ELIZADE UNIVERSITY, ILARA-MOKIN,
ONDO STATE, NIGERIA

DEPARTMENT OF MECHANICAL ENGINEERING

FIRST SEMESTER EXAMINATIONS

2019/2020 ACADEMIC SESSION

HOD'S SIGNATURE

COURSE: GNE 221 – Applied Mechanics (3 Units)

CLASS: 200 Level General Engineering

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer **ALL Questions in Section A and ANY other FOUR (4) in Section B.** Neat work is important to AVOID oversight. All Questions carry equal marks.

Date: February, 2020

Question 1 **SECTION A (Objectives – 12 Marks)**

1. Using I-III, examples of engineering particles include the following: (I) Air craft in Space (II) Ship in mid-sea (III) Earth in celestial sphere (a) I only (b) I and II only (c) I, II and III (d) II and III
2. _____ is a force that resists the movement of two contacting surfaces that slide relative to another. (a)Couple (b) Friction (c) Plane motion (d) Column
3. _____ is used to study the dynamic response or accelerated motion of a body. (a)Centroid (b) Center of gravity (c) Centre of mass (d) Moment of inertia
4. _____ states that 'the moment of inertia for an area about an axis is equal to its moment of inertia about a parallel axis passing through the area's centroid plus the product of the area and the square of the perpendicular distance between the axes'. (a) Equilibrium (b) Parallel axis theorem (c) Radius of gyration (d) Moment of inertia
5. _____ is a sketch of the body showing all forces that act on it. (a)Skeletal diagram (b) Equilibrium body diagram (c) Free sketch diagram (d) Free body diagram
6. The branch of engineering science which predicts and describe the condition of rest or motion of bodies under the action of applied force is called _____ (a) Mechanics (b) Strength of Materials (c) Statics (d) Theory of Elasticity
7. A _____ is a collection of forces acting on a body in one or more planes. (a)Concurrent force (b) Force system (c) Collinear force (d) Particle
8. The motion along a curved path confined to one plane is called _____ (a)Plane motion (b) Translational motion (c) Plane curvilinear motion (d) Curvilinear motion
9. _____ deals with the study of bodies in motion without considering the force that causes the motion (a) Kinetics (b) Dynamics (c) Kinematics (d) Rigid body
10. _____ is a fixed quantity used as standard of measurement (a) Quantity (b) Fundamental unit (c) Magnitude (d) Unit
11. The forces exerted by one's legs on a bicycle pedal is an example of a _____ (a)Force system (b) Couple system (c) Equilibrium system (d) Dynamic system
12. _____ is the resolution of force into two components (a) magnitude (b) Resultant components (c) rectangular components (d) orthodoxia components

SECTION B

Question 2 (Force and Force systems)

(a) Determine the x and y components of each of the forces shown in **fig. Q2(a).** **[3 Marks]**

(b) Determine the magnitude and the coordinate direction angles of the resultant force acting on the ring in **fig.Q2(b).** **[5 Marks]**

(c) A force of 500 N forms angles of 60°, 45°, and 120°, respectively, with the x, y, and z axes. Find the components Fx, Fy, and Fz of the force. [4 Marks]

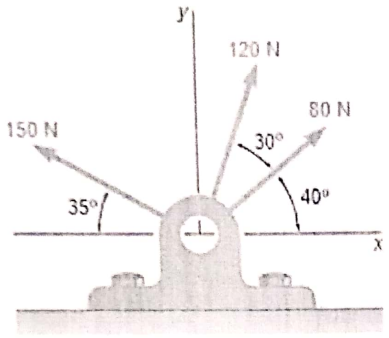

Fig. Q2(a)

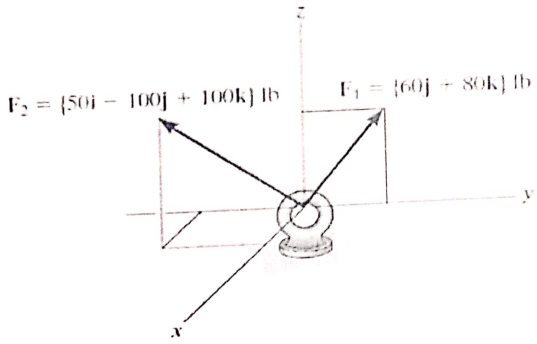

Fig. Q2(b)

