**		
	Ans.	***(Note: Exact position of point C is not mentioned, any other position of point C should be considered)***		
				
		$\sum F_x = +100 - 250 = -150\ N$	1	
		$\sum F_y = -200 + 300 = +100\ N$		
		$R = \sqrt{\left(\sum F_x\right)^2 + \left(\sum F_y\right)^2} = \sqrt{(150)^2 + (100)^2}$		
		$\boxed{R = 180.278\ N}$	1	
		As $\sum F_x = -ve$ and $\sum F_y = +ve$		
		$\boxed{R \text{ lies in } 2^{nd} \text{ quadrant}}$		4
		$\theta = \tan^{-1}\left\lvert \frac{\sum F_y}{\sum F_x} \right\rvert = \tan^{-1}\left\lvert \frac{100}{150} \right\rvert$		
		$\boxed{\theta = 33.690°}$	1	
		Taking moment of all forces @ point C		
		$\sum M_C = -(100 \times 2) + (300 \times 3) = +700\ Nm$		
		Let x be the perpendicular distance between R and C.		
		Using Varignon's theorem of moment		
		$\sum M_C = R \times x$		
		$700 = 180.278 \times x$		
		$\boxed{x = 3.883\ m \text{ from point C.}}$	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4		**OR**		



$\sum F_x = +300 - 200 = +100\,N$ — **1**

$\sum F_y = +250 - 100 = +150\,N$

$R=\sqrt{\left(\sum F_x\right)^2+\left(\sum F_y\right)^2}=\sqrt{(100)^2+(150)^2}$ — **1**

$\boxed{R=180.278\,N}$

As $\sum F_x = +ve$ and $\sum F_y = +ve$

$\boxed{R \text{ lies in } 1^{st} \text{ quadrant}}$

$\theta=\tan^{-1}\left|\frac{\sum F_y}{\sum F_x}\right|=\tan^{-1}\left|\frac{150}{100}\right|$ — **1** (Total Marks: **4**)

$\boxed{\theta=56.310°}$

Taking moment of all forces @ point C

$\sum M_C = -(100\times2)+(300\times3)=+700\,Nm$

Let x be the perpendicular distance between R and C.

