"UG" END SEMESTER EXAMINATION – MARCH, 2021
(REGULAR)
1ST YEAR B.TECH. MECHANICAL ENGINEERING

ENGINEERING MECHANICS
MENUGES01

[Full Marks : 80] **[Time : 3:00 hrs.]**

Assume suitable data(s), if not provided

A. Fill in the blanks/Multiple choice questions (*Compulsory*) – **[10X1 = 10]**

1. The magnitude of the moment about the base point O of the 600 N force (figure A1) is –

……

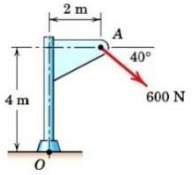

Figure A1

2. Which of the following are vector quantity(ies)?
a) Linear Displacement b) Linear Velocity
c) Linear Acceleration d) All of these

3. The point, through which the whole weight of the body acts, irrespective of its position, is known as –
a) center of mass b) centroid c) moment of inertia d) center of gravity

4. If the resultant of two forces P and Q acting at an angle θ makes an angle α with P, then the resultant should be – ……

5. If two forces each equal to P in magnitude act at right angles, their effect may be neutralized by a third force acting along their bisector in opposite direction whose magnitude is –

……

6. A framed structure is perfect if it contains members equal to –
a) $2n-3$ b) $3n-2$ c) $2n-1$ d) $n-2$

7. In the figure A2, angle α compared to β will be –
a) Greater b) Lower
c) Same d) Unpredictable

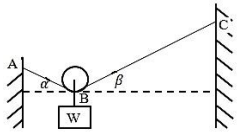

Figure A

8. Forces $5i + 6j + 7k$ N and $-8i - 9k$ N are acting at a point. The resultant force will be of magnitude –

……

9. The three forces keep acting at a point are in equilibrium, then –
a) The forces must be coplanar b) The forces need not be coplanar
c) The forces must be of equal magnitude d) The forces must be of unequal magnitude.

10. A mass of 10 kg is resting on a rough table. The friction force acting on it is –

……

B. Short questions (*Answer any five questions*): **[5X6 = 30]**

1. The forces F_1, F_2 *and* F_3, all of which act on point **A** of the bracket, as shown in the figure B1. Determine the resultant force and its direction.

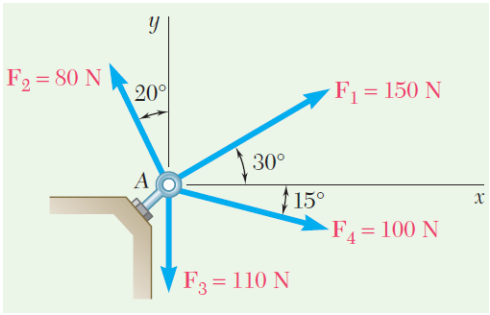

Figure B1

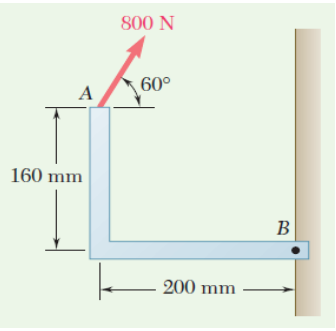

Figure B2

2. A force of 800 N acts on a bracket as shown in figure B2. Determine the moment of the force about B.

3. Locate the centroid of a circular sector with respect to its vertex. (figure B3).

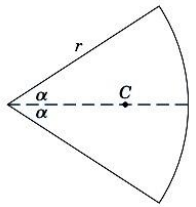

Figure B3

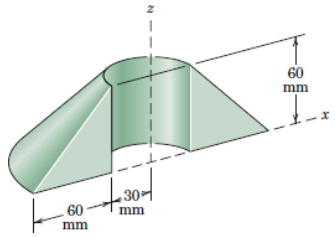

Figure B4

4. Calculate the volume V of the solid generated by revolving the 60-mm right-triangular area through 180^0 about z-axis. If this body were constructed of steel, what would be its mass "m"? (figure B4).

