KATHMANDU UNIVERSITY
End Semester Examination [C]
December, 2024

Marks Scored:

Level : B.E.
Year : II
Course : MEEG 216
Semester : I
Exam Roll No. :
Time: 30 mins.
F. M. : 20
Registration No.:
Date : 19 DEC 2024

SECTION "A"
[20Q. × 1 = 20 marks]

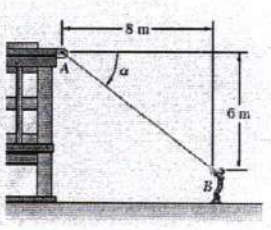
Choose the most appropriate answer and **encircle.** Assume the value of acceleration due to gravity (g) = 9.8 m/sec^2 wherever it is required to use.

1. The forces, which meet at one point and their lines of action lie in a plane, are called
   a. Coplanar non-concurrent forces
   b. Non-coplanar concurrent forces
   c. Non-coplanar non concurrent forces
   d. Parallel forces

2. Two forces of 30 N and 40 N are perpendicular to each other. The resultant of these forces will be
   a. 70 N b. 50 N c. 120 N d. 20N

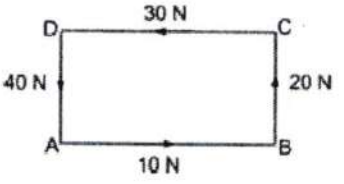
3. The principle of transmissibility of forces states that, when a force acts upon a body, its effect is
   a. same at every point on its line of action
   b. different at different points on its line of action
   c. minimum, if it acts at the centre of gravity of the body
   d. maximum, if it acts at the centre of gravity of the body

4. A man pulls with a force of 300 N on a rope attached to the top of a building, as shown in Fig. What are the horizontal and vertical components of the force exerted by the rope at point A?
   a. Fx= -240 N Fy= +180N
   b. Fx= +240 N Fy= +180N
   c. Fx= -240 N Fy= -180N
   d. Fx= +240 N Fy= -180N



5. Zero force members have ..... loadings.
   a. Minimum b. Maximum c. No d. Any

6. Forces 10 N, 20 N, 30 N and 40 N act along sides of a rectangle. Their resultant force will be_____.
   a. 100 N b. 32.32N
   c. 28.28N d. 40N

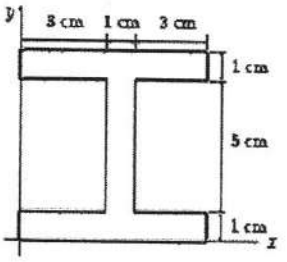


7. If a ball is thrown vertically upwards, the ball will reach highest elevation when
   a. acceleration is maximum b. velocity is maximum

c. velocity is zero d. acceleration is zero

8. To design the truss which of the following is **CORRECT**.
   a. All the loads are applied by the use of cables
   b. The loads are applied at the joints
   c. All the loads are applied to members
   d. The loads are applied at the supports

9. What are the coordinates of the centroid of the I beam section shown?
   a. $\bar{x} = \bar{y} = 3.5$ cm
   b. $\bar{x} = \bar{y} = 7$ cm
   c. $\bar{x} = 3.5$ cm $\bar{y} = 7$cm
   d. $\bar{x} = 7$ cm $\bar{y} = 3.5$ cm

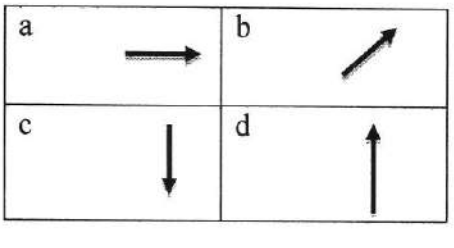


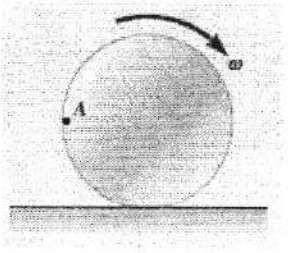
10. The angle of inclination of the plane at which the body begins to move down the plane, is called?
    a. Angle of repose b. Angle of inclination
    c. Angle of Friction d. Angle of motion

11. A Ball is dropped from the top of a tall building. If it takes 2.8 seconds to fall on the ground, find the height of the building.
    a. 30.5 m b. 25.7 m c. 38.4 m d. 48.5 m

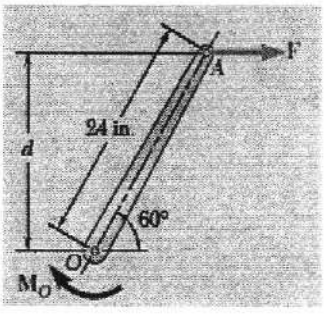
12. During elastic impact, the relative velocity of the two bodies after impact is _____ the relative velocity of the two bodies before impact.
    a. equal to b. equal and opposite to
    c. less than d. greater than

13. The ball rolls without slipping on the fixed surface as shown. What is the direction of the resultant velocity of point A?





