MERCHANT SHIPPING SECRETARIAT
GOVERNMENT OF SRI LANKA
CERTIFICATE OF COMPETENCY EXAMINATION

GRADE : OFFICER IN CHARGE OF A NAVIGATIONAL WATCH ON SHIPS OF 500 GT OR MORE (UNLIMITED)

SUBJECT : MATHEMATICS

DATE : 30th April 2024   Time : 0900 to 1200 hrs

Time allowed **THREE hours**	Total marks : 120
ANSWER ANY SIX (06) QUESTIONS	Pass marks : 50%

Formulae and all intermediate steps taken in reaching your answer should be clearly shown. You may draw sketches wherever required. Electronic devices capable of storing and retrieving are **not** allowed.

1. a) Find numerical value of the followings: (06 marks)

   i. $\dfrac{x^2 + x^{5/2}}{x^{-1/2}}$ ii. $\log_{1/2} 16$

   b) Find the value of $3\log_{10} 2 - \log_{10} 12 + \log_{10} 3 + \left(\dfrac{1}{2}\right)\log_{10} 25$ (06 marks)

   c) solve $\log_2(3^{2x-2} + 7) = 2 + \log_2(3^{x-1} + 1)$ (08 marks)

2. In the binomial expansion of $\left(x - \dfrac{1}{x}\right)^6$, Find

   a) the coefficient of x^4 (08 marks)

   b) the term independent of x. (08 marks)

   c) Show that there is no x^3 term in above binomial expansion. (04 marks)

3. a) Without using tables or calculator, evaluate (06 marks)

   i. $\sin 15^0 \cos 15^0$ ii. $\cos^2 22.5^0 - \sin^2 22.5^0$

   b) Prove that (08 marks)

   i. $\dfrac{\cos x - \sin x}{\cos x + \sin x} = \dfrac{1 - \sin 2x}{\cos 2x}$ ii. $\sin 3x = 3\sin x - 4\sin^3 x$

   c) Given that $0 \le x \le 2\pi$, solve the equation $\sqrt{3}\sin x + \cos x = 1$ (06 marks)

4. a) Solve the quadratic equation $2x^2 - 3x - 3 = 0$. (06 marks)

   b) Determine the nature of roots of quadratic equation $nx^2 - mx - n = 0$. (08 marks)

   c) Determine the range of value of **k** for which the quadratic equation

   $kx^2 + 6(k-2)x + 3(k+2) = 0$ has real distinct roots. (06 marks)

5. The function is given by $y = x^2 + 2x - 8$
   a) Find the coordinate of turning points. (06 marks)
   b) Find the coordinate of x and y intercepts. (08 marks)
   c) Sketch the graph of $y = x^2 + 2x - 8$. (06 marks)

6. a) Fit a straight line to the following data regarding x as independent variable. (06 marks)

x	1	2	3	4	6	8
y	2.4	3	3.6	4	5	6

   b) The diagram represents a swimming pool.
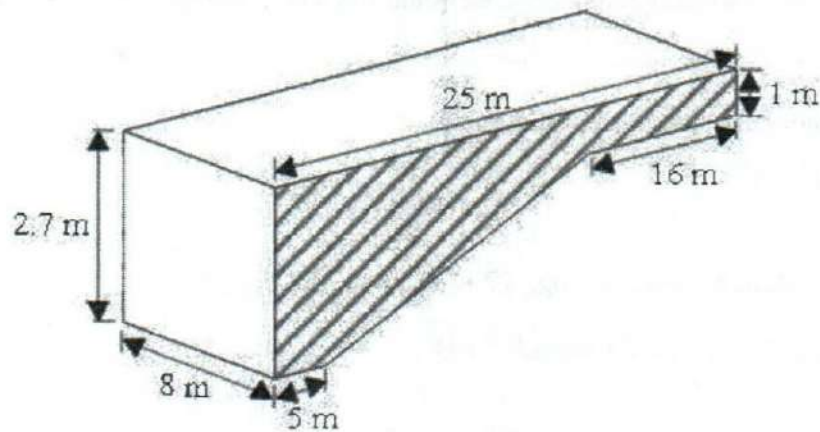
   Calculate the area of the shaded cross section. (08 marks)
   c) i.   If the swimming pool is completely filled with water, calculate the volume of water in the pool. (03 marks)
      ii. If 64 m³ leaks out of the pool, calculate the distance by which the water level falls. (03 marks)

