

**FEBRUARY 2018 / IN - SEM (T1)**  
**F. Y. B.TECH. (COMMON) (SEMESTER - II) (2017 PATTERN)**  
**COURSE NAME: Engineering Mechanics**

Model Answers and Scheme of Marking.

Examiners are requested to please verify the calculations before starting assessment

**Q. (1)**

- (a) Here  $R_x = 0$ , and  $R_y = R$  (downward) ... 1 mark  
 $R_x = P \sin \alpha - 80 \sin 35^\circ$  OR  $P \sin \alpha = 45.89 \text{ N}$  ... 1 mark  
But  $R = P \cos \alpha + 80 \cos 35^\circ$  ... 1 mark  
For  $R$  minimum;  $\cos \alpha = 0$  OR  $\alpha = 90^\circ$  i.e.  $P$  must be acting to the right. ... 1 mark  
 $P = 45.89 \text{ N}$  ... 1 mark  
 $R = 65.53 \text{ N}$  ... 1 mark [Total 6]
- (b)  $R_x = -40 \text{ kN}$ ,  $R_y = -80 \text{ kN}$  ... 1 + 1 marks  
 $R = 89.44 \text{ kN}$  at  $63.4^\circ$  ... 1 mark  
Intersects at 0.43 m to the right of origin and 0.86 m above the origin ... 3 marks [Total 6]
- (c)  $R = 4 \text{ kN} \uparrow$  ... 1 mark  
Assume  $R$  as shown (Sketch) ... 1 mark  
VTM about point A gives  $(4)x = 4(6) - 1.5(8) - 2.5(4)$  ... 1 mark  
Or  $x = 0.5 \text{ m}$  to the right of A ... 1 mark [Total 4]

OR

**Q.(2)**

- (a) Here  $R_x = 0$  and  $R_y = R = 5.59 \text{ kN} \uparrow$  ....1 mark  
Hence  $P \cos \theta + 18 \cos 60 = 24$  ....1 mark  
and  $P \sin \theta + 18 \sin 60 - 20 = 5.59$  ....1 mark  
Solving, we get  $P \approx 18 \text{ kN}$  and  $\theta \approx 33.7^\circ$  ... 3 marks [Total 6]
- (b)  $A_1 = -(0.5) \pi (20)^2 = -628.31 \text{ mm}^2$ ;  
 $x_1 = 27 \text{ mm}$ ,  $y_1 = 40 - [4(20)/3\pi] = 31.51 \text{ mm}$ ,  
 $A_2 = -35(13) = -455 \text{ mm}^2$ ,  
 $x_2 = 47 + (35/2) = 64.5 \text{ mm}$ ,  $y_2 = 6.5 \text{ mm}$ ,  
 $A_3 = (47+35)(40) = 3280 \text{ mm}^2$ ,  
 $x_3 = (47+35)/2 = 64.5 \text{ mm}$ ,  $y_3 = 20 \text{ mm}$ , .... Total 4 marks  
Hence  $\bar{x} = 40.14 \text{ mm}$  and  $\bar{y} = 19.50 \text{ mm}$  .... 1+1 marks [Total 6]
- (c) Maximum moment of the force about A will occur only when the force acts at right angles to line AC.... 1 mark  
Sketch 1mark **OR** From geometry,  $\tan(\text{ACB}) = 0.5/0.3$ . Hence  $\text{ACB} \approx 59^\circ$  .... 1 mark  
But  $\theta = 180^\circ - 59^\circ$ . Hence  $\theta = 121^\circ$  .... 1 mark  
 $M_{\max} = (\text{AC})(300) = (0.58)(300) = 174.93 \text{ N.m}$  clockwise .... 1 mark [Total 4]

P.T.O. →

**Q.(3)**

- (a) Correct FBD of beam ... 2 marks; Using  $\sum M_A = 0$ ,  $R_B = 44.4 \text{ kN} \downarrow$  ... 2 marks  
 $\sum F_y = 0$  OR  $\sum M_B = 0$  gives  $V_A = 8.4 \text{ kN} \downarrow$  ... 1 mark  
 $\sum F_x = 0$  gives  $H_A = 12 \text{ kN} \rightarrow$  ... 1 mark [Total 6]
- (b) FBD of cylinder 2 marks; Lami's theorem OR arithmetical conditions of equilibrium ( $\sum F_x = 0$ ,  $\sum F_y = 0$ )  
 For the point of contact on the right  $R_1 = 300 \text{ N}$  at  $54^\circ$  ... 1 mark  
 For the point of contact on the left  $R_2 = 185.41 \text{ N}$  at  $18^\circ$  ... 1 mark [Total 4]
- (c)  $F_1 = -0.440 \text{ i} - 0.176 \text{ j} - 0.880 \text{ k}$ ,  $F_2 = -0.716 \text{ i} - 0.537 \text{ j} - 1.789 \text{ k}$ , and  
 $F_3 = -0.497 \text{ i} + 0.497 \text{ j} - 1.657 \text{ k}$  ... 2 marks  
 $R = -0.222 \text{ i} - 0.216 \text{ j} - 4.326 \text{ k}$ ,  $R = 4.337 \text{ kN}$ ; Direction angles:  $92.9^\circ$ ,  $92.9^\circ$ , and  $175.9^\circ$  ... 2 marks  
 [Total 4]

OR

**Q.(4)**

- (a) Writing all forces as vectors correctly as follows:  
 $T_{AD} = -0.28 T_{AD} \text{ j} - 0.96 T_{AD} \text{ k}$ ,  $T_{BD} = 0.231 T_{BD} \text{ i} + 0.308 T_{BD} \text{ j} - 0.923 T_{BD} \text{ k}$ ,  
 $T_{CD} = -0.429 T_{CD} \text{ i} + 0.286 T_{CD} \text{ j} - 0.857 T_{CD} \text{ k}$ , and  $F = 1500 \text{ k}$  ... 3 marks  
 $T_{AD} = 833.75 \text{ N}$ ,  $T_{BD} = 505.31 \text{ N}$ ,  $T_{CD} = 272.11 \text{ N}$  ... 3 marks [Total 6]
- (b)  $R = 150 \text{ N}$  along + Z direction ... 1 mark  
 Let R act at  $(\bar{x}, \bar{y})$  ... Sketch 1 mark  
 VTM about Y axis gives  $\bar{x} = 0.357 \text{ m}$  ... 1 mark  
 VTM about X axis gives  $\bar{y} = 0.25 \text{ m}$  ... 1 mark [Total 4]
- (c) *Correct expl. with sketches of*  
 Simple Support, Hinged Support, Roller Support, and Fixed Support: 1 mark each [Total 4]

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