

EXAMINATION AND EVALUATION DIVISION  
DEPARTMENT OF POLYTECHNIC EDUCATION  
(MINISTRY OF HIGHER EDUCATION)

MECHANICAL ENGINEERING DEPARTMENT

FINAL EXAMINATION  
DISEMBER 2011 SESSION

**JJ311: MECHANICS OF MACHINES**

**DATE : 26 APRIL 2012(THURSDAY)**  
**DURATION : 2 HOURS(8.30 AM – 10.30 AM)**

This paper consists of **ELEVEN ( 11 )** pages including the front page.  
Section A : Objective (25 questions – answer all)  
Section B : Structured (4 question - answer 3 questions )

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JJ311: MECHANICS OF MACHINES

**SECTION A**

**OBJECTIVES (25 marks)**

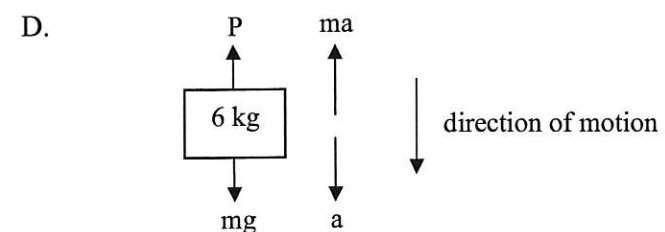
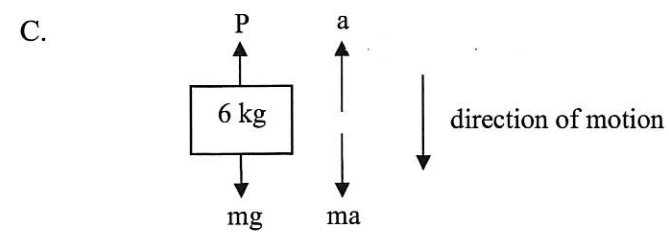
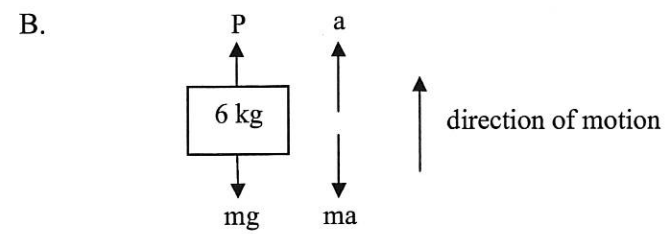
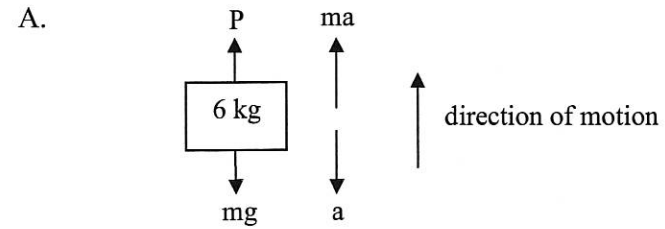
**INSTRUCTION:**

This section consists of **TWENTY FIVE (25)** objective questions.

Answer **ALL** questions in the answer booklet.

1. Which is the correct statement for the main functions of the hoisting machine?  
[CLO1]
  - A. Help to reduce friction between the drum and pulley
  - B. Help to lift up and down the loads
  - C. Help to increase power consumption
  - D. Help to reduce potential and kinetic energy
2. To find the driving torque in a hoisting system all the statements below are correct **EXCEPT** [CLO1]
  - A. The direction of inertia force is always opposite to the direction of the rope tension.
  - B. The direction of inertia force is always opposite to the direction of the mass acceleration.
  - C. The rotational direction of the drum is always opposite to the direction of friction torque.
  - D. The rotational direction of the drum is always opposite to the direction of brake torque.

3. A hoisting system is used to lift up a 300 kg of mass with constant velocity, the tension of the cable is[CLO1]
- A.  $P = (300 \times 9.81) \text{ N}$   
 B.  $P = (300 \times 9.81) + (300 \times a) \text{ N}$   
 C.  $P = (300 \times 9.81) - (300 \times a) \text{ N}$   
 D.  $P = (300 / 9.81) \text{ N}$
4. Which figure is correct if the load of 6 kg is needed to lift with acceleration?  
 [CLO1]