7. a) Find the centre and radius of the circle $x^2 + y^2 - 2x + 4y = 8$ (08 marks)

   b) A rough sketch of cross sectional view of an oil tank is illustrated in the figure below and the height of the tank has been measured by the intervals of **50 cm** distance.
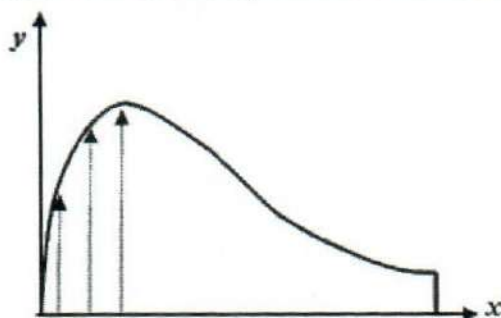
x(m)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
y(m)	0	2.2	4.3	5.1	4.9	4.6	4.1	3.8	3.2	2.0	1.70	1.68	1.68

    Determine the area of the layer (Hint : Use the Simpson's 1/3 Rule)   (12 marks)

8. a) Divide $2x^3 - 5x^2 + 7x + 3$ by $x - 2$ (06 marks)

   b) Factorize $x^3 - 7x^2 + 7x + 15$ using factor theorem.   (06 marks)

   c) Solve the inequality $x^2 - 3x \leq 10$.   (08 marks)

End.

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DIRECTORATE OF MERCHANT SHIPPING
GOVERNMENT OF SRI LANKA

CERTIFICATE OF COMPETENCY EXAMINATION

GRADE : OFFICER IN CHARGE OF A NAVIGATIONAL WATCH ON SHIPS OF 500 GT OR MORE (UNLIMITED)

SUBJECT : BASIC MANAGEMENT

DATE : 29 Apr 2024   Time 0900 to 1200 hrs

Time allowed THREE hours	Total marks : 100
Answer all FIVE (5) questions	Pass marks : 50%

Formulae and all intermediate steps taken in reaching your answer should be clearly shown. You may draw sketches wherever required.

1. Write short introductory notes defining the following terms and by applying each to a ballast tank cleaning operation with time constrains.
   a) Goal
   b) Objective
   c) SMART
   d) SWOT
   e) Strategy
       (20 marks)

2. Discuss how convention provisions are implemented?
       (20 marks)

3. Prepare a 25 item "safety & risk assessment" check list for proceeding to forward mooring stations upon arriving port.   (20 marks)

4. As an officer in charge of the cargo watch, if you have to come across with following situations at the same time: Describe how you manage the situation effectively.
   a) Ships Crane has collapsed down, also now need to perform cutting / welding work
   b) Deck crew member badly injured
   c) loading Reefer Containers
   d) Bunker barge is approaching.
       (20 marks)

5. Define following as specified in the STCW and list down two onboard ranks and three areas of work responsibilities under each on:
   a) Management level
   b) Operational level
   c) Support level
       (20 marks)

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MERCHANT SHIPPING SECRETARIAT
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CERTIFICATE OF COMPETENCY EXAMINATION

GRADE : OFFICER IN CHARGE OF A NAVIGATIONAL WATCH ON SHIPS OF 500 GT OR MORE (UNLIMITED)

SUBJECT : **MATHEMATICS**

DATE : 26th Apr 2024   0900Hrs to 1200Hrs

Time allowed THREE hours   Total marks : 100

Answer all questions   Pass marks : 50%

Formulae and all intermediate steps taken in reaching your answer should be clearly shown. You may draw sketches wherever required. Electronic devices capable of storing and retrieving are **not** allowed

1.

    a. The instant before a batter hits a 0.14-kilogram baseball, the velocity of the ball is 45 meters per second west. The instant after the batter hits the ball, the ball's velocity is 35 meters per second east. The bat and ball are in contact for 1.0×10^{-2} second. Determine the magnitude and direction of the average acceleration of the baseball while it is in contact with the bat.

