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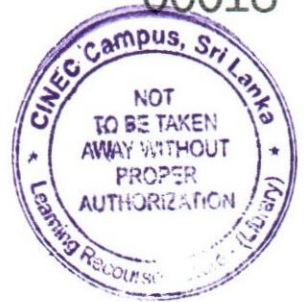## CINEC Campus (Pvt) Ltd

Examination for Officer in Charge of an Engineering Watch on Ships of 750kW Propulsion Power or More

Maritime Law

- **TIME ALLOWED - THREE HOURS**

- **Answer Any Four questions only**

- **Date: 2023.06.05**   **Pass marks: 50%**

Answers with clear sketches/diagrams, neat handwriting and clear expression will get full marks.

1. Referring to Risk Management on board ships,
   a. Explain why it has become necessary to carry out risk assessment.   **(02 Marks)**
   b. Briefly explain what type of hazards could exist onboard.   **(06 Marks)**
   c. Make a risk assessment and state the control measures that you would propose when team of riding technicians boarded the vessel for carrying out essential generator repair, taking into consideration the present Corona pandemic.   **(08 Marks)**

2. With Reference to International Maritime Organization (IMO).
   a. Illustrate the basic organizational structure of IMO.   **(07 Marks)**
   b. Briefly define following,
      I.   "Contracting Government".   **(03 Marks)**
      II.   "Ratification".   **(03 Marks)**
      III. "Tacit Approval".   **(03 Marks)**

3. Referring to United Nations Convention of the Law of Sea – III (UNCLOS-III), regulations for sharing ocean areas & its resources briefly explain following,
   a. Various sea areas as defined by the convention using a suitable sketch.   **(04 Marks)**
   b. "Port State Jurisdiction".   **(03 Marks)**
   c. "Flag State Jurisdiction".   **(03 Marks)**
   d. "Innocent Passage".   **(03 Marks)**
   e. "Force Majure"   **(03 Marks)**

4. With Regard to SOLAS requirements for watertight doors fitted on watertight bulkheads in cargo ships, State,
   a. Classes (Types) of watertight doors.   **(03 Marks)**
   b. State the difference between water tight and weather tight   **(04 Marks)**
   c. The applicable safe operating requirements for power operated watertight doors.
          (09 Marks)

5. With reference to SOLAS Chapter II-2 requirements,

   a. State the safety requirement applicable the for the CO2 (Multi-bottle system)   **(04 Marks)**
   b. Who will decide to release fixed gas flooding system onboard the ship.   **(04 Marks)**
   c. State the periodical tests requirement applicable for above systems? (weekly, annually, 2 yearly)
   (08 Marks)

6.
   a. State the four (04) main objectives of the International Load Line Convention for assigning a minimum "Free Board" to a sea going ship.   **(04 Marks)**
   b. What is meant by "Margin line" of a ship.   **(03 Marks)**
   c. What is meant by "Permeability of a Compartment"?   **(03 Marks)**
   d. State various items on board ship which are subjected to examine during load line survey.
   (06 Marks)

7. Regarding the 'Marpol' Convention,
   a. State the requirements to be fulfilled (with regard to equipment & procedures) by a ship when pumping out bilge water accumulated in a machinery space while the ship is in a special sea area as defined by Marpol Annex I.   **(08 Marks)**
   b. What are the categories of hazardous Cargo as per the Marpol Annex II.   **(02 Marks)**
   c. Briefly define the categories stated in section "b".   **(06 Marks)**

8. Emission of various gases from merchant ships are subjected to control by Marpol Annex VI.
   a. Explain the effect of "Green House Gasses" on global warming.   **(03 Marks)**
   b. Name four (04) Green House gases.   **(04 Marks)**
   c. List down 4 reasons of a high fuel oil consumption of a ship   **(04 Marks)**
   d. What are the certificates & documents required to carry on board ships to comply with annex VI requirements?   **(05 Marks)**

9. Survey & Certification is one of the important processes of a merchant ships.
   a. Briefly explain why it is required to carry out surveys and issue a certificate for sea going vessels.
   (02 Marks)
   b. State five (05) parties interested in ship certification.   **(05 Marks)**
   c. Differentiate the various categories of certificates carried on board ships.   **(03 Marks)**
   d. State the advantages of Harmonized system of Survey & Certification system (HSSC). **(02 Marks)**
   e. State the maximum validity period of certificates issued under above system and the surveys require to carry out during that period to keep the validity of the certificates.   **(04 Marks)**

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Examination for Officer in Charge of an Engineering Watch on Ships of 750kW Propulsion Power or More

Mathematics

- **TIME ALLOWED - THREE HOURS**

- **Answer ANY SIX Questions**

- **Date: 2023.06.01**   **Pass marks: 50%**

Answers with clear sketches/diagrams, neat handwriting and clear expression will get full marks

1. A quadratic function is defined by $f(x) \equiv x^2 + x + 7$.

    a. Find the set of values of x for which $f(x) > 19$.   (5 marks)

    b. Find the set of values of k for which $f(x) = kx$ has no real roots.   (5 marks)

    c. By considering the identity $x^2 + x + 7 = (x + A)^2 + B$, where A and B are constants, find the greatest value of $\dfrac{1}{f(x)}$.   (5 marks)

    d. Sketch the curve $y = f(x)$, showing any intercept with the coordinate axes. (5 marks)

2. If $z \neq 0$ and $2 + \cos\theta + i\sin\theta = \dfrac{3}{z}$, and z is a complex number and θ is in radian and $i = \sqrt{-1}$

    a. Determine $|z|$ (modulus of z)   (5 marks)

    b. Determine $\bar{z}$ (complex conjugate of z)   (5 marks)

    c. Show that

    $$2(z + \bar{z}) - |z|^2 = 3$$ (10 marks)

3.

   a. Solve the simultaneous equations using matrices (Gauss-Jordan method or Cramer's rule)

$$x + y + z = 3$$
$$x + 2y + 3z = 4$$ (10 marks)
$$x + 4y + 9z = 6$$

   b. Determine the inverse of the following matrix

$$A = \begin{pmatrix} 2 & 5 & 3 \\ 3 & 1 & 2 \\ 1 & 2 & 1 \end{pmatrix}$$ (10 marks)

4.