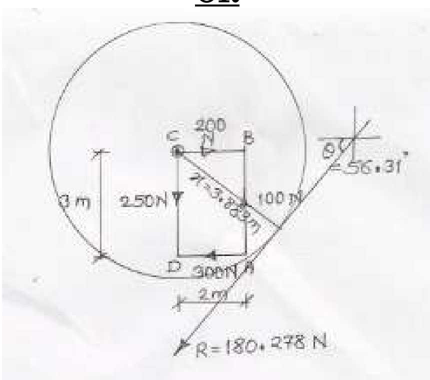
Using Varignon's theorem of moment

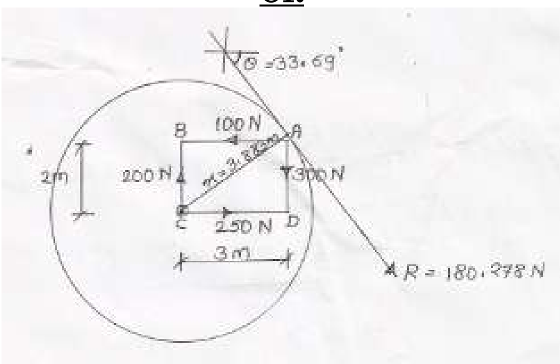
$\sum M_C = R\times x$

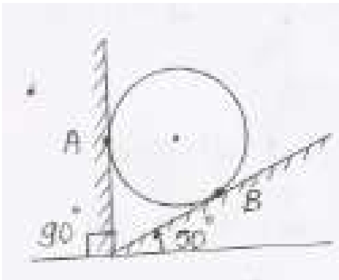
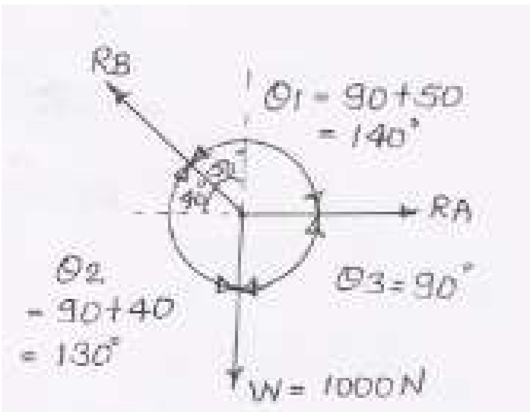
$700 = 180.278 \times x$

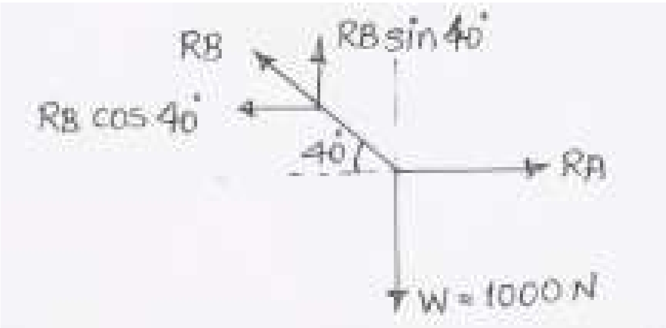
$\boxed{x = 3.883\ m \text{ from point C.}}$ — **1**

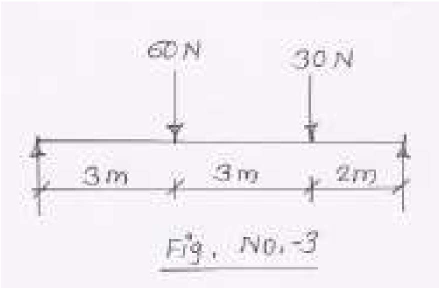
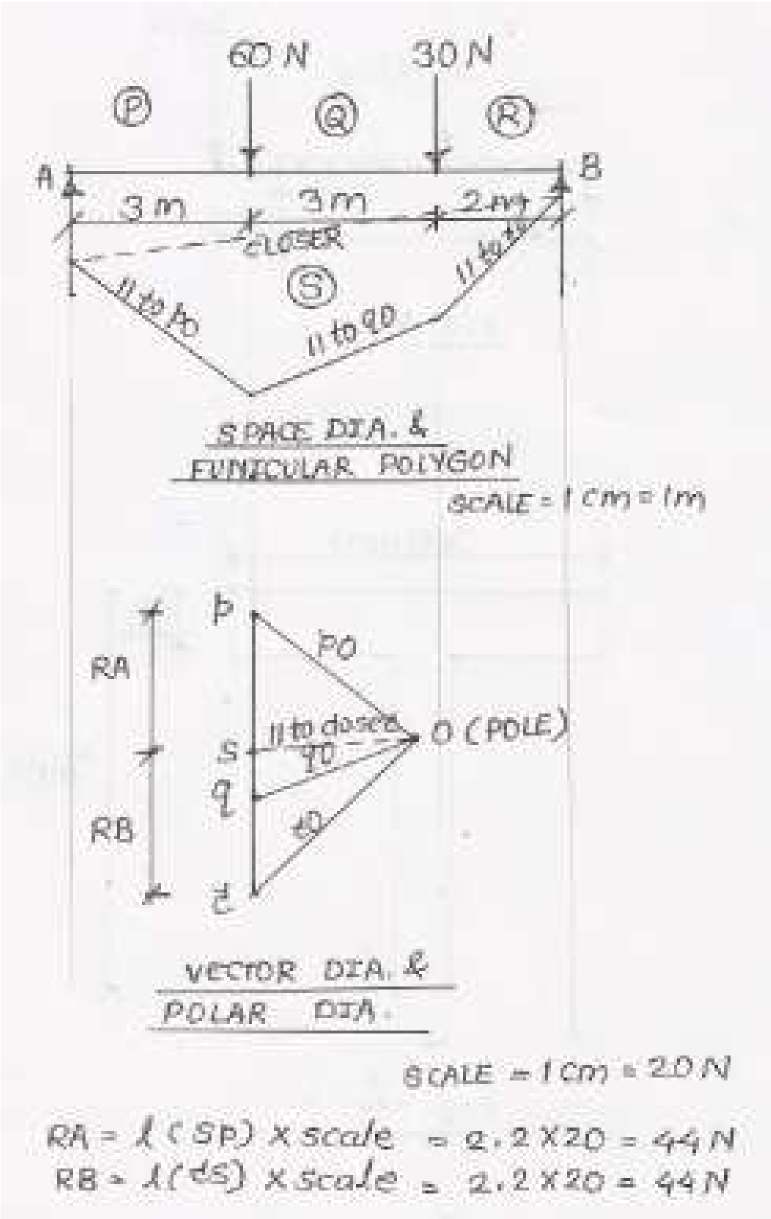
OR