                          (4 marks)

    b. Define electromagnetic induction.

                          (3 marks)

    c. What are the longest and shortest waves in the electromagnetic spectrum?

                          (2 marks)

    d. A particle rests in limiting equilibrium on a plane inclined at 30^0 to the horizontal. Determine the acceleration with which the particle will slide down the plane when the angle of inclination is increased to 40^0.

                          (6 marks)

                          (Total 15 marks)

2.

    a. In 1964, the temperature in the Siberian Village of Oymyakon reached -71^0C. What temperature is this on the Fahrenheit scale?   (06 marks)

    b. The highest officially recorded temperature in Death Valley, California in the United States was 134^0F. What is this temperature on the Celsius scale?   (06 marks)

    c. An aluminum cup of 100 cm^3 capacity is completely filled with glycerin at 22^0C. How much glycerin, if any, will spill out of the cup if the temperature of both the cup and glycerin is increased to 28^0C?. (The coefficient of volume expansions of glycerin and aluminum are $5.1 \times 10^{-4} / C^0$ and $69 \times 10^{-6} / C^0$ respectively).
    (08 marks)

                          (Total 20 marks)

3.

a. An A-5 Vigilante supersonic bomber, with a mass of 21000 kg, departs from its home airbase with a velocity of 400 m/s due east. What is the jet's momentum?

(4 marks)

b. A ray of light is traveling in glass with an index of refraction of n = 1.50 and strikes a glass/air interface. If the angle of incidence is 35°, what is the angle of refraction?

(5 marks)

c. Draw the shear and bending moment diagrams for the beam shown in the Figure.

(6 marks)
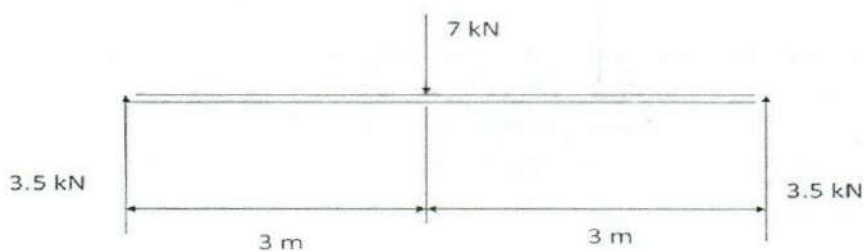
(Total 15 marks)

4.

a. Define Anode and Cathode of electrolysis.

(4 marks)

b. Jennifer pushes a sofa 3 meters across the floor by applying a force of 200N. If it takes her 6 seconds to push the sofa, what amount of power did she supply?

(3 marks)

c. Explain how to connect an ammeter and a voltmeter to a circuit.

(4 marks)

d. Motor A lifts a 5000N steel crossbar upward at a constant 2 m/s. Motor B lifts a 4000N steel support upward at a constant 3 m/s. Which motor is supplying more power?

(4 marks)

(15 marks)

5.

a. A compact disc player is designed to vary the disc's rotational velocity so that the point being read by the laser moves at a linear velocity of 1.25 m/s. What is the CD's rotational velocity in revs/s when the laser is reading information on an inner portion of the disc at a radius of 0.03m?

(4 marks)

b. A boat is travelling towards a cliff with a velocity of 10 ms^{-1}. The frequency of its horn is 350 Hz. Find the frequency heard by a boy standing on top of the cliff.(sound speed 330 ms^{-1})

(4 marks)

c. Define the magnetic flux.

(2 marks)

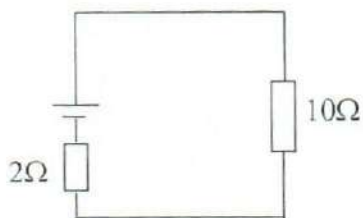d. Name two applications of diodes.

(2 marks)

e. Name 3 types of digital gates.

