BANGLADESH UNIVERSITY OF PROFESSIONALS
Military Institute of Science and Technology
B.Sc. In Environmental, Water Resources, and Coastal Engineering
Level-1, Term-I , Term Final Examination: May-June 2017

Subject: EWC-101, Analytical Mechanics

Time: 3.00 hours | Full Marks:. 280

INSTRUCTIONS:

a. Use **SEPARATE** answer scripts for each section.
b. Answer any **THREE** questions from each section.
c. Figures in the margin indicate full **marks.**
d. Assume reasonable data if necessary.
e. **Symbols** used have their usual meanings.

SECTION-A

Question – 1

a. In figure 1, let F = 400 lb and θ= 45°. Assuming both pulleys to have no friction, determine the forces at bearing A and B and dia D. **14**

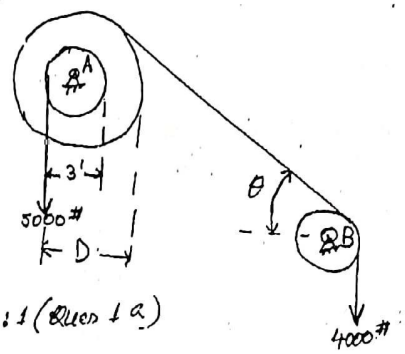


Fig: 1 (Ques 1 a)

b. The derrick shown in the fig : 2 supports a load of w=2000 lb. Find the tension in the boom cable and the components of the force exerted on the pin C. Assume θ =60° . **20**

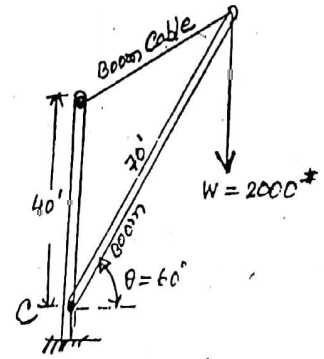


Fig: 2. (Ques 1.b)

c. The bellcrank shown in fig. 3 has a load E=100 lb. If θ=45°, find the reactions at B and C. **$12\frac{2}{3}$**

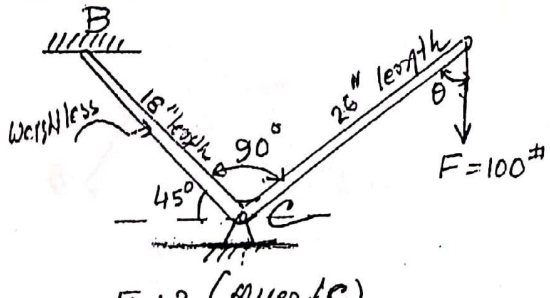


Fig: 3 (Ques 1c)

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Question – 2

a. An ore car B which weighs 15 tons is balanced by a weight A as shown in the fig: 4. θ=60°. What should be the weight A if there is no friction at any point? 15

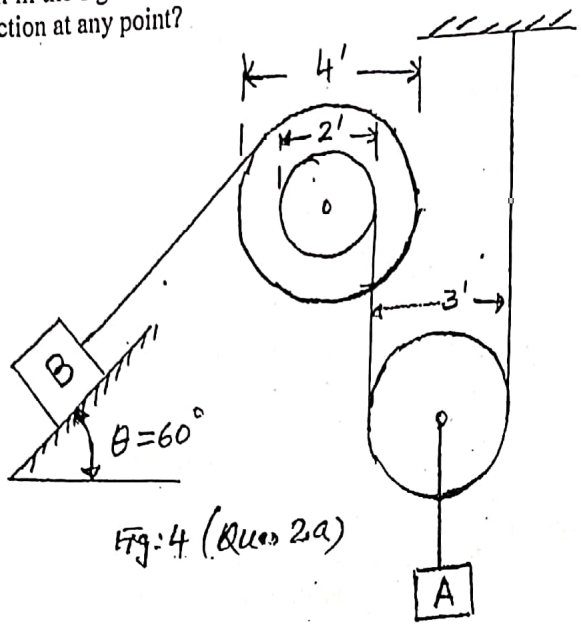


Fig: 4 (Ques 2a)

b. The frame shown in fig :5 is supported in a smooth track and loaded on the horizontal member BH with a 500 lb load. Determine the horizontal and vertical components of the pin reactions at A, B C, D and E. 20