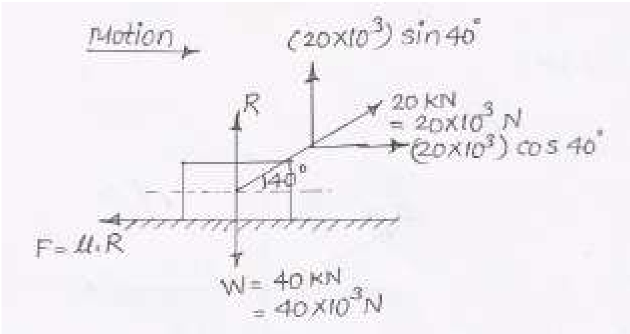
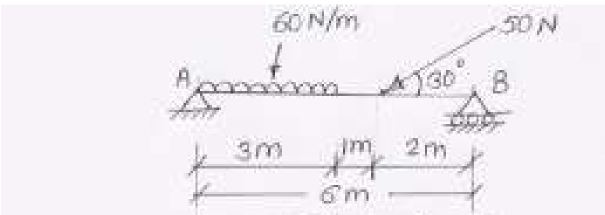
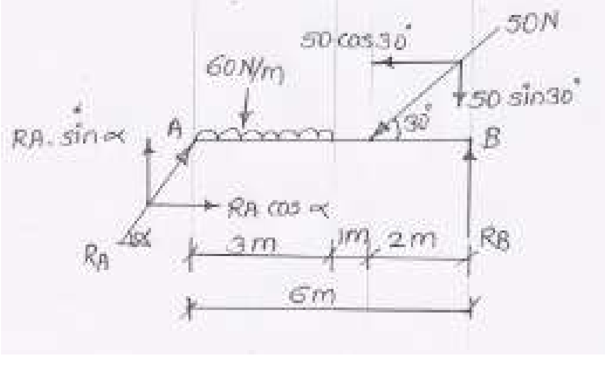


Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4		$\sum F_x = +200 - 300 = -100\,N$		
		$\sum F_y = -250 + 100 = -150\,N$	1	
		$R=\sqrt{\left(\sum F_x\right)^2+\left(\sum F_y\right)^2}=\sqrt{(100)^2+(150)^2}$	1	
		$\boxed{R=180.278\,N}$		
		As $\sum F_x = -ve$ and $\sum F_y = -ve$		
		$\boxed{R \text{ lies in } 3^{rd} \text{ quadrant}}$		
		$\theta=\tan^{-1}\left\lvert\frac{\sum F_y}{\sum F_x}\right\rvert=\tan^{-1}\left\lvert\frac{150}{100}\right\rvert$	1	4
		$\boxed{\theta=56.310°}$		
		Taking moment of all forces @ point C		
		$\sum M_C = -(100\times2)+(300\times3)=+700\,Nm$		
		Let x be the perpendicular distance between R and C.		
		Using Varignon's theorem of moment		
		$\sum M_C = R\times x$		
		$700 = 180.278 \times x$		
		$\boxed{x = 3.883 \text{ m from point C.}}$	1	
		OR		
				
