JUNE 2007

Code: AE-03
Subject: APPLIED MECHANICS
Time: 3 Hours **Max. Marks: 100**

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. A must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x10)

a. The moment of inertia of a thin ring of mass 'm' and radius 'R' about any diameter is

(A) mR^2 **(B)** $\frac{mR^2}{2}$

(C) $\frac{mR^2}{4}$ **(D)** $\frac{mR^2}{8}$

b. Rain is falling down vertically. A person sitting in a train moving with a velocity of 60 kmph feels that rain is falling down at an angle of 45°. What is the velocity of rain in kmph?

(A) 30 **(B)** 45
(C) 60 **(D)** 75

c. A shell of mass 20 Kg is fired from a gun of mass 2000 Kg. The shell has a velocity of 500 m/s, what is the velocity of recoil of gun in m/s?

(A) –500 **(B)** –250
(C) –2.5 **(D)** –5

d. Two masses of 2 Kg and 2.1 Kg are connected through a rope passing over a frictionless pulley. The acceleration of the system is given by

(A) $\frac{g}{20}$ **(B)** $\frac{g}{40}$

(C) $\frac{g}{41}$ **(D)** $\frac{g}{42}$

e. The Poisson's ratio for an elastically incompressible material is

(A) $\frac{1}{4}$. **(B)** $\frac{1}{3}$.

(C) $\frac{1}{2}$. **(D)** 1.

f. A beam 5 m long is simply supported at its ends and carries a load of 10 kN at a distance of 1 m from the left end. The maximum value of shear force at some section of the beam is

(A) 2 kN **(B)** 5 kN
(C) 8 kN **(D)** 10 kN

g. A simply supported beam of length ℓ carries a concentrated load W at its centre. What is the downward deflection at the Centre?

(A) $\frac{W\ell^3}{3EI}$ **(B)** $\frac{W\ell^3}{8EI}$

(C) $\frac{W\ell^3}{48EI}$ **(D)** $\frac{5W\ell^3}{384EI}$

h. A rectangular block of ice floats on the surface of water contained in a rectangular tank. When ice melts completely the level of water will

(A) remain same **(B)** rise
(C) fall **(D)** depend on the temperature of water

i. A forced vertex occurs when

(A) a fluid has a random motion
(B) the fluid particles turn in opposite direction to a free vortex
(C) the rotating fluid has both radial and tangential velocities
(D) each particle moves in a circular path with speed varying as distance from the axis of rotation.

j. A control volume refers to:

(A) a fixed region in space **(B)** an isolated system
(C) a closed system **(D)** an enclosure with adiabatic walls

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. State law of polygon of forces. **(2)**