   a. Prove that $\cot\dfrac{\theta}{2} - 2\cot\theta = \tan\dfrac{\theta}{2}$ (5 marks)

   b. Find the possible values of $\tan\dfrac{\theta}{2}$ if $\tan\theta = \dfrac{5}{12}$ (Hint: $\tan 2A = \dfrac{2\tan A}{1-\tan^2 A}$)   (5 marks)

   c. Find the general solution of the equation

      i. $\mathrm{Sin}\left(\theta + \dfrac{\pi}{3}\right) = \dfrac{\sqrt{3}}{2}$ (5 marks)

      ii. $\mathrm{Cos}^2\,\theta - \sqrt{3}\,\mathrm{Sin}\,\theta\,\mathrm{Cos}\,\theta = 0$ (5 marks)

5.

   a. Determine the partial fractions of $\dfrac{2x}{(2x-1)(x^2+1)}$ (5 marks)

   b. If $a = \log\dfrac{10}{9}, b = \log\dfrac{25}{24}$ and $c = \log\dfrac{81}{80}$, show that $7a - 2b + 3c = \log 2$ (5 marks)

   c. Show that the function $f(x) = x^2 + 4x + 7$ is positive for all real values of x and find its minimum value.   (10 marks)

6.

   a. Differentiate the following functions with respect to x

      i. $y = 2x^3 - \dfrac{1}{2x^2} + \ln|2x|$ (4 marks)

      ii. $y = \mathrm{Sin}\, 2x - \mathrm{Sec}^2 x$ (4 marks)

   b. Determine the stationary values of $y = \dfrac{x^3}{x^2 - 1}$ and describe the nature of them (6 marks)

   c. If $x = \cos t, \quad y = \sin t$, show that $y^3 \dfrac{d^2 y}{dx^2} + 1 = 0$ (6 marks)

7.

   a. Determine the integrals with respect to x

      i. $\displaystyle\int \dfrac{dx}{(x-2)(x-3)}$ (5 marks)

      ii. $\displaystyle\int \left(x^2 + \dfrac{1}{2x^3} - \dfrac{1}{x} \right) dx$ (5 marks)

   b. Show that $\displaystyle\int_0^{\pi/2} x \sin^2 x\, dx = \dfrac{1}{16}\left(\pi^2 + 4 \right)$ (10 marks)

      Hint: $\sin^2 \theta = \dfrac{1}{2}(1 - \cos 2\theta)$

8.

   a. Show that $\displaystyle\int_0^1 \dfrac{1}{1+x}\, dx = \ln 2$ (5 marks)

   b. Use 1/3 Simpson's rule to interpolate a value for the integration $\displaystyle\int_0^1 \dfrac{1}{1+x}\, dx$ for ten ordinates (n = 10).   (10 marks)

   c. Hence determine the value of ln 2 for four decimal places.   (5 marks)

9.

a. If $\sin(x-y) = \sin x - \cos x$, find y, if $0 \le y \le \dfrac{\pi}{2}$. Hence solve $\sin(x-y) = 1$ in the range

$0 \le x \le 2\pi$ (10 marks)

b. Show that $\tan A = \dfrac{1-\cos 2A}{\sin 2A}$ and hence find the value of $\tan 15^0$ by using the values

$\sin 30^0 = \dfrac{1}{2}, \cos 30^0 = \dfrac{\sqrt{3}}{2}$ (10 marks)

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Examination for Officer in Charge of an Engineering Watch on Ships of 750kW Propulsion Power or More

<u>**Thermodynamics**</u>

- **TIME ALLOWED - THREE HOURS**

- **Answer ANY SIX Questions**

- **Date: 2023.06.02**   **Pass marks: 50%**

<u>Answers with clear sketches/diagrams, neat handwriting and clear expression will get full marks</u>

For air $c_p = 1.005kJ/kg\ K$, $c_v = 0.717kJ/kg\ K$, $\gamma = 1.4$

Composition of air (mass proportions): *77 % of Nitrogen* and *23 % of Oxygen*

Specific heat capacity of water *4.2 kJ/kg K*, Latent heat of evaporation of water *2.256 MJ/kg*

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1. *0.5 m³* of air at *100 kPa* and *27 ⁰C* is compressed adiabatically in a close system to one-third of its original volume. The air is then cooled at constant pressure until its temperature is *70 ⁰C*. The air then expanded back to its original condition.

   a. Draw the PV diagram to represent the process on air   (4 marks)

   b. Determine

       i.   The temperature and pressure at the end of compression   (4 marks)

       ii. The volume at the end of heat rejection   (4 marks)

       iii. The work transfer during compression and constant pressure cooling
                                                                           (4 marks)

       iv. The polytropic exponent of the expansion process   (4 marks)

2.

   a. A fuel composition by mass is Carbon *75%*, Hydrogen *8%*, Oxygen *6%* and remainder incombustible. If *16 kg* of air is supplied per kg of fuel, determine

       i.   The calorific value of the fuel   (4 marks)

       ii. Stoichiomatric air fuel ratio   (4 marks)

       iii. The percentage of excess air supplied   (4 marks)

   Calorific values of Carbon and Hydrogen are *33.7 MJ.kg* and *144MJ/kg* respectively.

   b. A boiler delivers *2000 kg* of steam per hour at a pressure of *7 bar* and with a dryness fraction of *0.98*. The feed-water to boiler is at a temperature of *48 ⁰C*. Determine the thermal efficiency of the boiler if the fuel described under *'part a'* is used for firing at the rate of *250 kg/h*   (8 marks)

3. The test bed results for a naturally aspirated, six cylinder, two stroke compression ignition engine with a bore of **600 mm** and stroke of **1800 mm** are as follows

   Test speed **90 rev/min**

   Fuel net calorific value **42 MJ/kg**

   Consumption **1292 kg/h**

   Brake load **620 kN** at radius of **0.85 m**

   Average indicated mean effective pressure for the engine **13.82 bar**

   Determine

   a. Indicate power   (3 marks)

   b. Brake power and mechanical efficiency   (5 marks)

   c. Brake thermal efficiency and indicated thermal efficiency   (6 marks)

   d. The brake specific fuel consumption and indicated specific fuel consumption

                                                                                                                        (6 marks)

4. A furnace wall consists of **100 mm** wide refractory brick and **110 mm** wide insulating firebrick separated by an air gap. The outside wall is covered with **12 mm** thickness of plaster. The inner surface of the wall is at **2000 ^0C** and the room temperature is **25 ^0C**. The heat transfer rate from the outside wall surface to the air is **20 W/m^2**. The thermal conductivities of refractory brick, insulating firebrick, air and plaster are **1.6, 0.3, 0.0209** and **1.4 W/mK**, respectively.