5. Based on your answer in Question 4 above, the formula to determine the tension of the rope is \_\_\_\_\_ [CLO1]
- A.  $P = mg - ma$   
 B.  $P = mg - a$   
 C.  $P = mg + a$   
 D.  $P = mg + ma$
6. A mass-spring system makes 50 complete oscillations in 10 seconds. What is the periodic time and frequency of the oscillations? [CLO1]
- A. Period = 0.2 s , Frequency = 5 Hz  
 B. Period = 0.02 s , Frequency = 1.5 Hz  
 C. Period = 0.05 s , Frequency = 4 Hz  
 D. Period = 1.25 s , Frequency = 4 Hz
7. A simple pendulum oscillates with a periodic time of 5 seconds. How many complete oscillations does it make in 15 seconds? [CLO1]
- A. 5  
 B. 3.5  
 C. 3  
 D. 0.3
8. A mass-spring system oscillates with a frequency of 20 Hz. What is the period? [CLO1]
- A. 1/2 s  
 B. 1/10 s  
 C. 1/20 s  
 D. 1/0.2 s

9. What is the frequency of a mass-spring oscillation system with a spring constant of 125 N/m and mass of 3 kg? [CLO1]
- A. 1.027 Hz  
B. 10.27 Hz  
C. 0.27 Hz  
D. 1.27 Hz
10. What is the mass which causes a spring of  $k = 80$  N/m to stretch by 4 cm? [CLO1]
- A. 1.12 kg  
B. 0.326 kg  
C. 3.2 kg  
D. 11.32 kg
11. Friction force ( $F$ ), normal reaction ( $N$ ) and coefficient of friction ( $\mu$ ) are written as \_\_\_\_\_ [CLO3]
- A.  $N = \mu F$   
B.  $F = \mu N$   
C.  $\mu = FN$   
D.  $\mu = F/N$
12. The angle of friction is the \_\_\_\_\_ [CLO3]
- A. frictional force when the body is in the motion.  
B. ratio of friction and normal friction.  
C. angle between the normal reaction and the resultant of the normal reaction and limiting friction.  
D. angle between the friction force and the tangent.

13. A toolbox of mass  $M$  is resting on a flat board. One end of the board is lifted up until the toolbox just starts to slide. The angle  $\alpha$  that the board makes with the horizontal for this to occur depends on the \_\_\_\_\_ [CLO3]
- A. mass,  $M$   
B. gravity is not acting on it.  
C. normal force.  
D. coefficient of static friction,  $\mu$ .
14. A boy pulls a wooden box along a rough horizontal floor at constant speed by a force,  $P$  as shown in Figure A(14). In the diagram,  $F$  is the magnitude of the force of friction,  $N$  is the magnitude of the normal force, and  $mg$  is the magnitude of the force due to gravity. If the box is in equilibrium, which of the following is true?

[CLO3]

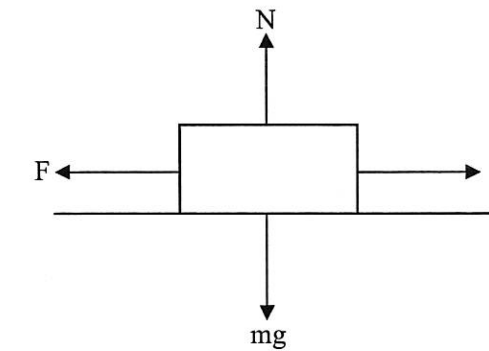


Figure A(14)

- A.  $P < F$  and  $N = mg$   
B.  $P > F$  and  $N > mg$   
C.  $P = F$  and  $N = mg$   
D.  $P = F$  and  $N > mg$

15. A 7.6 kg object is pulled along a horizontal surface. If the coefficient of friction between the surfaces is 0.20, find the frictional force? [CLO3]
- 1.49 N
  - 14.9 N
  - 1.52 N
  - 15.2 N
16. Which of the heavy industrial equipment below is **NOT** related with balancing concept? [CLO4]
- Electric generator
  - Pump
  - Turbine
  - Boiler
17. Dynamic balance occurs when \_\_\_\_\_ [CLO4]
- no resulting turning moment along the axis.
  - no resultant centrifugal force and centre of gravity is on the axis of rotation.
  - bodies at rest or forces that balance each other.
  - energy or forces that produce motion.
18. What is the definition of resultant force? [CLO4]
- A force acts upon an object that tends to restore it to a lower energy configuration.
  - A force resisting the relative motion of solid surfaces, fluid layers, and/or material elements sliding against each other.
  - A force which is the result of combination of two or more forces.
  - An imaginary force supposed to act upon an accelerated body, equal in magnitude and opposite in direction of the real forces.