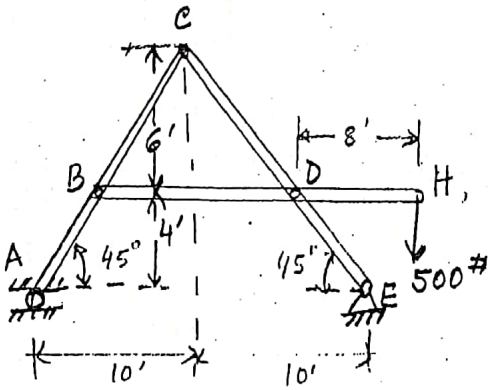


Fig: 5 (Ques 2.b)

c. The timbers AB, BC and BD, each 20ft long form a tripod as shown in fig: 6. The ends of the timbers on ground form an equilateral triangle ACD, the sides of which are each 20 ft long. If the safe compressive load for each timber is 20 kips, what safe load w may be suspended from point B. $10\frac{2}{3}$

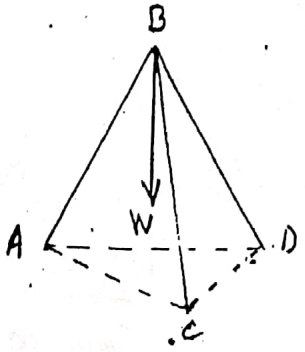


Fig: 6 (Ques 2.c)

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Question – 3

a. A force 1000 lb is exerted on the block A which is placed against the wedge B as shown in fig: 7. What force Q will cause the wedge B to be in impending motion downward? 18

Neglect the weight of both blocks A and B and assume that f=1/3 for all surfaces.

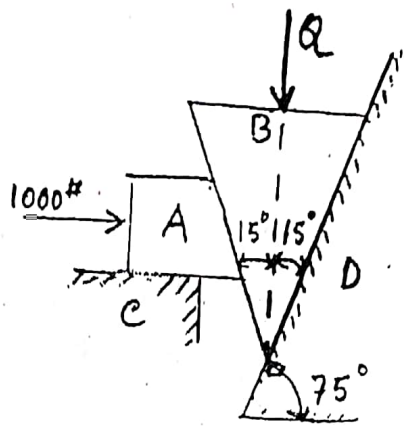


Fig: 7 (Ques 3.a)

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b. In fig: 8, $f_c=1/\pi$, $f_s=0$, $f_B=0.2$, $\theta=30°$ and $w_B=100$ lb. If B is to have motion down the plane impending, find the weight of A. $12\frac{2}{3}$

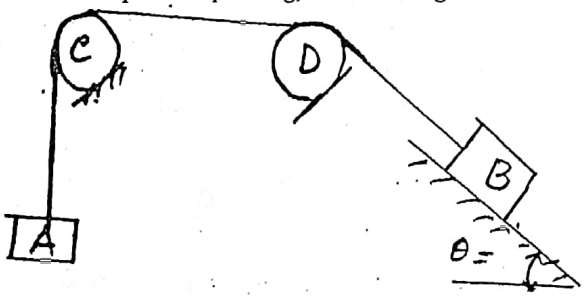


Fig: 8 (Ques 3.b)

c. Fig: 9 represents a boom that supports a load w= 1000 lb. If AB = BC = BD = 9ft and BE 12ft, Find the tension in the cable and force in each timber. 16

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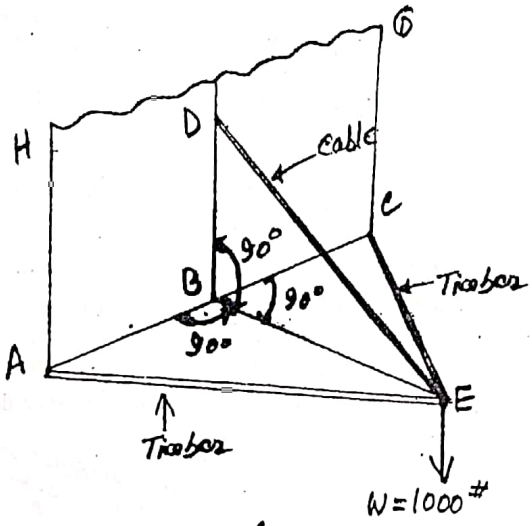


Fig: 9 (Ques. 3.c)

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Question – 4

a. In fig: 10. Let F_1=1000 lb and F_2= 4000 lb. Find the external reactions (components) at E and loads on the members CG, CH and EH.