(3 marks)

(Total 15 marks)

6. A battery with an e.m.f of 12V and internal resistance 2Ω is connected as shown in the figure to a resister of resistance 10Ω. .
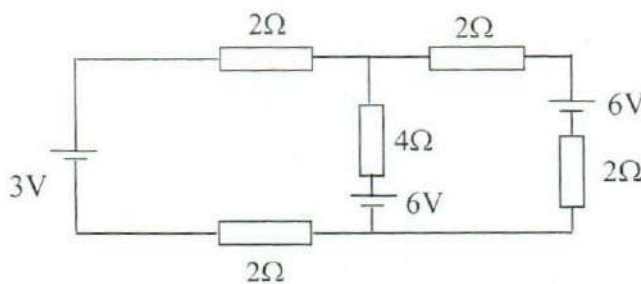

a. Calculate the potential difference across the 10Ω resister.   (08 marks)

b. Find the magnitude and direction of the current in each of branches of the following circuit.

(12 marks)

(Total 20 marks)

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GRADE   : OFFICER IN CHARGE OF A NAVIGATIONAL WATCH ON SHIPS OF
              500 GT OR MORE (UNLIMITED)

SUBJECT   : BRIDGE EQUIPMENT

DATE   : 26th Apr 2024

Time allowed THREE hours   Total marks   : 120

Answer all SIX (6) questions   Pass marks   : 50%

Formulae and all intermediate steps taken in reaching your answer should be clearly shown. You may draw sketches wherever required.

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1. a) Write short notes on following Auto pilot controls

   (i) Rudder Control   (ii) Weather Control   (06 Marks)

   b) Describe how to determine and eliminate the side error of a sextant   (06 marks)

   c) Write short notes on followings

   i) BNWAS   ii) Quartz crystal chronometer   (08 marks)

2. a) Explain the principle of "Electromagnetic log" with an aid of a diagram   (08 marks)

   b) Explain the following systems with reference to an echo sounder

   i) Continuous Wave System   ii) Pulse System   (08 marks)

   c) What are the second trace echoes?   (04 marks)

3. a) Briefly describe the function of DGPS   (06 marks)

   b) Explain the method of measuring time interval of GPS satellite signal   (06 marks)

   c) What is meant clock bias Error   (04 marks)

   d) What is the difference between e-loran and traditional loran-c system?   (04 marks)

4. a) Explain the following properties of free gyroscope
   i) Gyroscope Inertia (Rigidity in the space)
   ii) Three degree of Freedom   (08Marks)

   b) What are the "Static Data" and "Dynamic Data With reference to AIS?   (06 Marks)

   c) write down inherent Limits of AIS?   (06 Marks)

5. a) Describe the followings with reference to ECDIS
      (i) Raster Charts   (ii) Vector Charts   (05 marks each)

   b) Write short notes on following Auto pilot controls
      (i) Rudder Control(ii) Weather Control   (06 Marks)

   c) What are the advantages with an auto pilot?   (04 Marks)

6. a) List the contents of a LRIT message?   (03marks)

   b) Explain the different between LRIT system and the AIS system.   (05 marks)

   c) Describe the followings with reference to ECDIS
      (i) Raster Charts   (ii) Vector Charts   (06 marks)

   d) Describe the methods available for updating the Electronic charts (06 marks)

MERCHANT SHIPPING SECRETARIAT
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CERTIFICATE OF COMPETENCY EXAMINATION

GRADE : OFFICER IN CHARGE OF A NAVIGATIONAL WATCH ON SHIPS OF
500 GT OR MORE (UNLIMITED)
SUBJECT : GENERAL SHIP KNOWLEDGE
DATE : 25ᵗʰ April 2024   Time: 0900

| Time allowed **THREE hours** | Total marks : 120 |
| **ANSWER ALL QUESTIONS** | Pass marks : 50% |

Formulae and all intermediate steps taken in reaching your answer should be clearly shown.
You may draw sketches wherever required. Electronic devices capable of storing and retrieving
are **not** allowed.