19. \_\_\_\_\_ is an effect that seems to cause an object moving in a curve to be pushed away from the curve's center by the inertia of the body. [CLO4]
- Centrifugal force
  - Momentum
  - Inertia force
  - Resultant force
20. What symbol is used to represent angular velocity in mechanic motion? [CLO5]
- $\alpha$
  - $\mu$
  - $\omega$
  - $\theta$
21. Which of the following statements listed below is **NOT** the belt drives application in industry? [CLO5]
- Used in conveying systems.
  - Used for transmission of power.
  - Replacement of rigid type power transmission.
  - As a machine for raising and lowering load by means of a cable.
22. Which of the following below is **NOT** the type of belts used in belt drives? [CLO5]
- Flat belt
  - Vee belt
  - Timing belt.
  - Linear belt.

23. Belt can be produced by using materials listed below **EXCEPT** \_\_\_\_\_  
[CLO5]

- A. Leather
- B. PVC
- C. Metal
- D. Rubber

24. What is the type of arrangement belt drive shown in Figure A(24)?[CLO5]

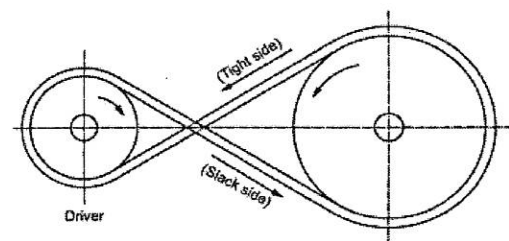


Figure A(24)

- A. Open belt drive
- B. Crossed belt drive
- C. Drive with idler pulley
- D. Drive with jockey or rider pulley

25. Which of the following below is the advantage of the belt drives?[CLO5]

- A. Less floor space is required for same number of machines.
- B. The increase of power in transmission is due in number of parts increasing.
- C. If any one of the power transmission elements fails, total system comes to stand still.
- D. Wide variation in speed and torque cannot be attained.

## SECTION B

### STRUCTURED (75 marks)

#### INSTRUCTION:

This section consists of **FOUR (4)** structured questions.

Answer **THREE (3)** questions only.

#### QUESTION 1

A hoisting system is used to lift up the load of 60 kg with an acceleration of  $2.1 \text{ m/s}^2$ . The pulley has 400 mm diameter, radius of gyration 35cm and mass 20 kg. A balancer of 45 kg is attached to the other end of the string. Ignore the friction between rope and pulley. [CLO1]

- i) Draw the Free Body Diagram of hoisting system. (4 marks)
- ii) Calculate the tension for each string. (6 marks)
- iii) Find the torque to operate the system. (4 marks)
- iv) After 5 seconds, the pulley has to stop. Determine necessary torque brake to stop movement of the load. (11 marks)

#### QUESTION 2

A piston, connecting rod and crank mechanism is shown in Figure 2 below. The crank rotates at a constant velocity of 300 rad/s. Find the acceleration of the piston and the angular acceleration of the link BC. The diagram is not drawn to scale. [CLO2]

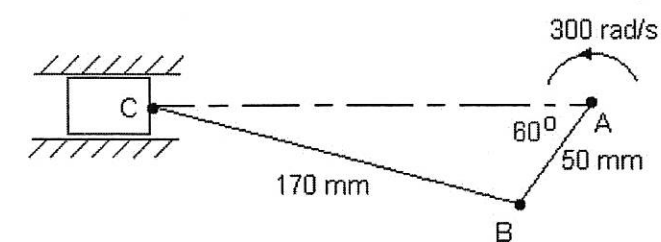


Figure 2

(25 marks)

**QUESTION 3**

A 100 kg block is pulled by a force which is positioned  $35^\circ$  inclined from the horizontal. If the coefficient of friction between two surfaces contact is 0.3, [CLO3]

- a) Draw the free body diagram (4 marks)
- b) Find the force required to initiate motion up the block. (13 marks)
- c) Calculate the minimum force to pull up the block (8 marks)

**QUESTION 4**

A close belt drive connects two pulleys of 420 mm and 280 mm, distance between two pulleys is 3 m. The larger pulley rotates at 200 rev/min and the maximum tension in it is not exceed 1.7 kN. Coefficient of friction between belt and pulleys is 0.3. Calculate:[CLO5]

- a) Angle of contact between the belt and each pulley (9 marks)
- b) Length of the belt (4 marks)
- c) Power transmitted by the belt (12 marks)