ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE, NIGERIA

DEPARTMENT OF MECHANICAL ENGINEERING

FIRST SEMESTER EXAMINATIONS

2020/2021 ACADEMIC SESSION

HOD'S SIGNATURE

COURSE: GNE 255 – Applied Mechanics (3 Units)

CLASS: 200 Level General Engineering

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer **Question 1 and ANY other FOUR (4).** Neat work is important to AVOID oversight. All Questions carry equal marks.

Date: March, 2021

Question 1(Introduction)

(a)(i) What is Applied Mechanics? (ii)With the aid of sketch, show the classification of Engineering Mechanics (iii) Explain the concept of ***particles*** and ***Rigid bodies*** with examples **[5 Marks]**

(b) (i) Differentiate between fundamental and derived unit with necessary examples. (ii) Briefly explain any two (2) systems of units. **[4 Marks]**

(c) (i) Converts 5.5 km/h to m/s. Then, how many ft/s is this? (ii) Convert the quantities 320 *lb*.s and 54 *slug*/ft^3 to appropriate SI units? [Given that: 1 *lb* ≈ 4.448 N; 1 *slug* ≈ 14.59 kg; 1 *ft* ≈ 0.3048 m] **[3 Marks]**

Question 2 (2-D Force and Force systems)

(a) Define the following: (i) rectangular coordinate (ii) force systems (iii) Concurrent force system (iv) parallelogram law of forces **[4 Marks]**

(b) Determine the magnitude and direction of the forces shown in **fig. Q2(b).** **[5 Marks]**

(c) A boat is to be pulled onto the shore using two ropes. Determine the magnitudes of forces P and T acting in each rope in order to develop a resultant force F_1, directed along the keel axis **aa** as shown in **fig.Q2(c)**. Given that Θ, Θ_1, F_1 are 40^0, 30^0 and 80 N respectively. **[3 Marks]**

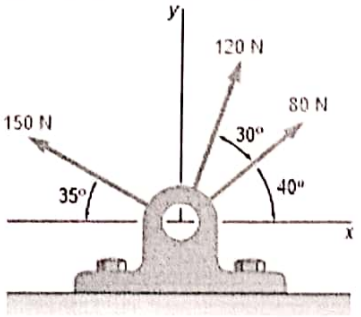

Fig. Q2(b)

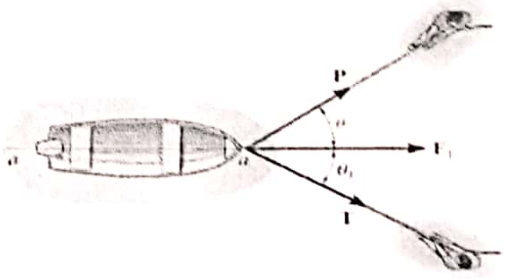

Fig. Q2(c)

Question 3 (3-D Force Systems)

(a) (i) Prove that $\vec{F} = F\boldsymbol{\lambda}$ (ii) prove that $\boldsymbol{cos^2\theta_x + cos^2\theta_y + cos^2\theta_z = 1}$ **[3 Marks]**

(b) Determine the magnitude and the coordinate direction angles of the resultant force acting on the ring in **fig.Q3(b)**. **[4 Marks]**

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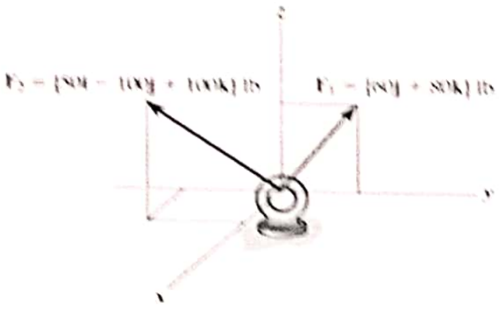

Fig. Q3(b)

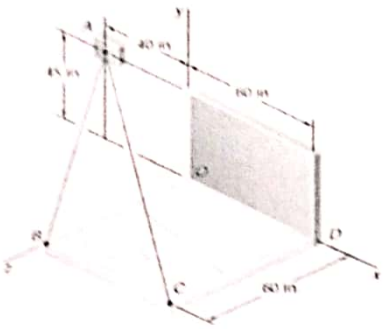

Fig. Q3(c)

(c) Knowing that the tension is 510 lb in cable AB and 425 lb in cable AC, determine the magnitude and direction of the resultant of the forces exerted at A by the two cables in fig.Q3(c). **[5 Marks]**

Question 4 (Force and Couple Moment)

(a) (i) Define couple, then give any three (3) engineering application of couple systems (ii) What is an equivalent couple? (iii) State the Varignon's principle **[5 Marks]**

(b) Determine the resultant couple moment of the three couple acting on the plates in **Fig. Q4(a)** **[2 Marks]**

(c) The wire *AB* is stretched between the corners *A* and *B* of a bent plate shown in **Fig. Q4(b)**. Knowing that the tension in the wire is 435 N, determine the moment about *O* of the force exerted by the wire on corner *A*. **[5 Marks]**