   a. Calculate

      i.   The overall heat transfer coefficient   (4 marks)

      ii. The thickness of the air gap   (4 marks)

      iii. The temperature at each interface of the wall   (8 marks)

   b. Sketch the temperature variation through the composite wall and the surrounding.
                                                                                                                        (4 marks)

5.

   a. Describe the condition for the minimum work transfer during the compression stroke in a compressor and the isothermal efficiency of a compressor.   (5 marks)

   b. A single stage single acting air compressor takes in air at **0.95 bar** and compresses it to **10 bar** and delivers at a rate of **0.05 m^3/s**. The compression and expansion follow the law **$PV^{1.25}$ = constant**. If the clearance volume **6%** of the swept volume and swept volume is **0.0145 m^3**. Determine

      i.   The power required   (5 marks)

      ii. The speed of compressor   (5 marks)

      iii. The volumetric efficiency   (5 marks)

6. Diesel cycle has a compression ratio of **14.5:1**. Compression begins at **1 bar** and **350 K**. The heat added during the constant pressure process is **1.2 MJ/kg**. Determine

   a. The maximum pressure in the cycle   (2 marks)

   b. The maximum temperature in the cycle   (2 marks)

   c. Work done per kg of air   (8 marks)

d. Thermal efficiency (4 marks)

e. The mean effective pressure (4 marks)

7. In an ideal dual combustion cycle the pressure and temperature at the beginning of the adiabatic compression are **0.93 bar** and **24 ^0C** respectively. The volume ratio of the adiabatic compression is **12:1**. At the end of constant volume heat addition, the pressure is **45 bar** and constant pressure heat addition continues **10 % of stroke**. Determine for the cycle

a. The pressure and temperature at each cardinal points (12 marks)

b. Thermal efficiency (4 marks)

c. The Carnot efficiency within the cycle temperature limits (4 marks)

8. **Refrigerant – 134a** enters the compressor of a refrigerator as super-heated vapor at **1.4 bar** and **-10 ^0C** at a rate of **0.12 kg/s**, and it leaves at **7 bar** and **50 ^0C**. The refrigerant is cooled in the condenser to saturated liquid at **26.72 ^0C** and it is throttled to **1.4 bar**.
a. Draw the **P-H** diagram to represent the processes in refrigeration cycle (4 marks)
b. Determine
   i.   Condition of the refrigerant at the evaporator inlet (4 marks)
   ii.   Compressor power (4 marks)
   iii. Refrigerating effect in kW (4 marks)
   iv.   Coefficient of performance (4 marks)
Hint: Use the properties in the table

Pressure, bar	Saturation temperature, ^0C	Enthalpy, kJ/kg		Entropy, kJ/kg K	
		h_f	h_g	s_f	s_g
1.4	-18.80	25.77	236.04	0.1055	0.9322
7	26.72	86.78	175.07	0.3242	0.9080

Pressure, bar	temperature,-10 ^0C		temperature, 20 ^0C		temperature, 50^0C	
	h(kJ/kg)	s(kJ/kg K)	h(kJ/kg)	s(kJ/kg K)	h(kJ/kg)	s(kJ/kg K)
1.4	243.40	0.9606	269.13	1.0532	296.09	1.1407
7	-	-	-	-	288.35	0.9867

9. In a fresh water generator, the generator shell of **1.5 m^3** capacity contains saturated water vapour and air at **40 ^0C** and vacuum pressure of **670 mmHg**. Due to air leakage into the vessel, the vacuum pressure falls to **572.5 mm Hg** and the temperature to **36 ^0C**. Estimate the followings
   a. The initial partial pressure of steam and air (5 marks)
   b. Initial mass of air in the generator shell (5 marks)
   c. The final partial pressure of steam and air (5 marks)
   d. The mass that has of air leaked into the generator shell (5 marks)

Assume that the atmospheric pressure reading is **760 mmHg** and **1 bar = 750 mmHg**

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Examination for Officer in Charge of an Engineering Watch on Ships of 750kW Propulsion Power or More

Electrotechnology

- **TIME ALLOWED - THREE HOURS**

- **Answer ANY FOUR questions from part A and ANY TWO questions from part B**

- **Date: 2023.05.31**   **Pass marks: 50%**

Answers with clear sketches/diagrams, neat handwriting and clear expression will get full marks

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Part A

1.

a)   i.   What factors determine the resistance of a resistor   (02 marks)

       ii.   What are the SI units of following electric quantities?   (03 marks)

           Resistivity, Electrical energy and voltage

b)   Calculate the resistance of a cylindrical iron rod 0.5 m long and 0.7 mm in diameter if the resistivity of the material is 9.756×10^{-8} ohm-meters   (04 marks)

c)   i.   Determine the equivalent resistance between the terminals A and B of network shown in fig.1   (06 marks)
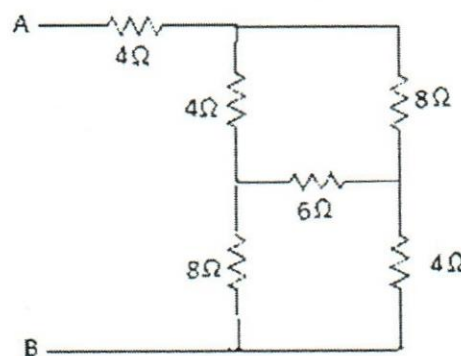
Figure 1

       ii.   Determine the current I and power P delivered by a 12 V dc voltage source applied at terminals A–B, with 'A' being at higher potential than 'B'.   (05 marks)

2.

a) State Kirchhoff's laws.   (04 marks)

b) Using Kirchhoff's current law, Find the magnitude and direction of unknown currents I_1, I_2, I_3
and I_4 in the figure 2 below.   (04 marks)
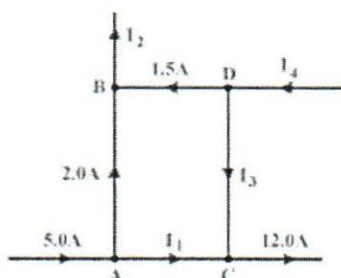
Figure 2

c) i. If the current source and all voltage source are ideal, Determine the current in each