		$\sum F_x = -100 + 250 = +150\,N$		
		$\sum F_y = +200 - 300 = -100\,N$	1	
		$R=\sqrt{\left(\sum F_x\right)^2+\left(\sum F_y\right)^2}=\sqrt{(150)^2+(100)^2}$		
		$\boxed{R=180.278\,N}$	1	
		As $\sum F_x = +ve$ and $\sum F_y = -ve$		
		$\boxed{R \text{ lies in } 4^{th} \text{ quadrant}}$		

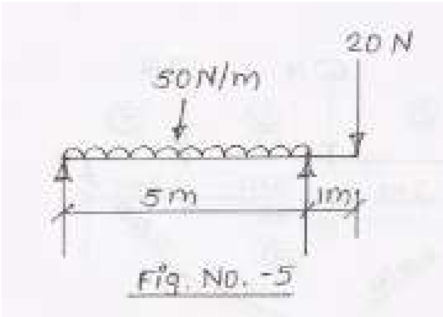
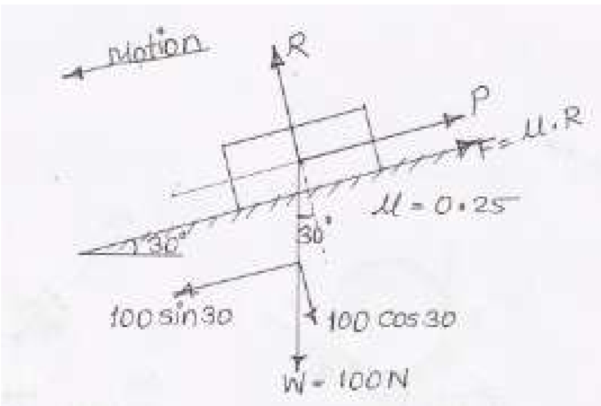
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4		$\theta=\tan^{-1}\left\|\frac{\sum F_y}{\sum F_x}\right\|=\tan^{-1}\left\|\frac{100}{150}\right\|$ $\boxed{\theta=33.690°}$	1	
		Taking moment of all forces @ point C $\sum M_C=-(100\times2)+(300\times3)=+700\ \text{Nm}$ Let x be the perpendicular distance between R and C. Using Varignon's theorem of moment $\sum M_C=R\times x$ $700 = 180.278\times x$ $\boxed{x=3.883\ \text{m from point C.}}$	1	4
	b)	**Calculate reactions offered by surface as shown in Figure No. 2, if a cylinder weighing 1000 N is resting on inclined surfaces at 90° and 50° with horizontal.**		
	Ans.	 Fig. No. 2		
		 FBD	1	
		Using Lami's Theorem, $\frac{1000}{\sin140}=\frac{R_A}{\sin130}=\frac{R_B}{\sin90}$ (1) (2) (3)	1	

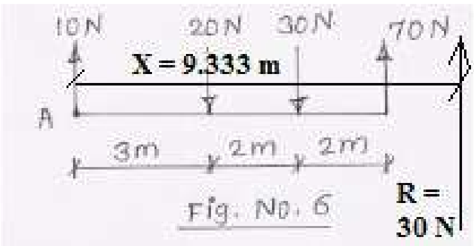
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4		Using term (1) and (2) $\frac{1000}{\sin 140} = \frac{R_A}{\sin 130}$ $R_A = \frac{1000 \times \sin 130}{\sin 140}$ $\boxed{R_A = 1191.753\,N}$	1	4
		Using term (1) and (3) $\frac{1000}{\sin 140} = \frac{R_B}{\sin 90}$ $R_B = \frac{1000 \times \sin 90}{\sin 140}$ $\boxed{R_B = 1555.723\,N}$	1	
		OR		
			1	
		Using conditions of equlibrium for concurrent force system and resolving all forces - $\sum F_x = 0$ $+R_A - R_B \times \cos 40 = 0$ $+R_A - R_B \times (0.766) = 0$----(1)	1	4
		$\sum F_y = 0$ $+R_B \times \sin 40 - 1000 = 0$ $+R_B \times (0.643) = 1000$ $\boxed{R_B = 1555.723\,N}$	1	
		Using equation (1) $+R_A - (1555.723 \times 0.766) = 0$ $\boxed{R_A = 1191.753\,N}$	1	