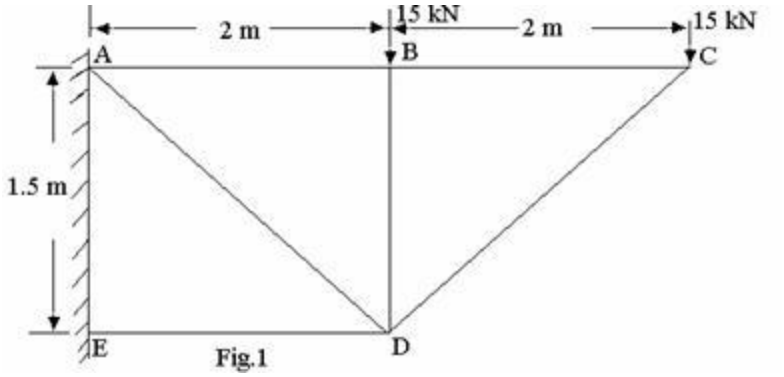

Fig.1

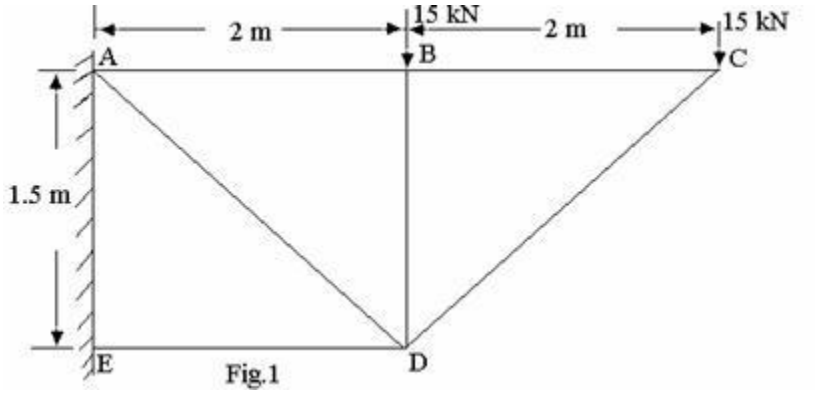

Fig.1

b. Determine the forces and the nature of the force in all the members of the truss shown in Fig.1 Find also reactions. Tabulate the results. Use method of joints. **(14)**

Q.3 a. Define mechanical advantage, velocity ratio and efficiency. **(3)**

b. In a lifting machine, an effort of 120 N raises a load of 5000 N. An effort of 76 N raises a load of 3000 N. What would be the effort required to raise a load of 6000 N. What can be the maximum efficiency of this machine, if the effort moves by 1400 mm to raise the load through 20 mm? **(13)**

Q.4 a. Define angular velocity and angular acceleration. **(2)**

b. A circus performer rides a jeep across a gap AB of 6 m as shown in Fig.2 i.e. jumps from A to B. What minimum speed he must have at A to cross this gap.

The incline at A is 10° and A and B are at the same level. **(14)**

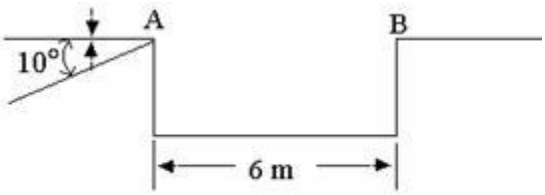

Fig.2

Q.5 a. State the principle of conservation of momentum. **(2)**

b. A car weighing 12 kN is moving along a straight line at a speed of 70 kmph. The brakes are suddenly applied and the car skids. Determine the time required for the car to stop, if the coefficient of friction between road and tyres is 0.68. What would be the time taken for the car to stop, if the road is slippery and the coefficient of friction is 0.12 between road and tyres. **(14)**

Q.6 a. State Hooke's Law. **(2)**

b. A steel rod 20 mm diameter passes centrally through a steel tube 25 mm internal and 40 mm external diameter. The tube is 75 cm long and is closed by rigid washers of negligible thickness which are fastened by nuts screwed to the rod. Calculate the stresses in the tube and rod when the nuts are tightened until the compressive load on the tube is 10 kN.
Find the increase in these stress when one nut is tightened and it advances by 1.25 mm. Take $E = 210 kN/mm^2$. **(14)**

Q.7 a. State the bending equation and give the units of all its terms. **(3)**

b. A cantilever 3 m long and of symmetrical section 0.5 m deep, carries a uniformly distributed load of 700 N/cm throughout its length. If $I = 49{,}000 cm^4$ and $E = 210 kN/mm^2$, calculate the deflection at the free end of the beam.
What will be the maximum point load in addition to the distributed load, that the cantilever can carry at a distance of 1 m from the free end, if

(i) the bending stress must not exceed $180 N/mm^2$
(ii) the deflection at the free end must not exceed 1.0 cm. **(13)**

Q.8 a. Define total pressure and centre of pressure. **(4)**

b. Find the magnitude and direction of the resultant force due to water pressure acting on a roller gate of cylindrical form of 5 m diameter when the gate is placed on a dam in such a way that water is going to spill. Take length of gate as 10 m. **(12)**

Q.9 a. Define stream function and state its physical significance. **(8)**

b. The velocity potential function ϕ is given by:

$$\phi = -\frac{xy^3}{3} - x^2 + \frac{x^3 y}{3} + y^2$$

(i) Find the velocity components in x and y directions.

(ii) Show that ϕ represents a possible case of flow. **(8)**