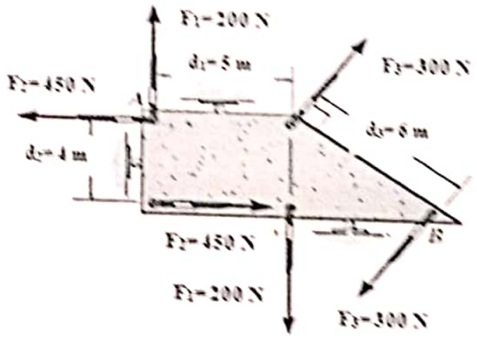

Fig. Q4(a)

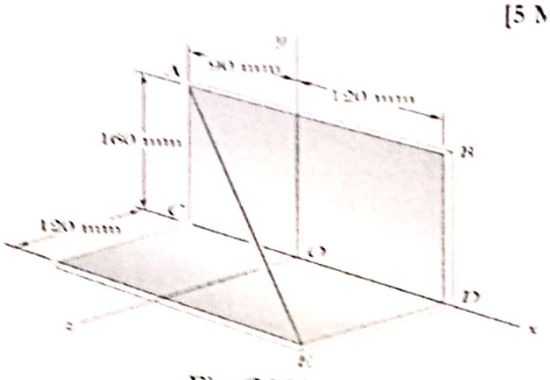

Fig. Q4(b)

Question 5 (Friction)

(a) (i) What is friction? (ii) In engineering applications, friction is both desirable and undesirable, explain? (iii) State any four (4) laws of static friction **[5 Marks]**

(b) An effort of 1500 N acting parallel to the plane is required to just move a certain body up an inclined plane of angle 12°. If the angle of inclination is increased to 15°, then the effort required is 1720 N. Find the weight of the body and the coefficient of friction. **[3 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) (i) Define a plane motion (ii) Tabulate the relationship between rectilinear and curvilinear plane motion **[3 Marks]**

(b) A taxi car is travelling at 54 km/hr when the traffic light 50 m ahead turns yellow. Determine the required constant deceleration of the car and the time needed to stop the car at the light.

[2 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 velocity, displacement and acceleration when t= 5seconds. **[2 ½ Marks]**

(d) 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. **[4 ½ Marks]**

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

(a) (i) State parallel axis theorem (ii) What is centroid? **[2 Marks]**

(b) Locate the centroid $(\bar{y})$ of the cross-sectional area of the beam shown **Fig. Q7(a)** **[3 Marks]**

(c)Determine the distance measured from the *x axis to the centroid of* the area of the triangle shown in **Fig. Q7(b)**. **[3 Marks]**

(d) Determine the moment of inertia of the cross-sectional area of the channel shown in **Fig. Q7(c)** with respect to the *x axis* **[4 Marks]**

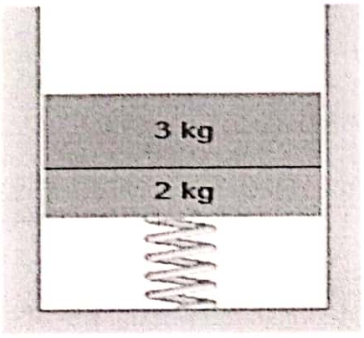

Fig. Q6(a)

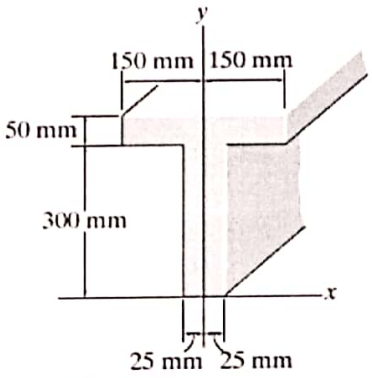

Fig. Q7(a)

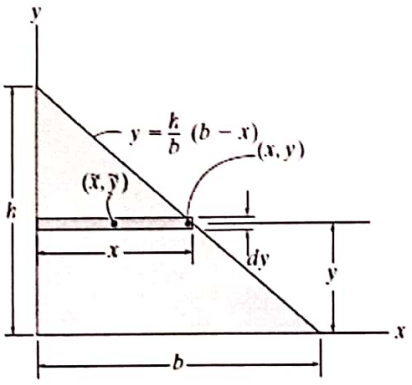

Fig. Q7(b)

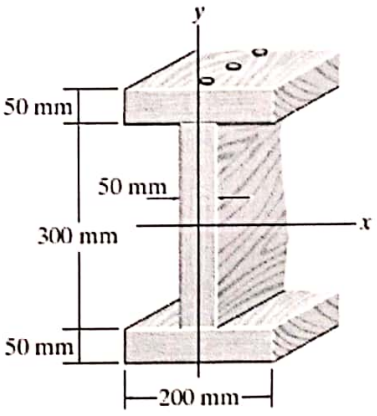

Fig. Q7(c)