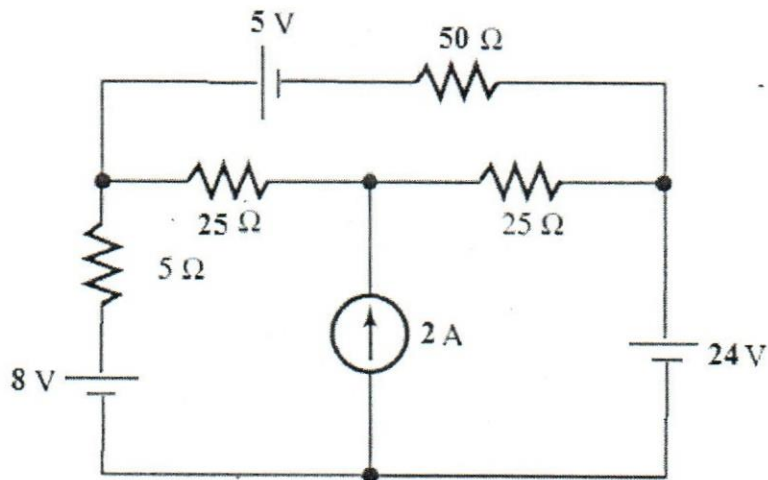branch in the circuit of figure 3.   (08 marks)

Figure 3

ii. Find voltage across current source.   (04 marks)

3.

a)   What is the definition of magnetic flux density, and what is its SI unit?   (04 marks)

b)   Draw the direction of the magnetic field inside the coil in the figure 4 below.   (04 marks)
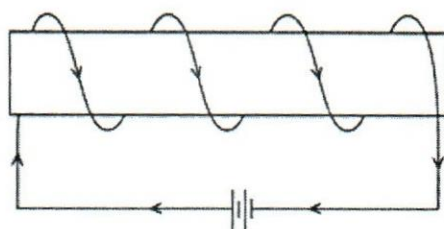
Figure 4

c)   A ring of 30 cm mean diameter is made using a cylindrical iron rod of diameter 2.5cm. A saw-cut 1-mm wide is made through the ring to create an air-gap. A coil with 500 turns of wire is wound on the ring. Calculate the current required in the exciting coil to produce a flux of 4mWb in the ring. Assume the relative permeability of iron at this flux density as 800. Neglect any leakage or fringing of the magnetic field. ($\mu_0 = 4\pi \times 10^{-7}$)   (12 marks)

4.

a) i.   Define the term frequency and periodic time.   (2 marks)

   ii.   Determine the frequencies for periodic times of 2ms.   (2 marks)

b) A coil of resistance 60 Ω and inductance 0.6 H is connected in series with a 29.34μF capacitor across a 240V, 50Hz supply. Calculate

   i.   the supply current and its phase angle   (4 marks)

   ii.   the circuit impedance,   (4 marks)

   iii.   the power consumed   (4 marks)

c)   If a capacitor of 160uF is connected in parallel with the above RLC circuit. Find the new current and new power factor of the power system.   (4 marks)

5.

   a)   State Faraday's laws of electromagnetic induction.   (4 marks)

   b)   Two coils A and B having turns 100 and 1000 respectively are wound side by side on a closed iron circuit of cross-sectional area 8 cm^2 and mean length 80 cm. The relative permeability of iron is 900.

      i.   Calculate the mutual inductance between the coils.   (6 marks)

      ii.   What will be the induced e.m.f. in coil B if current in the coil A is increased uniformly from zero to 10 A in 0.02second?   (4 marks)

c) Two coils connected in series have a self-inductance of 20mH and 60mH respectively. The total inductance of the combination was found to be 100mH. Determine the amount of mutual inductance that exists between the two coils assuming that they are aiding each other.

(6 marks)

6.

a) Draw the circuit diagrams of a separately excited DC generator and shunt DC generator with label all key parameters. (6 marks)

b) A shunt generator supplies 96 A at a terminal voltage of 230 V. The armature and shunt field resistance are 0.1 Ω and 50 Ω respectively. The iron and frictional losses are 2500 W.

Calculate, (14 marks)

i.   e.m.f generated
ii.   copper losses
iii.   commercial efficiency

Part B

7

a) Name 4 factors of which affect the insulation resistance on board. (4 marks)

b) Briefly explains how and what are the readings you should obtain when you check three phase induction motors winding condition? (8 marks)

c) If a motor is tested in an ambient temperature of 30^0 C, it is recorded its stator winding hot spot temperature as 65^0 C. If ship moves to another country its hot spot temperature rises to 75^0 C. What is the ambient temperature of the country? (8 marks)

8

a) Explain the protection provided for a three-phase induction motor when started on DOL method, by providing power circuit diagram. (10 marks)

b) What are the types of Air Circuit Breakers? And briefly explain the most common marine use one. (06 marks)

c) Name the 4 physical positions of Air Circuit Breakers. (04 marks)

9

a) Name all the safety devices for the three phase alternators. (10 marks)

b) Briefly explain what will happen if one of rotating rectifier diode get short circuited of three phase alternator which is running on full load. (06 marks)

b) Name the methods of excitation used for marine 3 phase alternators. (04 marks)

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Examination for Officer in Charge of an Engineering Watch on Ships of 750kW Propulsion Power or More

Applied Mechanics

- **TIME ALLOWED - THREE HOURS**

- **Answer ANY SIX Questions**

- **Date: 2023.05.30**   **Pass marks: 50%**

Answers with clear sketches/diagrams, neat handwriting and clear expression will get full marks

Density of water – 1000 kgm^{-3} Gravitational acceleration – 9.81 ms^{-2}

Density of sea water – 1025 kgm^{-3}

1.

1.1 Define work done and hence derive expressions for;

a.	Power	(2 Marks)
b.	Potential energy	(2 Marks)
c.	Kinetic energy	(2 Marks)

Clearly express any assumptions and notations used.

6.2 A body weighing 300 N is pushed up a 30^0 plane by a 400 N force acting parallel to the plane. If the initial velocity of the body is 1.5 m/sec and coefficient of kinetic friction is μ =0.2, calculate the velocity of the body after moving 6m, only using work-energy principles?   (14 Marks)

2.

