CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY – MARINE ENGINEER OFFICER

EXAMINATIONS ADMINISTERED BY THE
SCOTTISH QUALIFICATIONS AUTHORITY
ON BEHALF OF THE
MARITIME AND COASTGUARD AGENCY

STCW 95 CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-31 – APPLIED MECHANICS

TUESDAY, 29 MARCH 2011

1315 - 1615 hrs

Examination paper inserts:

Notes for the guidance of candidates:

1. Non-programmable calculators may be used.

2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by colleges:

Candidate’s examination workbook
Graph paper

APPLIED MECHANICS

Attempt SIX questions only

All questions carry equal marks

Marks for each part question are shown in brackets

1. A motor of mass 120kg with a radius of gyration of 0.5m is accelerated from rest to its full speed of 720 rev/min in 15 seconds. It is then clutched onto a stationary rotary pump of 50kg mass with a radius of gyration of 0.38m.

   Calculate EACH of the following:

   (a) the torque produced to accelerate the motor; (3)

   (b) the common speed of the motor and pump after the clutch is engaged; (5)

   (c) the energy lost during the clutching operation; (4)

   (d) the time for the motor and pump to reach full speed after engagement if the motor torque remains as calculated in Q1(a). (4)

2. A Porter Governor has two flyweights each of mass 1.4kg, a central mass of 20kg and arms of length 210mm.

   At 300 rev/min the sleeve is just about to rise and the arms are at an angle of 35° to the vertical.

   Calculate EACH of the following:

   (a) the friction force at the sleeve; (12)

   (b) the speed at which the sleeve would begin to fall. (4)

3. Two masses are suspended by a light cord from a light smooth moveable pulley. The moveable pulley is suspended over a fixed light smooth pulley by a light cord with a mass of 7kg attached to the other end of the cord as shown in Fig Q3. The masses are then released from the rest position.

Calculate EACH of the following:

(a) the acceleration of the 7kg mass; (8)

(b) the tension in each cord. (8)

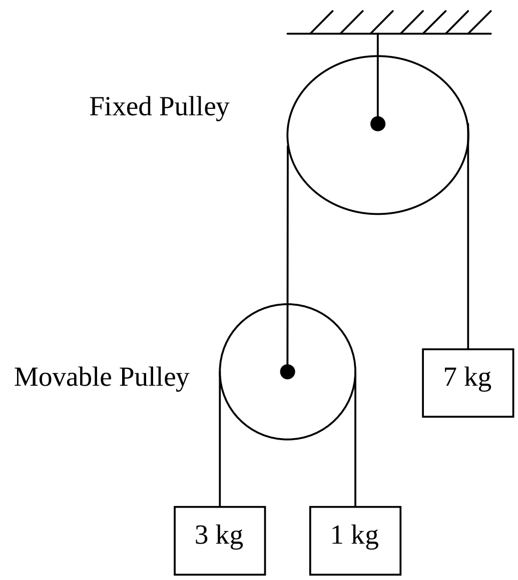

Fig Q3

4. A vessel travelling due West at 18 knots sights another vessel eight nautical miles away in a direction 20° South of West. Thirty minutes later the second vessel is three nautical miles away in a direction 50° South of West.

Determine EACH of the following:

(a) the distance of nearest approach between the two vessels if they both maintain their present speed and course; (8)

(b) the course and speed of the second vessel. (8)

5. Sea water is pumped through a cooler at a rate of 220 tonnes per hour. The pump suction is 9m below the waterline, the length of pipeline between the pump and the cooler is 22m and the cooler is 6m above the pump. The pump discharge pipe has a diameter of 140mm. The maximum allowable cooler pressure drop is 0.5 bar and the cooler discharges directly overboard, 3m below the waterline. Friction losses in the suction pipeline can be ignored, but for the pump discharge pipeline the friction coefficient for D'Arcy's formula can be taken as 0.009.

Calculate EACH of the following:

(a) the pump suction pressure; (2)

(b) the head lost due to the pipeline friction between the pump and the cooler; (4)

(c) the pump discharge pressure when the maximum pressure drop across the cooler is reached; (6)

(d) the maximum power delivered by the pump. (4)

Note: Density of Seawater = 1025 kg/m^3

6. The lock gate shown in Fig Q6 has two identical rectangular gates supported by hinges at A and B and meeting at C. The fresh water in the river is at a level of 6m on the outside of the gates and 3m within the lock.