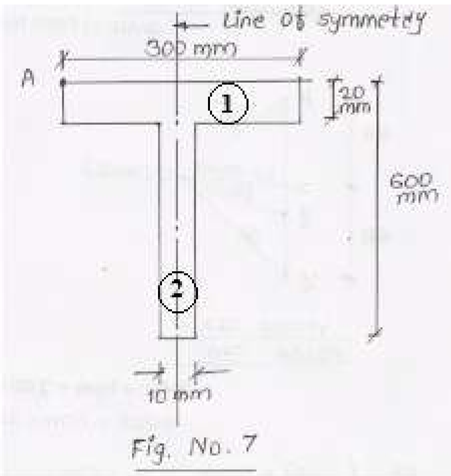
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4	c)	**Calculate graphically the reactions of a beam loaded as shown in Figure No. 3.**		
				
	Ans.		2 2	4
		(Note :Answer may vary by ± 2 N)		

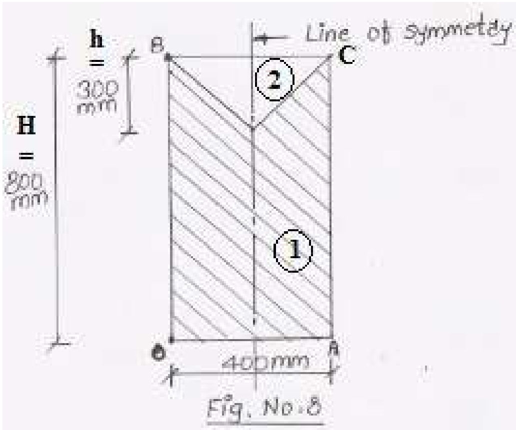
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4	d)	**A block weighing 40 kN resting on a rough horizontal plane can be moved by a force of 20 kN applied at an angle 40° with horizontal. Find the coefficient of friction.**		
	Ans.		1	
		$\sum F_y = 0$ $+R+(20\times10^3\times\sin 40)-(40\times10^3)=0$ $R = 27144.248$ N	1 ½	4
		$\sum F_x = 0$ $+(20\times10^3\times\cos 40)-\mu\times R=0$ $+(20\times10^3\times\cos 40)-\mu\times 27144.248=0$ $\boxed{\mu = 0.564}$	1 ½	
	e)	**A simply supported beam of 6 m span has subjected to loading as shown in Figure No. 4. Find support reactions by analytical method.**  Fig. No.-4		
	Ans.		1	