2.1 A ball A falls vertically from rest from the top of a tower 63 m high. At the same time as A begins to fall, another ball B is projected vertically upward from the bottom of the tower with a starting velocity of 21 m/s. After sometime two balls collide with each other. Find the distance of the point where the balls collide from the bottom of the tower.   (10 marks)

2.2 If the ball A lost half of its velocity due to the collision, calculate the speed at which the ball A hit the ground.   (10 marks)

3.

3.1 Define *relative density* and *specific gravity*   (4 Marks)

3.2 State and prove Archimedes Principle   (4 Marks)

3.3 A Block of wood having a mass of 12 Kg floats on fluid. Find the volume of the block inside the fluid if the relative density of the fluid is 0.7. And also find the extra weight that should be placed on the object for it to immerse another100 cm^3 in the water. (12 Marks)

4.

4.1 Explain the idea of a clutch and describe the primary purpose of a friction clutch? (6 marks)

4.2 The plate clutch provides five contact surfaces has outer diameter 650 mm and inner diameter 450 mm, provides maximum intensity of pressure at any point in the contact surface is not to exceed 0.55 N/mm^2. The coefficient of friction between contact surfaces is 0.55. Find amount of power transmission when clutch runs at speed of 5500 rpm. (14 marks)
5.

5.1 An electric motor is connected to a pedestal grinding wheel and is rotating at its regular angular speed of 1.06×10^2 rev/min. after some time it was switched off. The rotating wheel was decelerated uniformly at a rate of 1.96 rad/s^2.

    a. How long does it take the grinding wheel to completely stop? (4 marks)
    b. During the time interval found in part (a), how many radians and revolutions has the wheel turned? (4 marks)

5.2 After complete stop of the wheel, the motor was switched back on. If the angular acceleration of the motor is 2.4 rad/s^2, how long it would take the wheel to get to its regular angular speed assuming no losses during the process? (12 marks)

6.

6.1 A simply supported beam carrying 200kN/m uniformly distributed load and two point loads of 600kN each is shown in below diagram. Considering the loading arrangement of the beam draw;

    a. Shear force diagram (8 marks)
   b. Bending moment diagram (10 marks)
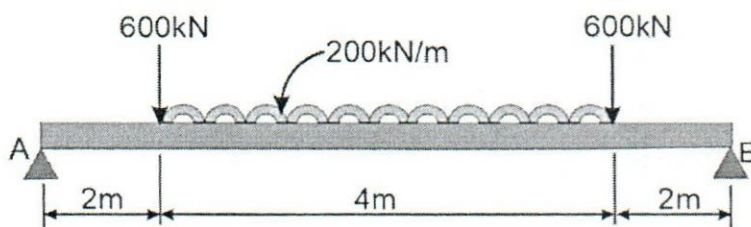
7.

7.1 Write Bernoulli's equation and identify the variables (4 Marks)

7.2 In a smooth pipe of uniform diameter 25 cm a pressure of 50 kPa was observed at section 1 which is at an elevation of 10m above the deck. The section 2 of the pipe at an elevation of 12m above the deck, the liquid pressure is observed to be 20 kPa. If the fluid flowing inside the pipe is fresh water having a velocity of 1.25 ms^{-1}, determine;

a. Volume flow rate (4 Marks)
b. The direction of flow (6 Marks)
c. The head loss between these two sections. (6 Marks)

8.

8.1 Below shows a shape made-out from thin metal sheet. Find the coordinate (x, y) of the center of gravity of the given shape. Clearly indicate the x and y axes selected in your diagram.(Hint: the center of gravity of a semi-circle is at a distance of $4r/3\pi$ from its base measured along the radius) (20 marks)
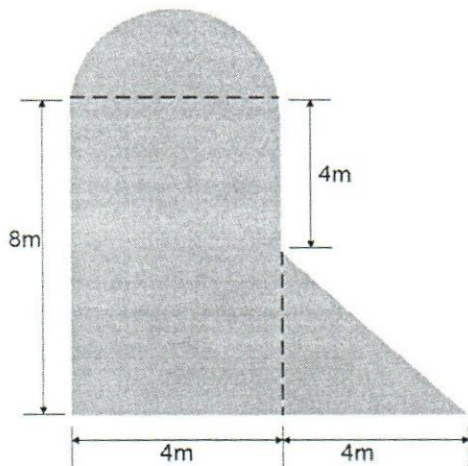

9.

9.1 Show that the total pressure force acting on a surface immersed in a liquid is equal to $F = h\rho g A$ with usual notations. (4 Marks)

9.2 A circular opening, 3m diameter in a vertical side of a tank is closed by a disc of 3m diameter which can rotate about a horizontal axis AB passing through its diameter. Calculate;

a. The pressure force on the disc surface (4 Marks)
b. Center of pressure if the head of water above the horizontal diameter is 4m (6 marks)
c. The torque required at the horizontal axis AB, to maintain the disc in equilibrium in the vertical position. (6 Marks)
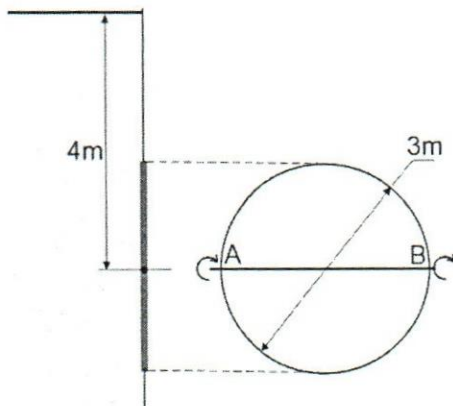
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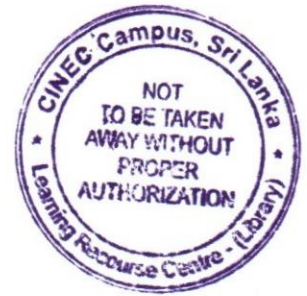
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Examination for Officer in Charge of an Engineering Watch on Ships of 750kW Propulsion Power or More

NAVAL ARCHITECTURE AND SHIP CONSTRUCTION

- **TIME ALLOWED - THREE HOURS**

- **Answer ANY FOUR (04) questions from Part A and ANY TWO (02) questions from Part B**

- **Date: 2023.05.29**   **Pass marks: 50%**

Part A: NAVAL ARCHITECTURE

1.

The ½ breadth of the load water plane of a ship 150 M long commencing from aft are as follows.

