Total No. of printed pages = 10

Me-201/EM/2nd Sem(New)/2018/J/A

ENGINEERING MECHANICS

(New Course)

Full Marks – 70

Time – Three hours

The figures in the margin indicate full marks for the questions.

PART – A

Marks – 25

Answer *all* the questions.

1. Fill in the blanks : 10×1=10

   i. A vector, whose magnitude is _____, is known as unit vector.

   ii. The perpendicular distance between the lines of the forces of the two equal and opposite parallel forces, is known as _____ of the couple.

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iii. The force, which brings the set of forces in equilibrium is called an _____.

iv. The C.G of a semicircle is located at a distance _____ from its base along vertical radius r.

v. The forces, whose line of action lie on the _____ line, are known as collinear forces.

vi. The C.G of a hemisphere is at a distance of _____ from its base along vertical radius r.

vii. The M.I of a circular section of diameter d, is given by the relation _____.

viii. The unit of work done in S.I units is _____.

ix. The rate of doing work is _____.

x. The kinetic energy of a body of mass m, and velocity v, is equal to _____.

2. Choose the correct answer. $15\times1=15$

i. If the resultant of two forces P and Q acting at an angle α with P, then

(a) $\tan\alpha = \dfrac{P\sin\theta}{P+Q\cos\theta}$

(b) $\tan\alpha = \dfrac{P\cos\theta}{P+Q\cos\theta}$

(c) $\tan\alpha = \frac{Q\sin\theta}{P + Q\cos\theta}$

(d) $\tan\alpha = \frac{Q\cos\theta}{P + Q\cos\theta}$

where θ is the angle between P and Q.

ii. A couple consist of

(a) Two like parallel forces of same magnitude

(b) Two like parallel forces of different magnitudes

(c) Two unlike parallel forces of same magnitude

(d) Two unlike parallel forces of different magnitudes

iii. If the sum of all the forces acting on a body is zero, then the body may be in equilibrium provided the forces are

(a) Parallel

(b) Like parallel

(c) Unlike parallel

iv. The C.G of an equilateral triangle with each side 'a' is at a distance of _____ from any of the three sides.

(a) $\frac{\alpha\sqrt{3}}{2}$

(b) $\frac{\alpha}{2\sqrt{3}}$

(c) $\frac{\alpha\sqrt{2}}{3}$

(d) $\frac{\alpha}{3\sqrt{2}}$

v. The M.I of a triangular section of base 'b' and height 'h' about an axis passing through its vertex and parallel to the base is _____ as that passing through its C.G and parallel to the base.

(a) Twelve times

(b) Nine times

(c) Six times

(d) Four times

vi. The magnitude of the force of friction between two bodies, one lying above the other, depends upon the roughness of the _____.

(a) Upper body

(b) Lower body

(c) Both the bodies

(d) Body having more roughness

vii. In an ideal machine, the M.A (Mechanical Advantage) is _____ V.R. (Velocity Ratio)

(a) Equal to

(b) Less than

(c) Greater than

(d) None of above

viii. In a simply supported beam carrying triangular load, the reactions cannot be vertical.

(a) True

(b) False

ix. Which of the following is not a scalar quantity ?

(a) Displacement

(b) Mass

(c) Distance

(d) Density

x. The force of friction always acts in a direction opposite to that

(a) In which the body tends to move

(b) In which the body is moving

(c) Both (a) and (b) above

(d) None of the two

xi. The units of energy and work done are the same.

(a) Agree

(b) Disagree

xii. The maximum velocity of a vehicle, in order to avoid skidding on a level circular path is

(a) μgr

(b) $\sqrt{(\mu gr)}$

(c) $\frac{1}{2}\mu gr$

(d) $\frac{1}{2}\sqrt{(\mu gr)}$

xiii. The maximum mechanical advantages of a lifting machine is

(a) 1+m

(b) 1–m

(c) m

(d) $\frac{1}{m}$

xiv. The velocity ratio of a simple wheel and axle with D and d as diameters of effort wheel and load axle is

(a) D+d

(b) D–d

(c) D×d

(d) $\frac{D}{d}$

xv. The velocity ratio of a first system of pulleys with 4 pulleys is

(a) 4

(b) 16

(c) 8

(d) 15

PART–B

Marks – 45

Answer any *five* questions.

3. (a) State the parallelogram law of forces. 2

(b) State the characteristics of a force. 2

(c) Find the magnitude of the two forces, such that if they act at right angles, their resultant is $\sqrt{10}$N. If they act at 60°, their resultant is $\sqrt{13}$N. 5

4. (a) State and prove Lami's theorem. 1+3=4

(b) Two men carry a weight of 2 kN by means of two ropes fixed to the weight. One rope is inclined at 45 and the other at 30 with the vertices. Find the tension in each rope. 5

5. (a) Find the magnitude and direction of the resultant of the concurrent forces of 8N, 12N, 15N and 20N, making angles of 30°, 70°, 120°15' and 155° respectively with a fixed line. 5

(b) Find the horizontal force required to drag a body of weight 100N along a horizontal plane. If the plane, when gradually raised upto 15 degrees, the body will begin to slide. 4

6. (a) Distinguish between centre of gravity and centroid. 2

(b) State the various methods of finding out the centre of gravity of a body. 2

(c) Find the centroid of an unequal angle section 100 mm × 80 mm × 20 mm. 5

7. (a) Describe the different types of loading with neat sketches. 5

(b) A simply supported beam AB of span 4m is carrying a point load of 5, 2 and 3 kN at 1, 2 and 3m respectively from the support A. Calculate the reactions at the supports A and B. 4

8. (a) What is a machine ? Explain the difference between a simple machine and a compound machine. 1+1=2

(b) In a lifting machine, an effort of 40N raised a load of 1 kN. If efficiency of the machine is 0.5, what is the velocity ratio ? If on this machine, an effort of 74N raised a load of 2 kN, what is now the efficiency ? What will be the effort required to raise a load of 5 kN ? 7

9. Find the moment of inertia about the centroidal X-X and Y-Y axes of the angle section of 100 × 80 × 20 mm. 9