Calculate EACH of the following:

(a) the resultant hydrostatic force on one gate; (4)

(b) the height from the bottom of the gate at which this resultant hydrostatic force acts; (4)

(c) the reaction force 'R' between the two gates. (8)

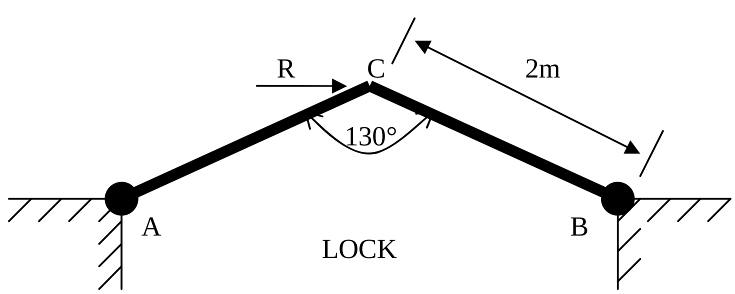

Fig Q6

7. A section of a hydraulic control system is shown in Fig Q7. The system is filled with an incompressible fluid. Movement of the input piston *A* causes the output pistons *B* and *C* to move. Piston *C* moves against a spring of stiffness 40kN/m. Piston *B* has no resistance to movement but reaches a rigid stop after 30mm travel. Piston A has a diameter of 40mm and pistons *B* and *C* are each 80mm diameter.

Calculate the total movement of the piston A, *X* when a force of 1200N is applied to it. (16)

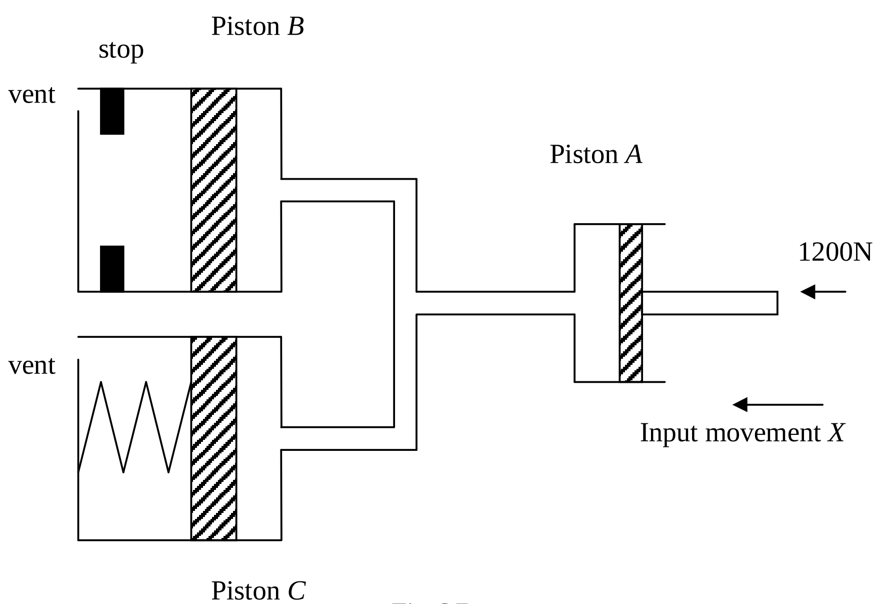

Fig Q7

8. Two close-coiled helical springs of different length with the following dimensions are fitted concentrically in parallel on a flat horizontal surface:

	Mean Coil Diameter	Wire Diameter	No. of Coils	Free Length
Outer Spring	55mm	6mm	12	120mm
Inner Spring	40mm	5mm	9	100mm

The combined springs are subjected to a total load of 600N.

Calculate EACH of the following:

(a) the compression of each spring; (10)

(b) the load carried by each spring. (6)

Note: Modulus of Rigidity for Spring Material = 80GN/m^2.

9. A uniform ladder AB 3.8m long rests on a smooth plane. The plane rises at an angle of 12° to the horizontal, away from a vertical wall as shown in Fig Q9. The coefficient of friction between the ladder and the wall is 0.7.

(a) Sketch the arrangement showing all of the forces. (4)

(b) Calculate EACH of the following:

(i) the angle of the ladder to the wall when the ladder is just about to slip down the plane; (8)

(ii) the angle of the ladder to the wall when the ladder is just about to slip up the plane. (4)

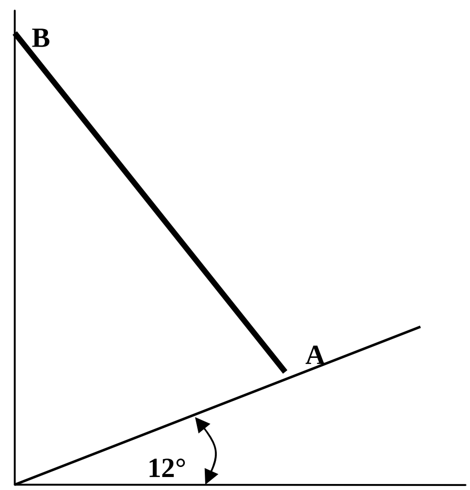

Fig Q9