Section	AP	1	2	3	4	5	6	7	8	9	FP
½ Breadths of water plane	.3	3.8	6.0	7.7	8.3	9.0	8.4	7.8	6.9	4.7	0

Calculate

(i)   Area of the water plane   (6 Marks)

(ii)   Water plane area coefficient (C_w)   (3 Marks)

(iii) Distance of centroid from mid-ship   (7 Marks)

2. With regard to water resistance exerted by ship's hull explain following.

   a.

   (i)   Frictional resistance   (2 Marks)

   (ii)   Residuary resistance.   (2 Marks)

   b. List down the factors effecting Residuary Resistance   (3 Marks)

   c. A 6 m model of a ship has a wetted surface area of 8 m². When towed at a speed of 3 knots in fresh water the total resistance is found to be 38N.

If the ship is 130m long, calculate the effective power at the corresponding speed.

$$f = 0.417 + \frac{0.773}{L+2.862}$$

$R_f = f\ SV^n$ **(N)** where S is in m^2 Taken n=1.825

SCF= 1.15 (ship correlation factor)   (9 Marks)

3.   (a) Define following terms with respect to marine propellers.

     i. Theoretical Speed (Vt)   (2 Marks)

     ii Wake Fraction (w)   (2 Marks)

     iii Speed of Advance (Va)   (2 Marks)

     iv Real Slip   (2 Marks)

   b. A propeller of 5.5m diameter has a pitch ratio of 0.8 When turning at 120 rev/min the, the wake fraction is found to be 0.32 and the real slip 35%.

Calculate the ship speed   (3 marks)

Speed of advance   (3marks)

Apparent slip   (2marks)

4. (a) Explain the meaning of freshwater allowance.   (4 Marks)

   (b) A ship of 8000 tonne displacement floats in sea water of $1.025t/\ m^3$ and has a TPC of 14. The vessel moves into fresh water of $1.000\ t/m^3$ and loads 300 tonnes of oil fuel. Calculate the change in mean draught.   (12 marks)

5. (i) Define the centre of gravity   (2 marks)

   (ii) A ship 3000 tonne displacement has 500 tonne of cargo on board. The cargo is lowered 3m and an additional 500 tonne of cargo is taken on board 3m vertically above the original position of the centre of gravity. Determine the alteration in position of the centre of gravity.

(14 marks)

6. A ship of 5000 tonne displacement, 96 m long floats at draught of 5.6m forward and 6.3m aft. The TPC is 11.5, GM_L 105m and centre of flotation 2.4m aft of mid-ship.

Calculate (i) MCT1cm   (4 marks)

   (II) The new end draught when 88 tonne are added 31m forward of mid-ship.

(12 marks)

Part B:

Answer to any two (02) questions only

7. i) Sketch and name the parts of a forward construction of a ship and describe the construction features. (8 Marks)

ii) sketch and describe a two stroke main engine seating arrangement of a ship. (8 Marks)

8. a) with the aid of a sketch explain the causes and reamadies for following welding faults
   I. Slag Inclusions (2 marks)
   II. Porosity (2 marks)
   III. Overlapping (2 marks)
   IV. Lack of penetration (1 marks)

   b) Sketch and describe the usage of
      x)**Three types** of welding joints used in *manual metal arc welding* (MMA or MMAW)process in ship construction (6 marks)

   y) what are the applications of above **three** joints in ship building (3 marks)

9. I. With the aid of a sketch describe the arrangements provided to keep the decks clear of green(rough) seas. (3 Marks)

   II. Sketch & describe Bilge keel the answer should include the
      construction
      purpose
      position
      method of attachment (6 marks)

   III. Sketch and describe the method of achieving water tightness of a hatch cover at

      a) Periphery (outer edges) (4 marks)
      b) and at the cross joint. (3 marks)
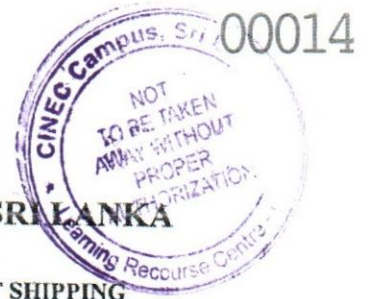
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Time 04 hours Marine Engineering Drawing and Design (ED 287)

Figure shows details of a **Diaphragm Regulator.**

Draw the following views, using **third angle projection,** of the **Diaphragm Regulator** with the parts assembled in their correct relative positions. Select a suitable scale.
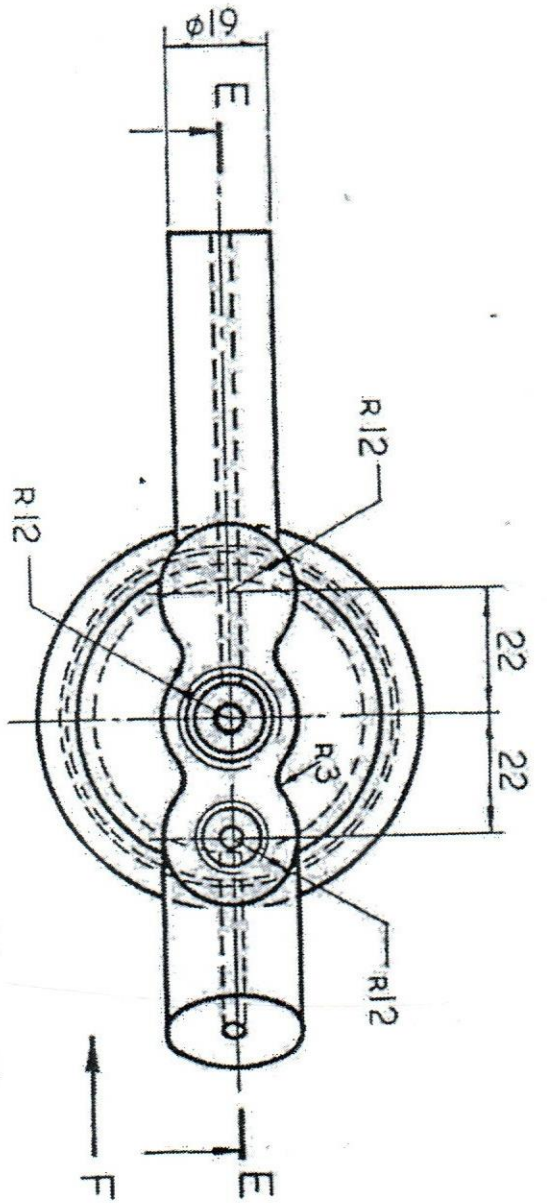
(a) Sectional elevation, the plane of the section and the direction of the required view being shown at **EE.**

(b) Elevation looking in the direction of the arrow **F.**

Suitable dimensions should be estimated where not provided. Hidden detail is not required in any view.