Question 3 (Force and Couple Moment)

(a) Determine the required magnitude of couple Moments M_1, M_2 and M_3 in Fig. Q3(a) so that the resultant couple moment is $\mathbf{M_R = (-300i + 450j - 600k)\ Nm}$. [4 Marks]

(b) An antenna is guyed by three cables as shown. Knowing that the tension in cable *AB* is 288 N, replace the force exerted at *A* by cable *AB* with an equivalent force-couple system at the center *O* of the base of the antenna shown in Fig. Q3(b). [8 Marks]

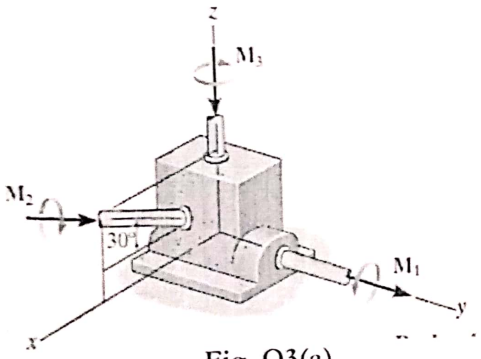

Fig. Q3(a)

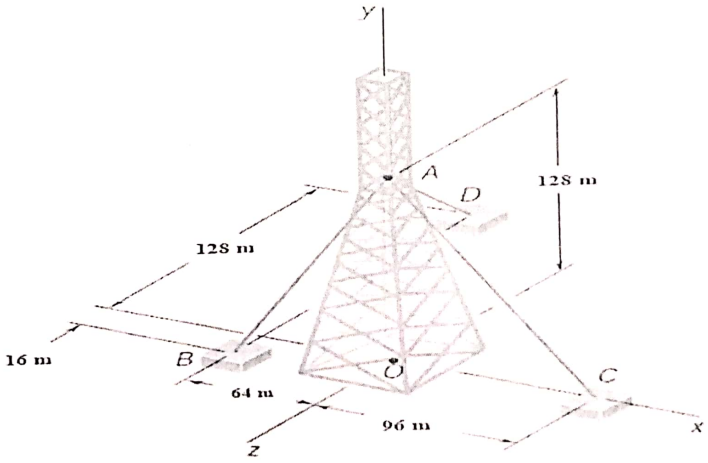

Fig. Q3(b)

Question 4 (Equilibrium of Structures, Machine Parts and Supports)

(a) Two crates shown in Fig Q4(a), each of mass 350 kg, are placed as shown in the bed of a 1400-kg pickup truck. Determine the reactions at each of the two (*a*) rear wheels *A*, (*b*) front wheels *B*. [7 Marks]

(b)(i) Prove that $\vec{F} = F\lambda$ (ii) prove that $\cos^2\theta_x + \cos^2\theta_y + \cos^2\theta_z = 1$ [5 Marks]

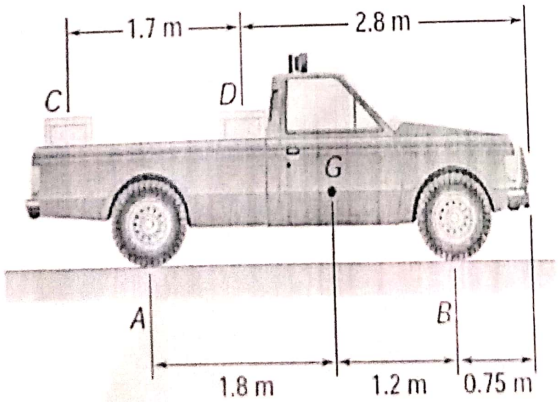

Fig. Q4(a)

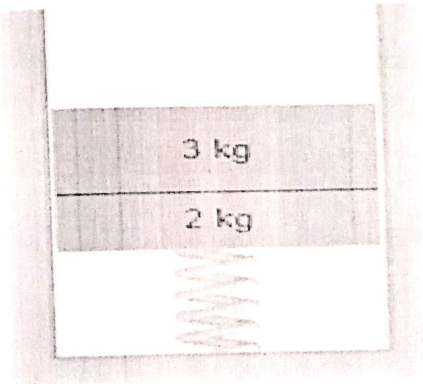

Fig. Q6(a)