14. Vertical force F is applied to the end of a lever, which is attached to a shaft at O. Value of force F to create 1200 lb.in. moment about o is
    a. 100 lb
    b. 58 lb
    c. 50 lb
    d. 52 lb



15. When work is done in moving a particle around a closed loop in a field is zero, forces in the field are called

a. Zero forces
b. Non-Conservative forces
c. Conservative forces
d. Viscous forces

16. A 20 Ton railroad car moving with 0.5 m/s speed to the right collides with 35 Ton car which is at the rest. the coefficient of restitution between the two cars is e=0.05. determine the common speed of the cars after collision

a. 0.15 m/s
b. 0.18 m/s
c. 0.21 m/s
d. 0.24 m/s

17. A ladder is resting on smooth ground and leaning against a rough vertical wall. The force of friction will act

a. towards the wall at its upper and
b. away from the wall at its upper end
c. downward at its upper end
d. upward at its upper end

18. The motion of a particle is defined by the relation $x = 2t^3 - 9t^2 + 12t + 10$, where x and t are expressed in feet and seconds, respectively. The acceleration of the particle after 2s is

a. $-6.00\ ft./s^2$
b. $+6.00\ ft./s^2$
c. $-3.00\ ft./s^2$
d. $+3.00\ ft./s^2$

19. The moment of inertia of a triangular section of base b and height h about an axis passing through its C.G. and parallel to the base, is

a. $bh^3/4$
b. $bh^3/8$
c. $bh^3/12$
d. $bh^3/36$

20. For perfectly elastic bodies, the value of the coefficient of restitution is

a. 0
b. Between 0 and 1
c. 1
d. 0.5

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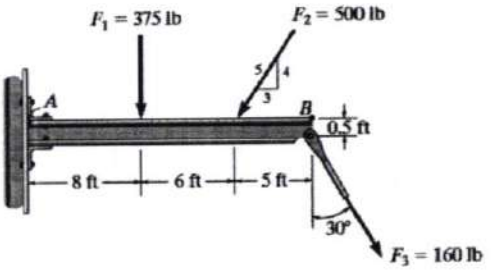
SECTION "B"
[55 marks]

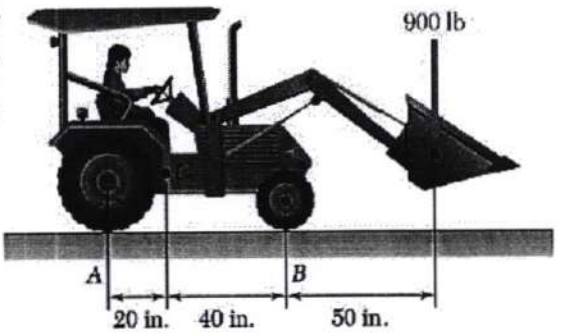
Attempt *ALL* questions. Assume data with justification if necessary.

1.

a. Determine the moment about point A of each of the three forces acting on the beam. [3]

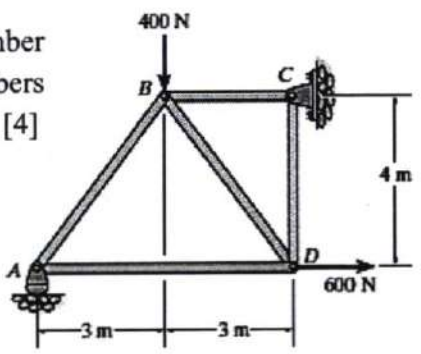


b. A 2100-lb tractor is used to lift 900 lb of gravel. Determine the reaction at each of the two (a) rear wheels A, and (b) front wheels B. [2+2]

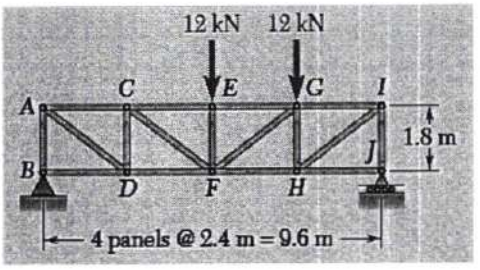


2.

a. Determine the force in each truss member shown in Figure. Indicate whether the members are in tension or compression. [4]

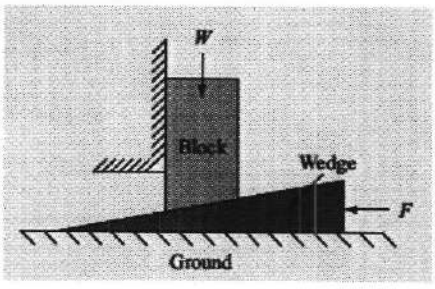


b. Determine the force in members CD and DF of the truss shown. [4]

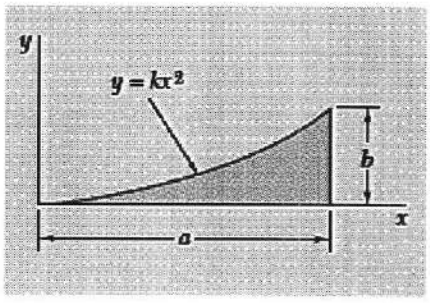


P.T.O.