Complete the drawing by including the title, projection symbol, dimensions and a list of materials of parts.
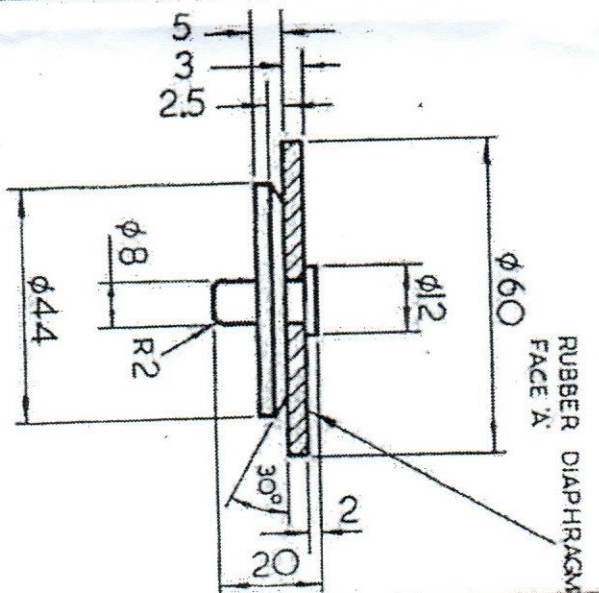
Marking System

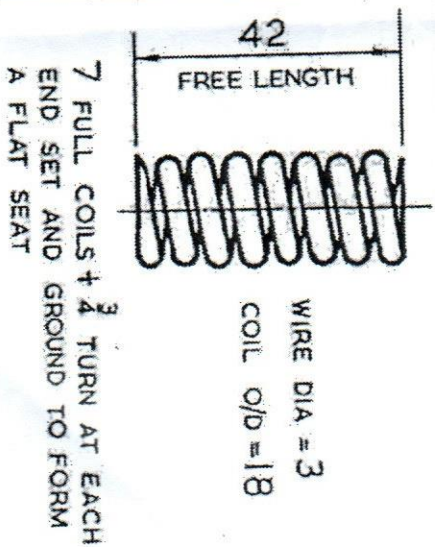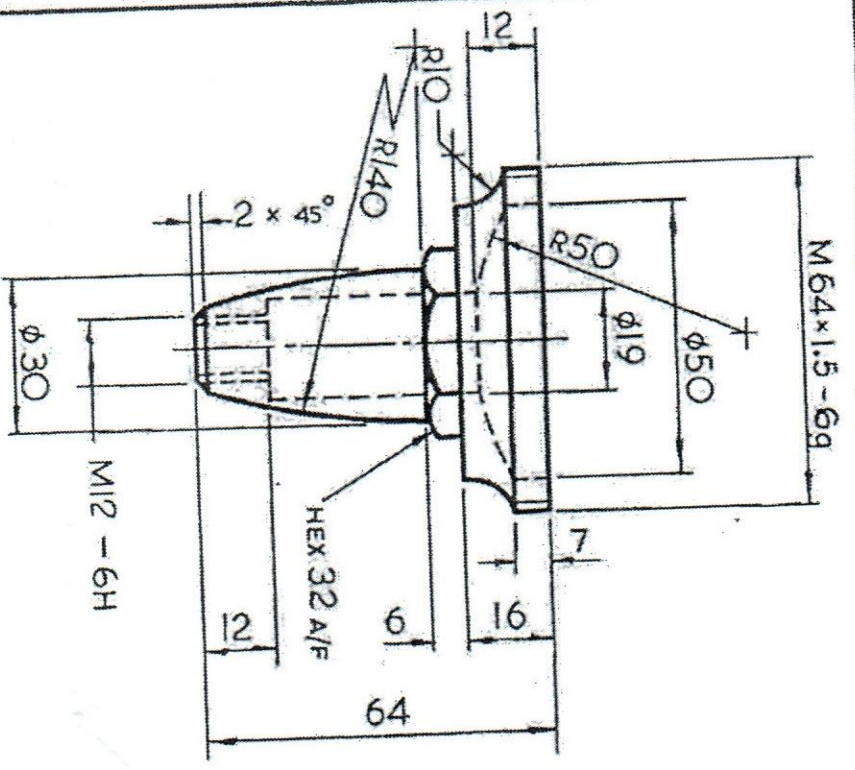|	
(i). Assembling accuracy of view (a)	(45 marks)
(ii). Assembling accuracy of view (b)	(30 marks)
(iii). Optimization of space	(05 marks)
(iv). Dimensioning	(05 marks)
(v). List of materials of parts	(05 marks)
(vi).Title block, projection symbol, lettering	(05 marks)
(vii). Final appearance, neatness	(05 marks)

①

BODY - BRASS
ONE REQUIRED

M64 × 1.5–6H

M20 × 1.5–6H
× 10 DEEP

M14 × 1.5–6H
× 11 DEEP

FACE 'B'