Question 5 (Friction)

(a) Differentiate between solid and wet friction [2 Marks]

(b) A force F acting along an incline plane is just sufficient to maintain a body on a plane, the angle of friction λ being less than the angle of the plane α. Prove that the least force acting along the plane sufficient to drag the body up the plane is $P = \frac{F\sin(\alpha+\lambda)}{\sin(\alpha-\lambda)}$ [6 Marks]

(c) A body resting on a rough horizontal plane required a pull of 180 N inclined at 30° to the plane just to move it. It was found that a push of 220 N inclined at 30° to the plane just to move the body. Determine the weight of the body and the coefficient of friction. [4 Marks]

Question 6 (Plane motions, Newton's Law of Motion, Energy and Momentum analysis)

(a) A 3-kg block shown in fig. Q6(a) rests on top of a 2-kg block supported by but not attached to a spring of constant 40 N/m. The upper block is suddenly removed. Determine (a) the maximum speed reached by the 2-kg block, (b) the maximum height reached by the 2-kg block. [5 ½ Marks]

(b) The displacement of a point is given by $s = 2t^3 + t^2 + 6$, where s is in meters and t is the time in seconds. Determine the displacement of the point when the velocity changes from 8.4 m/s to 18 m/s. Find also the acceleration at the instant when the velocity of the particle is 30 m/s. [4 Marks]

(c) The angular displacement of a body is a function of time and is given by the equation

$$\theta = 10 - 3t + 6t^2$$

Where t is in seconds: Determine the angular displacement, velocity and acceleration when t= 5seconds. [2 ½ Marks]

Question 7 (Centroids and First and Second Moments of Area)

(a) Locate the centroid $(\bar{y})$ of the cross-sectional area of the beam shown Fig. Q7(a) [4 Marks]

(b) Determine the centroid $(\bar{x})$ of the shaded area shown in Fig. Q7(b). [4 Marks]

(c) Determine the moment of inertia of the cross-sectional area of the T-beam shown in Fig. Q7(c) with respect to the x^1 axis passing through the centroid of the cross section. [4 Marks]

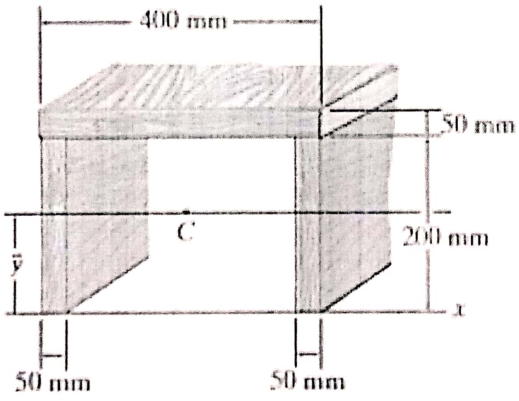

Fig. Q7(a)

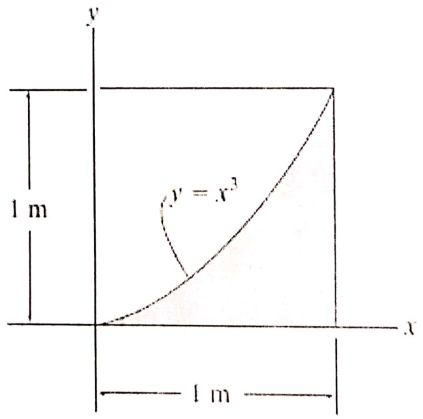

Fig. Q7(b)

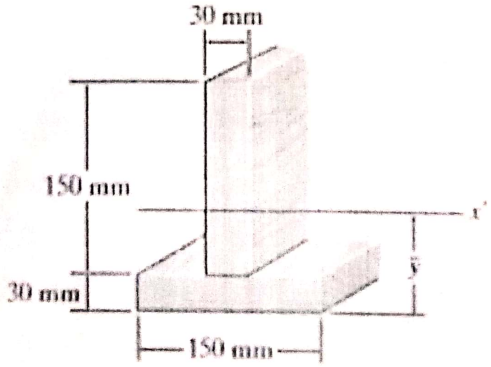

Fig. Q7(c)