3. A block of mass 150 kg is to be raised by means of inserting a 10° wedge weighing 50 kg under it and by applying a horizontal force at it as shown. Assuming the coefficient of friction between all surfaces of contact as 0.3, determine what minimum horizontal force should be applied to raise the block. [6]



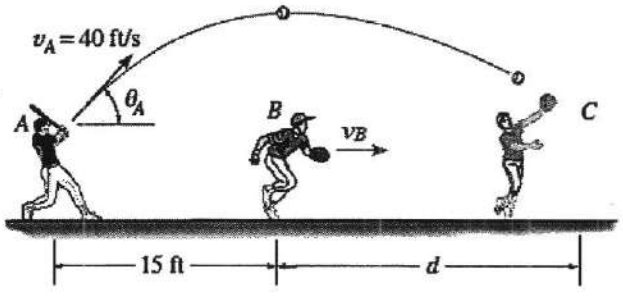
4. Determine the location of the centroid of a parabolic spandrel by direct integration and determine the moment of inertia about the x and y axes. [5+5]



5.

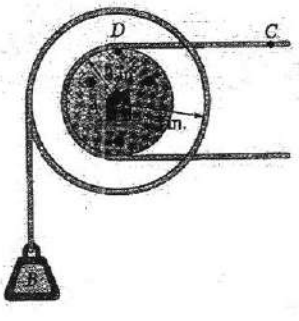
a. A snowboarder starts from rest at the top of a hill. As he rides down the slope, GPS coordinates are used to determine his displacement as a function of time: **x= $0.5t^3 + t^2 + 2t$** where **x** and **t** are expressed in **ft.** and **seconds**, respectively. Determine the position, velocity, and acceleration of the boarder when **t = 5** seconds. [3]

b. The cricket batsman A hits the ball at v_A **= 40 ft/s** and θ_A **= 60°** from the horizontal. When the ball is directly overhead of player B he begins to run under it. Determine the constant speed v_B at which B must run and the distance d in order to make the catch at the same elevation at which the ball was hit. (acceleration due to gravity =32.2 ft/s^2). [5]

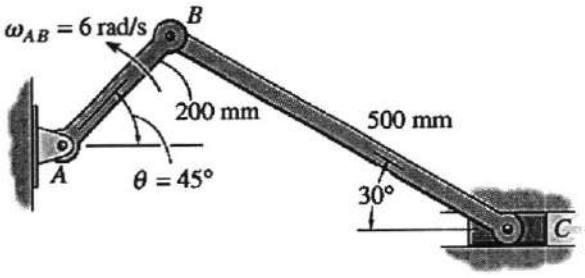


6.

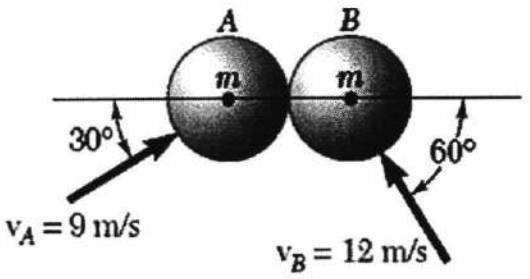
a. Cable C has a constant acceleration of 9 in/s^2 and an initial velocity of 12 in/s, both directed to the right. Determine (a) the number of revolutions of the pulley in 2 s, (b) the velocity and change in position of the load B after 2 s, and (c) the acceleration of the point D on the rim of the inner pulley at t = 0. [4]



b. If bar AB has an angular velocity ω_{AB} = **6 rad/s**, determine the velocity of the slider block C at the instant shown. [4]



7. The magnitude and direction of the velocities of two identical frictionless balls before they strike each other are as shown. Assuming e = 0.9, determine the magnitude and direction of the velocity of each ball after the impact. [8]



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SECTION "A"

[20Q. × 0.5 = 10 marks]

Choose and mark [X] encircle the most appropriate option from each set of choices

1. Which of the following is an example of dimensionless variables
   [ ] Mass [ ] Mole
   [ ] Volumetric growth rate [ ] Specific gravity