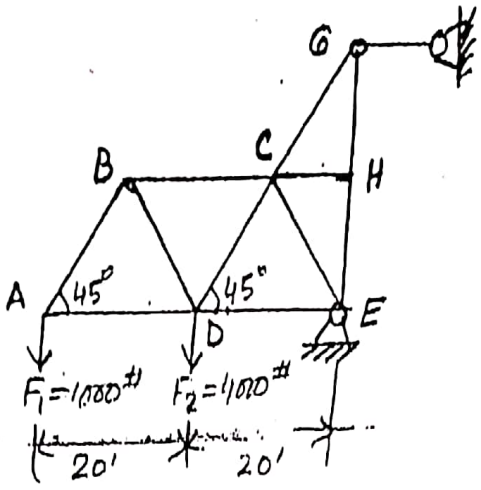


Fig: 10 (Ques 4.a)

b. Two cables A and B terminates on a pole as shown in fig:11 and exert force in a horizontal plane at C. The guy cable makes an angle with the pole of 45° and the anchor D is to be so located that the pole will have only a compressive load. Let, θ=30°, A= 7500 lb and B= 12000 lb and CE =25 ft. Find the value of angle α and the tension in the cable CD. 15

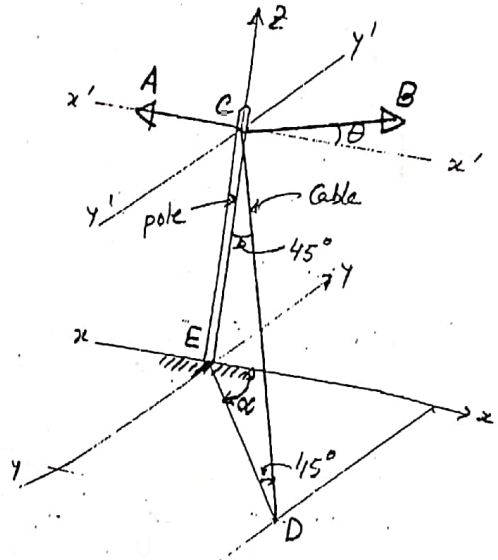


Fig: 11 (Ques 4.b)

c. A force F is acted upon a body A as shown in figure 12. Line of action of F is horizontal. Body A is connected with another body B with a weightless cable. Given w_A=300 lb, w_B = 500 lb, f_A =f_B = 1/3. What force E will cause impending motion upward (toward right)? What will be the tension in the cable? 1

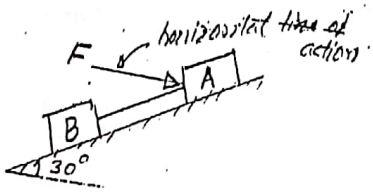


Fig 12: (Ques 4.c)

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SECTION-B

Question 5

a. The sliding members A and B, fig. 5(a), are constrained to move at all times in the y and x directions, respectively. They are connected by the rod whose length is L =10 ft. At the instant when x= 8ft., v_B =20 fps toward the right and a_B = -15 fps^2 toward the left. Determine the velocity and acceleration of A at this instant. $15\frac{2}{3}$

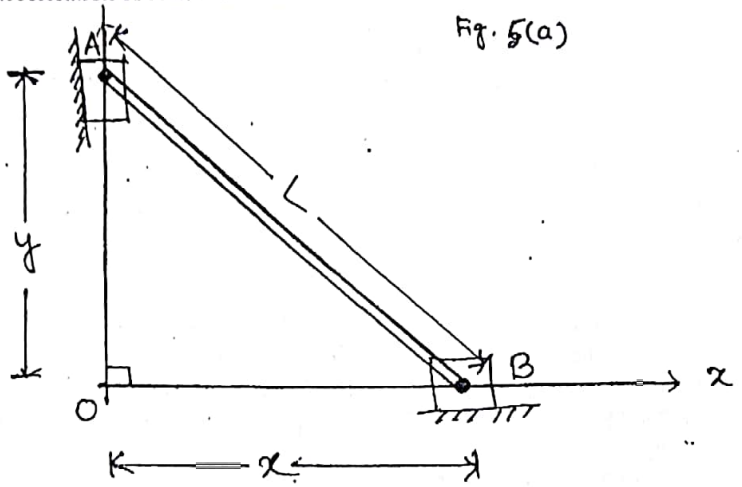


Fig. 5(a)

b. Considering that, a sphere is generated by the revolution of semi-circular area about its diameter. Determine the volume and surface area of that sphere in terms of its radius. Use relevant theorems of Pappus and Guldinus. 13

c. For the following composite section as shown in fig. 5(c), determine the moment of inertia and corresponding radius of gyration about centroidal axis parallel to x axis. All dimensions are in mm. 18

