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 SECOND ENGINEER REG. III/2 (UNLIMITED)

042-23 – MATHEMATICS,

THURSDAY, 10 APRIL 2014

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 examination centres:

Candidate’s examination workbook
Graph Paper

MATHEMATICS

Attempt SIX questions only

All questions carry equal marks

Marks for each part question are shown in brackets

1. (a) A ship leaves port A at 0600 hours and heads for port B at a speed of 15 knots.

A tug leaves port B at 1100 hours and heads for port A at 9 knots.

Ports A and B are 243 nautical miles apart.

Calculate the time at which the ship and tug will pass each other. (8)

(b) Solve for x in the following equation:

$$\frac{x+2}{x-2}+\frac{x+21}{x+3}=5$$

(8)

2. (a) Under certain conditions the thrust T of a propeller varies jointly as the fourth power of its diameter d and the square of the number of revolutions n per second.

Determine the approximate percentage change in T if d is decreased by 1% and n is increased by 3%. (8)

(b) Solve the following system of equations for A and B in the ranges

$0 \leq A \leq \frac{\pi}{2}$ and $0 \leq B \leq \frac{\pi}{2}$ radians.

$4\sin A + 5\cos B = 1.8$
$3\sin A - 2\cos B = 0.4$

(8)

3. (a) Fully factorise EACH of the following:

(i) ax - bx + ay – by (3)

(ii) $a^2x^2 + b^2y^2 - a^2y^2 - b^2x^2$ (4)

(b) The formula $M = \dfrac{wx(l-x)}{2}$ gives the bending moment M at a point in a beam.

Calculate the values of x when M = 80, l = 30, and w = 2 . (5)

(c) Solve the following equation for x:

$$\frac{x^2-4}{x+2} = x^2 + 4x$$ (4)

4. (a) Solve the following equation for x in the range $x > 0$:

$\log(x^2 + 23) - \log(x + 1) = \log 8$ (6)

(b) Simplify fully using rules of indices:

$$\frac{(8a^6b^9c^3)^{\frac{2}{3}}}{(2a^2bc^3)^2}$$ (5)

(c) Solve for t in the following equation:

$3 = 14e^{-0.05t}$ (5)

5. (a) Draw the graph of $y = 2\cos\theta - \sin\theta$ in the range $1 \le \theta \le 5$ radians in intervals of 0.5 radians. (10)

Suggested scales: *horizontal axis* 2 cm = 0.5
vertical axis 2 cm = 0.4

(b) Determine EACH of the following using the graph drawn in Q5(a):

(i) the minimum value of y; (2)

(ii) the values of θ such that $y = 0$. (4)

6. A ship, maintaining a constant course, is observed from a coastguard watchtower to be 4.2 miles distant and bearing 030°.

Later the ship was observed to be 6.4 miles off on a bearing of 110°.

Calculate EACH of the following:

(a) the ship's course; (11)

(b) the shortest distance between the ship and the watchtower. (5)

7. (a) The cost, in £ millions per day, of pumping oil from an offshore oil terminal is related to the radius of the pipe carrying the oil.

For a pipe of radius r metres the cost is given by $C = \mathrm{r} + \frac{4}{\mathrm{r}} + 0.5$

Calculate EACH of the following:

(i) the radius of pipe which minimises the cost; (6)

(ii) the minimum cost per day. (2)

(b) $y = 10x^{0.4} + e^{2x} - 60\sqrt{x}$

Determine EACH of the following:

(i) $\frac{dy}{dx}$ (4)

(ii) $\frac{d^2y}{dx^2}$ (4)

8. The sheave of a pulley-block may be considered as being formed by rotating the area bounded by the curve $y = x^2 + 6$ and the lines $x = -1$, $x = 1$ and $y = 1$, about the x-axis through one complete revolution.

(a) Sketch the bounded area. (4)

(b) State the diameter of the axle hole of the sheave. (2)

(c) Calculate the volume of the sheave. (10)

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9. The end section of a cylindrical oil tank of diameter 220 cm as shown in Fig Q9, and the tank is lying with its axis horizontal and the level of oil in the tank is 60 cm.

Oil is pumped into the tank until the level of oil in the tank is 100 cm.

Calculate the percentage increase in the volume of oil in the tank.

(16)

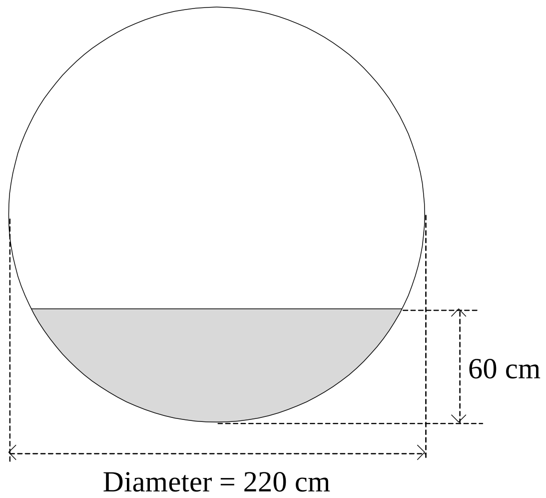

Fig Q9