2. Unit of specific growth rate is
   [ ] h-1 [ ] gh-1 [ ] gL-1h-1 [ ] Moles h-1

3. The concept of material balance is based upon
   [ ] Conservation of mass [ ] Conservation of energy
   [ ] Conservation of momentum [ ] Conservation of volume

4. An example of a closed system is
   [ ] Batch Process [ ] Fed batch Process
   [ ] Semi batch Process [ ] Continuous Process

5. RQ (Respiratory Quotient) can be defined as
   [ ] Volume of carbon dioxide evolved ÷ Volume of oxygen consumed
   [ ] Volume of carbon dioxide evolved = Volume of oxygen consumed
   [ ] Volume of oxygen evolved ÷ Volume of carbon dioxide consumed
   [ ] Volume of oxygen consumed ÷ Volume of carbon dioxide evolved

6. General equation of cell growth is
   [ ] $C_wH_xO_yN_z + O_2 + H_gO_hN_i \rightarrow cC_\alpha H_\beta ON + CO_2 + H_2O$
   [ ] $cC_wH_xO_yN_z + O_2 + dH_gO_hN_i \rightarrow eC_\alpha H_\beta ON + CO_2 + H_2O$
   [ ] $aC_wH_xO_yN_z + bO_2 + cH_gO_hN_i \rightarrow dC_\alpha H_\beta ON + eCO_2 + fH_2O$
   [ ] $C_wH_xO_yN_z + aO_2 + bH_gO_hN_i \rightarrow cCH_\alpha O_\beta N_\delta + dCO_2 + eH_2O$

7. Biomass yield is often calculated as
   [ ] g cells produced /g product formed
   [ ] g product formed/ g substrate consumed
   [ ] g cells produced/ g substrate consumed
   [ ] g substrate formed/ g product produced

8. In a stirred tank reactor, the equipment that reduces vertex formation is
   [ ] agitator [ ] Impeller [ ] Baffles [ ] Sparger

9. Maximum theoretical biomass yield is obtained from the substrate:
[ ] Glucose [ ] Fructose [ ] Methane [ ] Starch

10. Which of the following is not an intensive variable?
[ ] Temperature [ ] density [ ] mole fraction [ ] Volume

11. Oxygen demand of a typical bacteria without growth is approximately
[ ] 1 [ ] 2 [ ] 4 [ ] 6

12. Stoichiometric yield is also known as
[ ] Observed yield [ ] Apparent Yield [ ] Theoretical yield [ ] Maximum yield

13. In Michaelis -Menten kinetics the units of the unit of Michaelis constant (Km) is
[ ] mg/ml [ ] mg [ ] mg/ml/min [ ] mg/min

14. What is the width of baffle in terms of the tank diameter?
[ ] 1/5- 1/10 * tank diameter [ ] 1/10-1/12 * tank diameter
[ ] 1/12-1/15 * tank diameter [ ] 1/5-1/12 * tank diameter

15. Maximum theoretical biomass yield for glucose is
[ ] 0.4 [ ] 0.6 [ ] 0.8 [ ] 0.9

16. Heat of reaction (ΔH_{rxn}) for fully aerobic metabolism is approximately
[ ] – 130 kJ $gmol^{-1}$ O_2 consumed [ ] – 230 kJ $gmol^{-1}$ O_2 consumed
[ ] – 460 kJ $gmol^{-1}$ O_2 consumed [ ] – 550 kJ $gmol^{-1}$ O_2 consumed

17. Which of the following is the slowest step in an ideal mixing process?
[ ] Distribution [ ] Diffusion
[ ] Dispersion [ ] Decomposition

18. The equipment used for aeration in a bioreactor is called
[ ] Sparger [ ] Baffle [ ] Stirrer [ ] Impeller

19. During death phase the specific growth rate (μ) is
[ ] $\mu > 0$ [ ] $\mu > 1$ [ ] $\mu < 0$ [ ] $\mu < 1$

20. The standard heat of combustion for bacteria is approximately
[ ] -23.2 kJ g^{-1} [ ] -20.4 kJ g^{-1} [ ] -21.2 kJ g^{-1} [ ] -19.2 kJ g^{-1}

SECTION "B"
[10Q x 1 = 10 marks]

Fill in the blanks.

21. A _____ process allows matter to flow in and out of the system/fermenter.

22. Reynolds number is an example of _____ variables.

23. The dimension of specific volume is _____.

24. Available electrons are _____ during metabolism

25. The most frequently used impeller in the fermentation industry is _____.

26. _____ energy is the sum of all molecular, atomic, and subatomic energies of matter.

27. The properties of a system that depends on the quantity of matter present is called _____ properties.

28. The number of available electrons for a carbon atom is _____.

29. The expression for calculation of product yield (Y_{ps}) is _____.

30. _____ flow is generated by impellers with blades aligned parallel to the stirrer shaft.