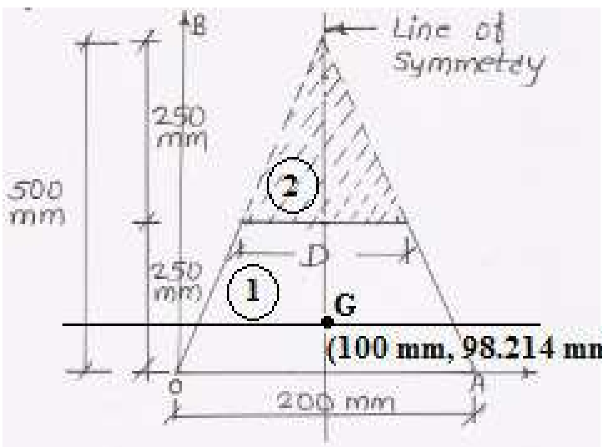
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4		$\sum M_A=0$ $+(60\times3\times1.5)+(50\times\sin30\times4)-(R_B\times6)=0$ $\boxed{R_B=61.667N}$	1	
		$\sum F_x=0$ $+(R_A\times\cos\alpha)-(50\times\cos30)=0$ $(R_A\times\cos\alpha)=43.301$----(1) $\sum F_y=0$ $+(R_A\times\sin\alpha)-(60\times3)-(50\times\sin30)+R_B=0$ $(R_A\times\sin\alpha)+R_B=205$ $(R_A\times\sin\alpha)+61.667=205$ $(R_A\times\sin\alpha)=143.333$----(2) Divide equation (2) by equation (1) $\frac{(R_A\times\sin\alpha)}{(R_A\times\cos\alpha)}=\frac{143.333}{43.301}$ $\tan\alpha=3.310$ $\alpha=\tan^{-1}(3.310)$ $\alpha=73.190°$	1	4
		Putting value of α in equation (1) $(R_A\times\cos73.190)=43.301$ $\boxed{R_A=149.727N}$	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 5		**Attempt any TWO of the following :**		12
	a)	**Calculate the reactions of beam loaded as shown in Figure No. 5 by analytical method.** 		
	Ans.	$\sum F_y = 0$		
		$+R_A - (50\times5) + R_B - 20 = 0$	1	
		$R_A + R_B = 270$ N----(1)	1	
		$\sum M_B = 0$		
		$(R_A\times5) - (50\times5\times2.5) + (20\times1) = 0$	1	6
		$R_A = 121\text{N} \ (\uparrow)$	1	
		Putting value of R_A in equation (1)	1	
		$R_A + R_B = 270$		
		$121 + R_B = 270$		
		$R_B = 149\text{N} \ (\uparrow)$	1	
	b)	**A block weighing 100 N on a 30° inclined rough plane. If coefficient of friction is 0.25. Calculate force required to be applied parallel to plane to make the block slide downward.**		
	Ans.		1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 5		$\sum F_y=0$ $+R-(100\times\cos 30)=0$ $R=86.603\,N$ $\sum F_x=0$ $+P+F-(100\times\sin 30)=0$ $+P+(\mu\times R)-(100\times\sin 30)=0$ $+P+(0.25\times 86.603)-(100\times\sin 30)=0$ $\boxed{P=28.349\,N}$	1 1 1 1 1	6
	c)	**Locate the resultant with magnitude and direction for a parallel force system as shown in Figure No. 6.** 	1	
	Ans.	R = +10 - 20 - 30 + 70 R = 30 N (Vertically upward) Taking moment of all forces @ point A. Let, R acts at 'x' distance from point A. Using Varigon's theorem of moment. $\sum M_{F_A}=M_{R_A}$ $+(20\times 3)+(30\times 5)-(70\times 7)=-R\times x$ $x=9.333\,m$ R acts at 9.333 m from point A vertically upward.	1 1 1 1 1	6