1. a) With the aid of a sketch, explain racking stress and how it is caused. (08 marks)

   b) Draw a cross section of a transversely framed ship naming its parts. (12 marks)

2. a) Briefly explain Panting and Pounding. (04 marks)

   b) With a labelled diagram, show the panting arrangement of a ship. (08 marks)

   c) Explain with a simple suitable sketch, Hogging and Sagging. (08 marks)

3. a) With a simple sketch explain the purpose of bilge keel. (10 marks)

   b) Draw an Unbalanced rudder naming its parts. (10 marks)

4. A ship with a displacement of 7799 T KG 6.942 m KM 8.84 m, carries out the
following operations.

Loads No.1 TD	601 T	KG 11.17 m
Loads No.3 Hold	1520 T	KG 1.7 m
Loads No,5 Hold	420 T	KG 6.91 m
Pumps out fore peak tank	106.1 T	KG 6.31.m
Pumps out No.4 (P & S) Tanks	261.2 T	KG 0.68 m

If the FSC is 0.155 m, calculate the GM Fluid. (20 marks)

5.   A ship of 180 m in length, MCT 1 cm 350 tm.   TPC 35

Centre of flotation 3 m aft of midships

Present drafts: F 6.8 m   A 8.8 m

Calculate the final drafts after carrying out following operations.

Load	5000 T	25 m aft of CoF
Load	2500 T	45 m forward of CoF
Disch.	1200 T	35 m forward of CoF

400 T saltwater run into AP tank 80 m aft of CoF   (20 marks)

6. a)   A vessel floating in DW density 1.014 with her winter load line 80 mm below the
Water line on port side and 160 mm below water line on stbd side .

FWA is 180 mm.   TPC 20 summer load draft 9.0 m

Find the Deadweight available.   (12 marks)

b)   Derive the formula FWA mm = Displacement/4 TPC   (08 marks)

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MERCHANT SHIPPING SECRETARIAT
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CERTIFICATE OF COMPETENCY EXAMINATION

GRADE   : OFFICER IN CHARGE OF A NAVIGATIONAL WATCH ON SHIPS OF 500
             GT OR MORE (UNLIMITED)

SUBJECT   : ENGINEERING KNOWLEDGE

DATE   : 25TH ARP 2024   Time : 1300 HRS

| Time allowed **THREE hours** | Total marks : 96 |
| **ANSWER ANY SIX QUESTIONS** | Pass marks : 50% |

Formulae and all intermediate steps taken in reaching your answer should be clearly shown. You may draw sketches wherever required. Electronic devices capable of storing and retrieving are **not** allowed.

1)

   a) Name 6 main point of valve timing diagram of a two- stroke diesel engine as per diagram shown below

                                                           (06 marks)
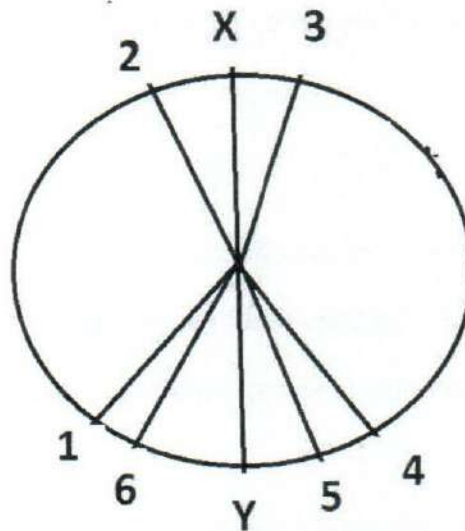
   b) What is the 'OVERLAP" period of the diagram

                                                           (02 marks)

   c) Name four strokes of a diesel engine.