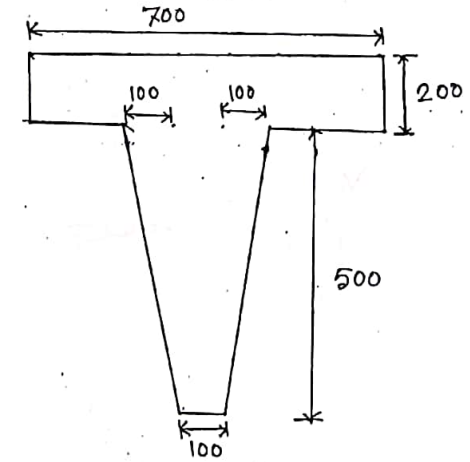


Fig 5(c)

Question 6

a. A train runs at a speed of 120 km/hr in a curve track of radius 900m. The application of brakes suddenly causes the train to slow down at a constant rate. After 6 seconds, the speed has been reduced to 72 km/hr. Determine the acceleration of the train immediately after the brake is applied. 14

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b. A slender brass rod of uniform cross-section is welded at the mid height of a cast-iron cylinder as shown in fig 6(b). Weight of the brass rod and unit weight of cast iron are 20 lb and 490 lb/ft^3 respectively. Calculate the radius of gyration of this composite mass with respect to z′ axis. 18

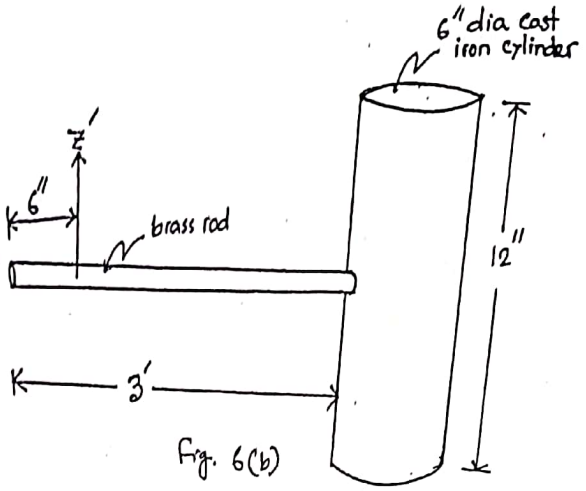


Fig. 6(b)

c. Using the method of direct integration, locate the coordinates of centroid of the bounded area as shown in fig 6(c)

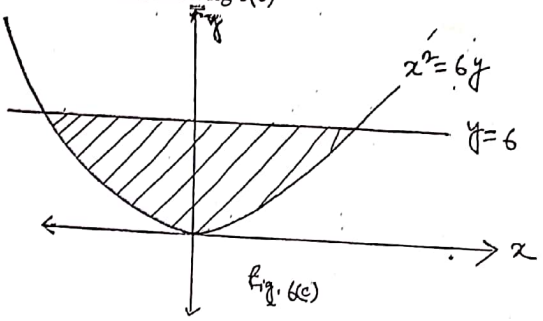


Fig. 6(c)

Question 7

a. A jet of water flowing at a rate of W=5 lb per sec issues from a nozzle with velocity V_{s1} =400 fps (fig. 7(a)). It enters a fixed blade and is turned through 120° before it is discharged. Determine: 16

(i) What are the horizontal and vertical components of the force exerted upon the fixed blade?

(ii) When the blade starts to move with a speed V_B =200 fps toward the right, find the reaction Qx and Qy.

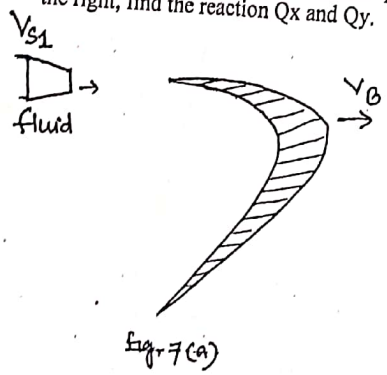


Fig. 7(a)

b. A cable loaded with 110 lb/ft horizontally is strung between two supports which are 81 ft apart. One support is 15 ft below the other and the sag measured from the higher support is 20 ft. Compute: 1

(i) Minimum Tension at the Cable
(ii) Tension at each support
(iii) Length of the Cable

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c. Locate the coordinates of the centroid of the composite shaded area as shown in fig 7(c). 16

