

**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 78 as amended MANAGEMENT ENGINEER REG. III/2 (UNLIMITED)

040-35 - MATHEMATICS

THURSDAY, 14 DECEMBER 2017

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:

MATHEMATICS

Attempt SIX questions only

All questions carry equal marks

Marks for each part question are shown in brackets

1. (a) Solve the following complex equation for a and b :

$$7a + 3b + j(4a - 5b) = 15 + j22$$

(8)

(b) The impedance, z , of an electronic circuit is given by $z = 4 + j3$ and the current, i , is represented by $i = 6 + j5$.

(8)

Determine, in polar form, the voltage, v , across the impedance, given that $v = iz$.

2. (a) Solve for x in the following equation:

$$\frac{5x + 3}{7x + 3} - \frac{x + 7}{x + 2} = -3$$

(8)

(b) The electrical resistance of a wire varies directly as the length of the wire and inversely as the square of the radius of the cross-section of the wire.

A wire, 6 m long and 0.4 mm radius, has a resistance of 0.3Ω .

Calculate the resistance of a wire of the same material, 9 m long and 0.3 mm radius.

(8)

3. (a) Solve the following system of equations for x and y :

$$\begin{aligned} 3x^2 + 2y^2 + y &= 13 \\ 3x + 2y &= 7 \end{aligned}$$

(8)

(b) Make p the subject of the following formula:

$$t = r \left(\sqrt{\frac{f+r}{f-d}} - 1 \right)$$

(8)

(4)

(4)

(4)

(4)

4. (a) Solve EACH of the following equations for x :

(i) $8 = 16e^{-0.2x}$ $\ln 8 = \ln 16 - 0.2x$

(ii) $\ln(e^x + 25) = 4.2$ $\frac{\ln 8}{\ln 6} = -0.2x$

(iii) $3^{3+4x} = 27^{2x-1}$

(b) Express the following in its simplest form:

$$\frac{\sqrt{ab^2}}{\left(a^2b^4\right)^{\frac{3}{4}}}$$

(4)

5. The data shown in Table Q5 gives the fuel consumption, F (tonnes/day), of a vessel at speed v (knots).

(10)

(a) By drawing an appropriate straight-line graph, verify that the data fits an equation of the form:

$$F = av^2 + b, \text{ where } a \text{ and } b \text{ are constants.}$$

v	8	10	12	15	18
F	14.44	20.20	27.24	40.20	56.04

Table Q5

Suggested scales with landscape orientation:

horizontal axis 2 cm = 20
vertical axis 2 cm = 10

(b) Use the graph drawn in Q5(a) to estimate the values of a and b .

(5)

(c) Estimate the fuel consumption at a speed of 20 knots.

(1)

6. (a) A jib crane consists of a vertical post AB, 6.5 m in length, the inclined jib BC, 16 m in length and a tie AC. Angle BAC is 124° .

Calculate BACH of the following:

(i) the inclination of the jib to the vertical;

(ii) the length of the tie.

(b) A thin triangular metal plate has dimensions as shown in Fig Q6(b).

Calculate the length of PR.

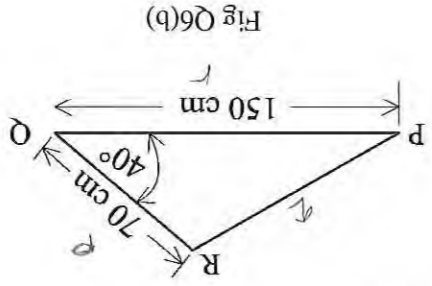


Fig Q6(b)

(4)

(4)

(8)

C

7. (a) The cost, £P million, of laying 1000 m of pipe for a water main is given by:

$$P = \frac{400}{9A} + 4A$$
 where A is the cross-sectional area of the pipe in m^2 .

(i) Determine the cross-sectional area of the most economical pipe to use.

(ii) Calculate the minimum cost of laying 1000 m of pipe.

(b) Determine the coordinates and nature of the stationary points on the curve:

$$y = 2x^3 - 24x - 32$$

(6)

8. The region in the first quadrant enclosed by the parabola $y^2 = x$, the x-axis and the line $x = 4$ is represented by the shaded area in Fig Q8.

Determine EACH of the following for the shaded region:

- (a) its area; (6)
- (b) the volume of solid of revolution formed by rotating it through one revolution about the x-axis; (5)
- (c) the volume of solid of revolution formed by rotating it through one revolution about the y-axis. (5)

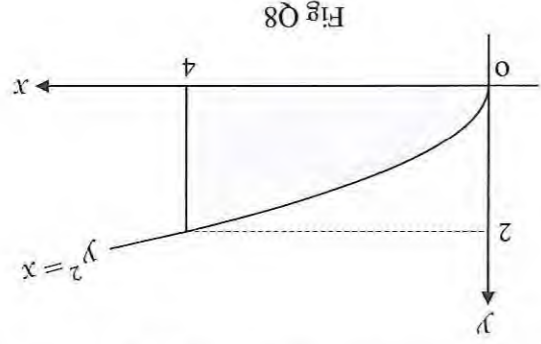


Fig Q8

9. (a) Determine EACH of the following, without using a calculator conversion function:

- (1) (i) the hexadecimal operation AD9C – FE8; (2)
- (1) (ii) the conversion of 1101011₂ to decimal; (1)
- (1) (iii) the conversion of 4B7₁₆ to binary. (1)

(b) The logic circuit shown in Fig Q9(b) has inputs A and B and output X.

- (3) (i) Produce the truth table for this circuit. (3)
- (1) (ii) State the type of logic gate which produces the same output as this circuit. (1)

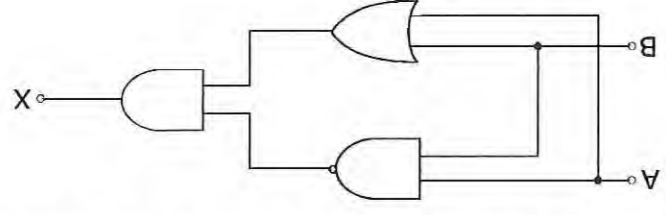


Fig Q9(b)

(c) Simplify, as fully as possible, EACH of the following Boolean expressions:

- (4) (i) $A.B.C + A.B.C + A.C + B.C$ (4)
- (4) (ii) $\underline{Q + R.S + Q.R}$ (4)