                                                           (08 marks)

2)

   a) Make a detailed sketch of a basic refrigeration cycle.   (08 marks)

   b) Name the safety features attached to above system   (08 marks)

3)

   a) Explain the meaning of A.C.(alternative current) power supply. (06 marks)

   b) What is meant by DC (direct current) power supply?   (04 marks)

   c) What precautions should be taken before starting a repair work in an electric circuit?   (6 marks)

4)

   a) What type of pump is commonly used for ballast operation onboard and explain the reason for using particular type.   (06 marks)

   b) Explain the difference between a positive displacement pump and centrifugal pump   (04 marks)

   c) Sketch and explain the priming device of a centrifugal pump?   (06 marks)

5)

   a) Name 3 equipment which can be run by steam.   (6 marks)

   b) Sketch a smoke tube boiler and label all the mountings.   (8 marks)

   c) What is the best source of boiler feed water and why it is so important? (2 marks)

6)   Make short notes on the following equipment.

   a) Emergency steering

                     (06 marks)

   b) Emergency fire pump

                     (06 marks)

   c) Emergency air compressor

                     (04 marks)

7)

   a) Why electricity can be dangerous?

(06 marks)

   b) What precautions should be taken before starting a repair work in an electric circuit?

(10 marks)

8)

What are the main causes for the following problems in a main engine?
   a) Scavenge fire
   b) Uptake fire
   c) Starting airline explosion
   d) Crank case explosion.

(04 marks each)

9)

   a) List the three-equipment available on board in order to meet the "MARPOL" requirements.

(06 marks)

   b) Sketch and explain the Oily Water Separator onboard.

(10 marks)

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MERCHANT SHIPPING SECRETARIAT
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CERTIFICATE OF COMPETENCY EXAMINATION

GRADE : OFFICER IN CHARGE OF A NAVIGATIONAL WATCH ON SHIPS OF 500 GT OR MORE (UNLIMITED)

SUBJECT : PRINCIPLES OF NAVIGATION

DATE : 19/04/2024   Time : 1300 to 1600 hrs

Time allowed **THREE hours**   Total marks : 120

ANSWER ALL QUESTIONS   Pass marks : 50%

Formulae and all intermediate steps taken in reaching your answer should be clearly shown. You may draw sketches wherever required. Electronic devices capable of storing and retrieving are **not** allowed.

1) Define the following with the help of diagrams;

     a) i) GHA   ii) SHA   iii) Declination   iv) Magnitude

                             (10 marks)

     b)   With the aid diagrams derive the followings

            i) $LHA* = GHA\gamma + SHA* + Long (E)$

            ii) $LHA* = GHA\gamma + SHA* - Long (W)$ (05 marks)

     c)   Calculate the LHA of a star whose RA is 75°, for an observer in longitude 50°E, when GHAγ is 200°.

                             (05 marks)

2) a) Why does the duration of the Moon's Synodic Period is longer than Sidereal Period?

                             (06 marks)

     b) With an aid of a sketch describe lunar eclipse.   (06 marks)

     c) Describe with diagram the phases of the moon.   (08 marks)

3) a) Explain the Kepler's three laws of planetary motion.   (10 marks)

     b) Describe difference of Inferior and Superior conjunctions.   (5 marks)

     c) With add of a diagram explain Apparent motion of planet "Jupiter".   (5 marks)

4). a) What is Equation of time and describe two components E1 and E2 of Equation of time.

(09 marks)

b) Fill below diagram with details and show the Equation of time.

(06 marks)

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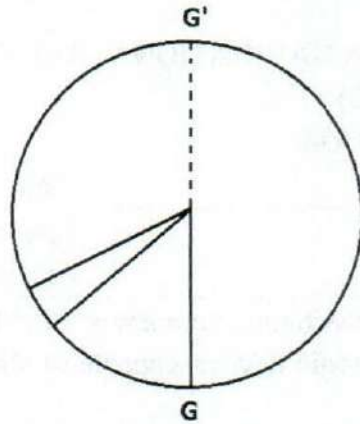
c) Describe how you find Equation of time from Almanac.   (05 marks)

5) a) Sketch the PZX triangle and mark the parts in the triangle.   (10 marks)

b) States the Napier's rules for right angled spherical triangle with clear diagram. (05 marks)

c) List corrections to be applied to Sextant Altitude to get True Altitude.   (05 marks)

6) a) State the three common chart projections.   (06 marks)

b) Describe the use of gnomonic charts for plotting a great circle track between
two points and describe the procedure of transferring the great circle track to a
Mercator chart.   (08 marks)

c) List the advantages of Mercator charts.

(06 marks)