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		**Attempt any TWO of the following :**		12
	a)	**Calculate position of centroid for T section as shown in Figure No. 7 with respect to 'A'.** 		
	Ans.	(1) Area calculation $a_1 = 300 \times 20 = 6000\,mm^2$ $a_2 = 10 \times 580 = 5800\,mm^2$ $a = a_1 + a_2 = 11800\,mm^2$	2	
		(2) $\bar{x}$ calculation As given figure is symmetric @ y axis, $\bar{x} = \frac{300}{2}$	1	
		$\boxed{\bar{x} = 150\,mm \text{ from point A horizontally rightward on line of symmetry}}$		6
		(3) $\bar{y}$ calculation $y_1 = \frac{20}{2} = 10\,mm$ $y_2 = 20 + \left(\frac{580}{2}\right) = 310\,mm$	1	
		$\bar{y} = \frac{(a_1 \times y_1) + (a_2 \times y_2)}{a} = \frac{(6000 \times 10) + (5800 \times 310)}{11800}$	1	
		$\boxed{\bar{y} = 157.458\,mm \text{ from point A vertically downward on line of symmetry}}$	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6	b)	**Calculate position of centroid of shaded area as shown in Figure No. 8.**		
	Ans.			
		(Note: Position of centroid can be calculated from bottom or top.)		
		(i) Centroid from bottom:		
		(1) Area calculation		
		$a_1 = 400 \times 800 = 320000\,mm^2$		
		$a_2 = \frac{1}{2} \times 400 \times 300 = 60000\,mm^2$	2	
		$a = a_1 - a_2 = 260000\,mm^2$		
		(2) $\bar{x}$ calculation		
		As given figure is symmetric @ y axis,		
		$\bar{x} = \frac{400}{2}$	1	6
		$\boxed{\bar{x} = 200\,mm \text{ from OB on line of symmetry}}$		
		(3) $\bar{y}$ calculation		
		$y_1 = \frac{H}{2} = \frac{800}{2} = 400\,mm$	1	
		$y_2 = H - \left(\frac{h}{3}\right) = 800 - \left(\frac{300}{3}\right) = 700\,mm$		
		$\bar{y} = \frac{(a_1 \times y_1) - (a_2 \times y_2)}{a} = \frac{(320000 \times 400) - (60000 \times 700)}{260000}$	1	
		$\boxed{\bar{y} = 330.769\,mm \text{ from OA on line of symmetry}}$	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		**OR**		
		(ii) Centroid from top :		
		(1) Area calculation		
		$a_1 = 400 \times 800 = 320000\,mm^2$	2	
		$a_2 = \frac{1}{2} \times 400 \times 300 = 60000\,mm^2$		
		$a = a_1 - a_2 = 260000\,mm^2$		
		(2) $\bar{x}$ calculation		
		As given figure is symmetric @ y axis,	1	
		$\bar{x} = \frac{400}{2}$		6
		$\boxed{\bar{x} = 200\,mm \text{ from OB on line of symmetry}}$		
		(3) $\bar{y}$ calculation		
		$y_1 = \frac{H}{2} = \frac{800}{2} = 400\,mm$	1	
		$y_2 = \frac{h}{3} = \left(\frac{300}{3}\right) = 100\,mm$	1	
		$\bar{y} = \frac{(a_1 \times y_1) - (a_2 \times y_2)}{a} = \frac{(320000 \times 400) - (60000 \times 100)}{260000}$		
		$\boxed{\bar{y} = 469.230\,mm \text{ from BC on line of symmetry}}$	1	
	c)	**A solid cone of 500 mm height and 200 mm base diameter. The portion above half of its height is removed. Locate the point at which remaining body can be balanced.**		
	Ans.		1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		(1) From similar triangles, $\frac{500}{200}=\frac{250}{D}$ $D=\frac{250\times200}{500}=100\,mm$	1	
		(2) Volume calculation Let, V_1 = Volume of bigger cone V_2 = Volume of smaller cone $V_1=\frac{1}{3}\times\pi\times100^2\times500=5235.988\times10^3\,mm^3$ $V_2=\frac{1}{3}\times\pi\times50^2\times250=654.498\times10^3\,mm^3$ $V=V_1-V_2=4581.49\times10^3\,mm^3$	1	
		(2) $\bar{x}$ calculation As given figure is symmetric @ y axis, $\bar{x}=\frac{200}{2}$ $\boxed{\bar{x}=100\,mm \text{ from OB on line of symmetry}}$	1	6
		(3) $\bar{y}$ calculation $y_1=\frac{500}{4}=125\,mm$ $y_2=250+\left(\frac{250}{4}\right)=312.5\,mm$	1	
		$\bar{y}=\frac{(V_1\times y_1)-(V_2\times y_2)}{V}$ $=\frac{(5235.988\times10^3\times125)-(654.498\times10^3\times312.5)}{4581.49\times10^3}$ $\boxed{\bar{y}=98.214\,mm \text{ from OA on line of symmetry}}$	1	