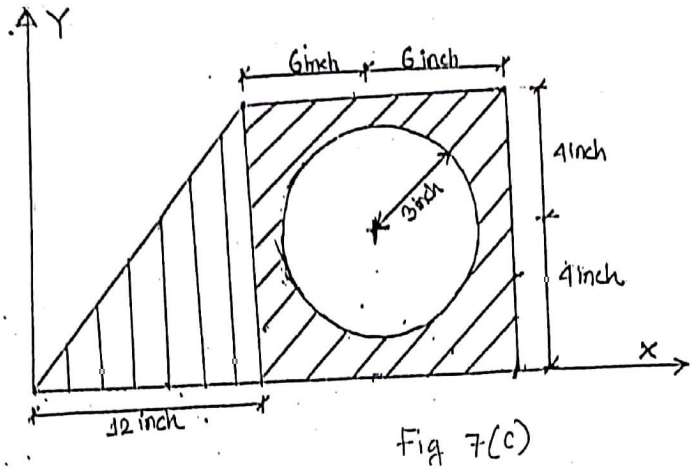


Fig 7(c)

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Question 8

a. A body A is projected vertically downward from a 500 ft. cliff with an initial velocity of 10 fps. One second later, a body B is projected vertically upward from the bottom of the cliff with an initial velocity 70 fps. 15

(i) When do these bodies pass one another? Time to be measured from the beginning of the motion of A.

(ii) How far above the bottom of the cliff are the bodies when they pass? Neglect air resistance.

b. Find the height of the concrete dam (section is shown in fig 8(b)) where water is considered to be always at the top, XY. Here, the overturning moment of water pressure is one-third of the moment of weight of the dam resisting overturning (weight of the concrete dam). Let the unit weights of water and concrete be 62.5 lb/ft^3 and 150 lb/ft^3 respectively. $16\frac{2}{3}$

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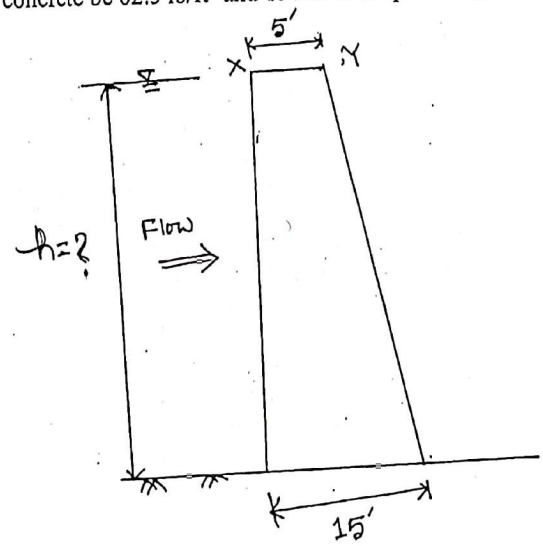


Fig. 8(b)

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c. For the shaded area, as shown in fig. 8(c), determine, moment of inertia and corresponding radius of gyration about the centroidal axis parallel to y-axis.

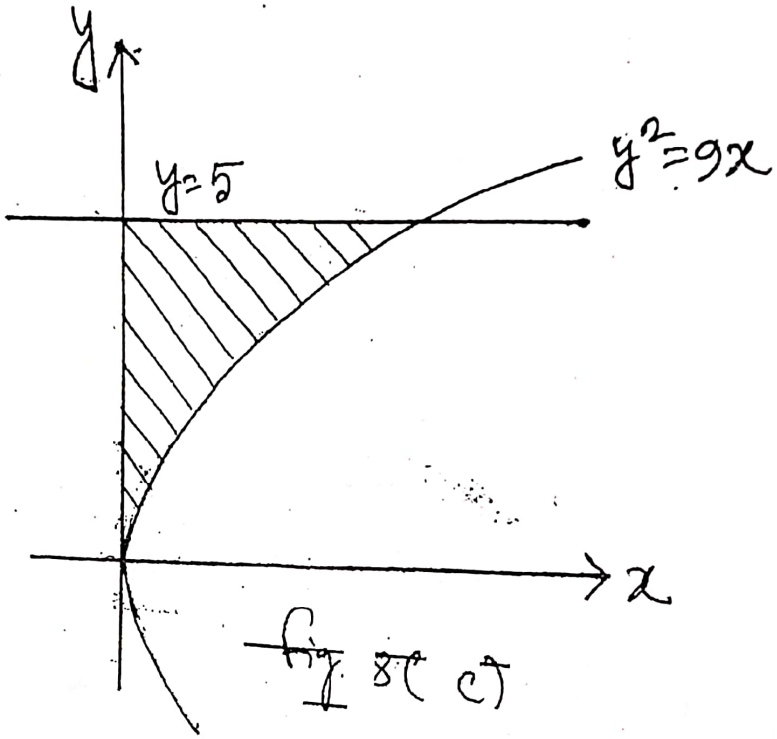


fig 8(c)

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