Combined First and Second Semester B.Tech. Degree Examination, January 2019
(2013 Scheme)
13.105 : ENGINEERING MECHANICS (ABCEFHMNPRSTU)

Time : 3 Hours
Max. Marks : 100

PART – A

Answer all questions. Each question carries 4 marks. (5×4=20 Marks)

1. Explain Varigon’s theorem.
2. State the laws of static friction. What is meant by wedge friction.
3. List the types of supports and loads on a beam.
4. What weight should be hung on a spiral spring having a stiffness of 88.29 N/m, so that it will oscillate with a periodic time of one second?
5. What is meant by super elevation? What is the necessity of providing the same?

PART – B

Answer one full question from each Module. Each question carries 20 marks. (4×20=80 Marks)

Module – I

6. Two forces 400 N and 300 N act at a point as shown in Fig.1. The resultant of the two forces is 600 N. Determine the angle between the forces and the direction of the resultant.

---

Fig. 1
7. A machine weighing 1500 N is supported by two chains attached to some point on the machine. One of these ropes goes to the eye bolts in the wall and is inclined at 30° to the horizontal and the other goes to the hook in the ceiling and is inclined at 45° to the horizontal. Find the tensions in the two chains.

Module – II

8. Find the moment of inertia about the centroidal axis X-X for the lamina shown in Fig. 2.

![Fig. 2](image)

9. Find the support reactions of the beam loaded as shown in Fig. 3.

![Fig. 3](image)

Module – III

10. a) A block and pulley system is shown in Fig. 4. The coefficient of kinetic friction between the block and the plane is 0.25. The pulley is frictionless. Find the acceleration of the blocks and the tension in the string when the system is just released. Also find the time required for 100 N block to come down by 2 m using D’Alembert’s principle.

![Fig. 4](image)

b) Three perfectly elastic balls A, B and C of weights 40 N, 80 N and 16 N move in the same direction with velocities of 8 m/s, 2 m/s and 1.5 m/s respectively. If the ball A impinges with the ball B, which in turn impinges with the ball C, prove that the balls A and B will be brought to rest by the impacts.
11. a) The motion of a particle along a curve is described by the expressions
\[ x = t^3 + 2t^2 - 5t + 3 \] and \[ y = t^2 - 6t + 5 \] where \( x \) and \( y \) are in metres and \( t \) is in seconds.
Find the velocity and acceleration of the particle when \( t = 3 \) seconds.

b) A ball of mass 120 g is moving towards a bat with a velocity of 30 m/sec. When hit by a bat at 30° with vertical, it attains a velocity of 45 m/sec. If the bat and the ball are in contact for a period of 0.02 seconds, determine the average impulse force exerted by the bat on the ball during the impact.

Module - IV

12. a) A 25 kN automobile is moving at a speed of 60 kmph when the brakes are fully applied causing all the four wheels to skid. Determine the time required to stop the automobile
   i) on concrete road for which \( \mu = 0.74 \) and
   ii) on ice for which \( \mu = 0.07 \).

b) A 5 kN ball is dropped on to the top of a spring from a height of 150 mm. Find the compression of the spring, if its stiffness is 1N/mm.

13. a) Frequency of free vibrations of a weight 'W' attached to a spring is 25 cycles per second. If the frequency becomes 10 cycles per second, when an extra weight of 15 N is coupled with 'W', determine the stiffness of the spring.

b) A cricket ball moving with 25 m/s strikes the ground at 30° to horizontal. If the co-efficient of restitution is 0.63, find the velocity and direction of motion of the cricket ball when it reaches the boundary line.