5. The position coordinate of a particle which is confined to move along a straight line is given by $s = 2t^3 - 25t + 7$, where s is measured in meters from a convenient origin and t is in seconds. Determine –
a) The time required for the particle to reach a velocity of $72\,m/s$ from its initial condition at $t = 0$,
b) The acceleration of the particle when $v = 30\,m/s$,
c) The net displacement of the particle during the interval from $t = 1s$ to $t = 4s$

6. A 75-kg man stands on a spring scale in an elevator. During the first 3-seconds of motion from reset, the tension "T" in the hoisting cable is 8300N. Find the reading R of the scale in newton during this interval and the upward velocity "v" of the elevator at the end of the 3-seconds. The total mass of the elevator, man and scale is 800 kg.

C. Long questions (*Answer any four questions*): [4X10 = 40]

1. For the vectors $\boldsymbol{V_1}$ and $\boldsymbol{V_2}$ shown in the figure C1,
   - **a)** Determine the magnitude S of their vector sum $\boldsymbol{S} = V_1 + V_2$
   - **b)** Determine the angle $\boldsymbol{\alpha}$ between $\boldsymbol{S}$ and the positive x-axis.
   - **c)** Write $\boldsymbol{S}$ as a vector in terms of the unit vectors $\boldsymbol{i}$ and $\boldsymbol{j}$ and then write a unit vector $\boldsymbol{n}$ along the vector sum $\boldsymbol{S}$.
   - **d)** Determine the vector difference $\boldsymbol{D} = V_1 - V_2$

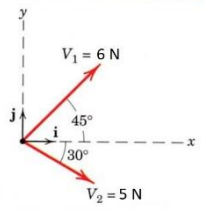

Figure C1

2. Determine the resultant of the four forces and one couple which act on the plate shown in figure C3.

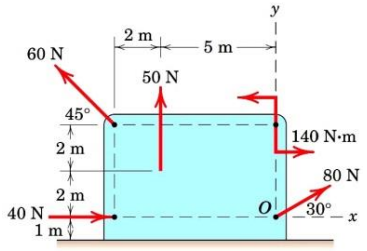

Figure C3

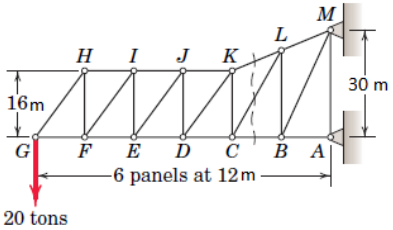

Figure C4

3. Compute the forces induced in members KL, CL and CB by 20 ton load on the cantilever truss (figure C4).

4. Determine the range of values which the mass m_0 may have so that the 100 kg block shown in the figure C5 will neither start moving up the plane nor slip down the plane. The coefficient of static friction for the contact surface is 0.20. (figure C5)

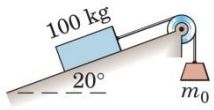

Figure C5

5. Each of the two uniform hinged bars has a mass m and length l, and is supported and loaded as shown. For a given force P, determine the angle θ for equilibrium. (figure C6)

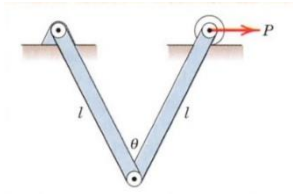

Figure C6

6. A tennis player strikes the tennis ball with her racket when the ball is at the uppermost point of its trajectory as shown. The horizontal velocity of the ball just before impact with the racket is $v_1 = 50\ m/s$, and just after impact its velocity is $v_1 = 70\ m/s$, as directed at the 15^0 angle as shown. If the 20-gm ball is in contact with the racket for 0.02 sec, determine the magnitude of the average force **R** exerted by the racket on the ball. Also determine the angle β made by **R** with the horizontal. (figure C7)

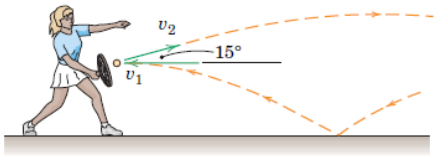

Figure C7

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