50

32

20

19

12

10

ø3

50

ø70

ø58

ø50

ø3

ø12

ø3

20

ø3

30°

ø25

ø19

E

R12

R12

R12

R3

22

22

E

F
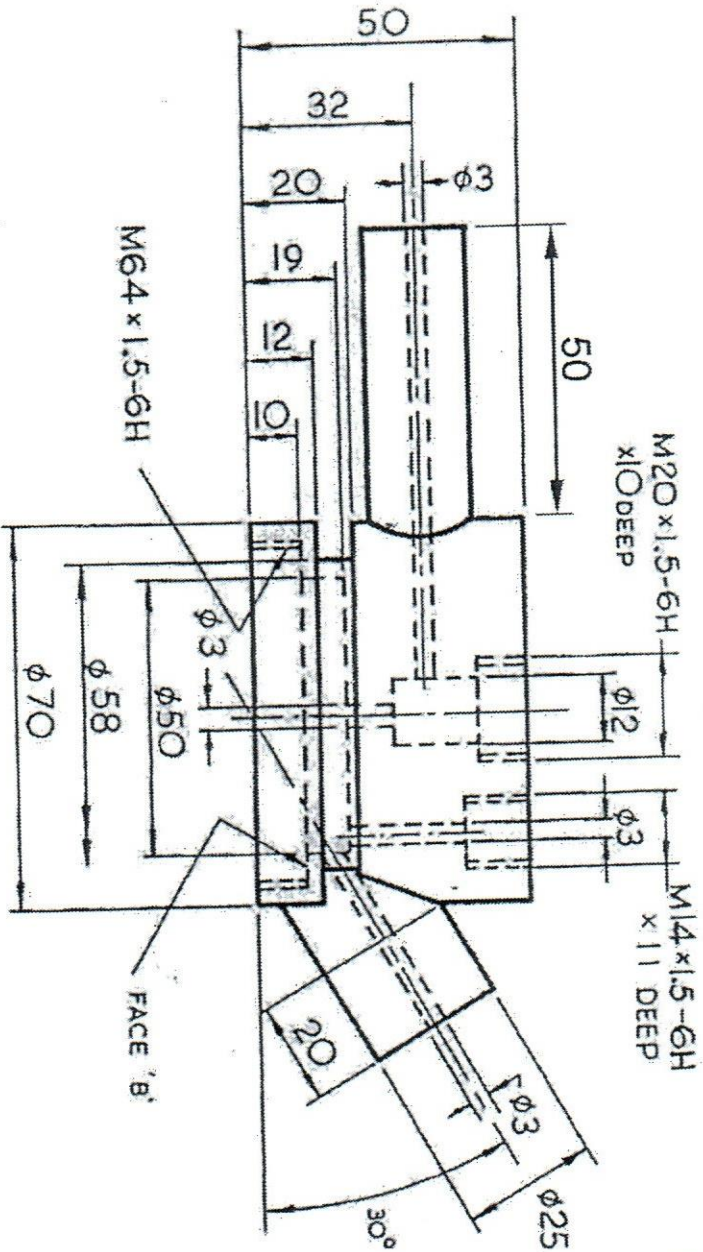
②

DIAPHRAGM ASSEMBLY
– RUBBER & BRASS
ONE REQUIRED

RUBBER DIAPHRAGM
FACE 'A'

5

3

2.5

ø60

ø44

ø8

ø12

R2

30°

2

20

④

SPRING - STEEL
ONE REQUIRED

42
FREE LENGTH

7 FULL COILS + ¾ TURN AT EACH
END SET AND GROUND TO FORM
A FLAT SEAT

WIRE DIA = 3

COIL O/D = 18

③

COVER - BRASS

ONE REQUIRED

R10

R140

2 × 45°

R50

M64×1.5 - 6g

φ19

φ50

φ30

M12 - 6H

HEX 32 A/F

12

7

6

16

12

64

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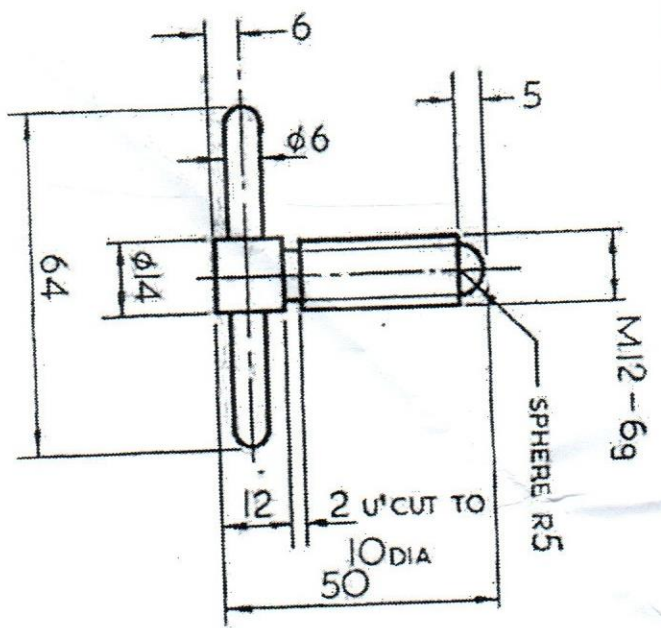
⑥

SCREW - BRASS

ONE REQUIRED

6

5

φ6

φ14

M12 - 6g

64

SPHERE R5

12

2 U'CUT TO 10 DIA

50

DIAPHRAGM REGULATOR

DATE	
THIRD ANGLE PROJECTION	
ALL DIMENSIONS IN MM	
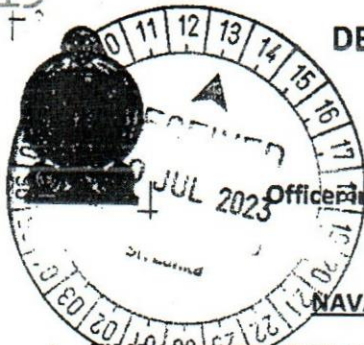
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⑤

LOCATOR - BRASS

ONE REQUIRED

10

R2

φ8

φ11

φ18

120°

1.5 × 45°

3

Library

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NAVAL ARCHITECTURE AND SHIP CONSTRUCTION

- TIME ALLOWED - THREE HOURS

- Answer ANY FOUR (04) questions from Part A and ANY TWO (02) questions from Part B

- Date:

Pass marks: 50%

Part A: NAVAL ARCHITECTURE

1. The half ordinates at the summer draft of a 180m long ship are as follows.

Section	AP	½	1	1½	2	3	4	5	6	7	8	8½	9	9½	FP
½ Ordinates(m)	.5	2.4	4.6	6.8	7.9	8.5	8.8	9.1	8.8	8.3	7.8	7.1	4.8	2.2	0

   a. Calculate the area of the water plan at summer draft of the ship. (06 Marks)
   b. Calculate the "Water Plan Area Coefficient" (C_w) of the ship. (02 Marks)
   c. Find the Longitudinal Center of flotation (LCF) of the ship at summer draft. (08 Marks)

2. A ship of 15000 tonne displacement has its longitudinal center of gravity 1.2 m aft of mid-ship.

   Following operations are now carried out while the ship is in a port.

   Discharged 3000 t Cargo @ 9.0m LCG forward of midship

   Loaded 10 t dry provisions @ 32.0m LCG aft of midship

   Loaded 400 t Fuel oil @ 10.0m LCG aft of midship

   Loaded 1800 t Cargo @ 15m forward of midship

   Loaded 100 t Fresh water @ 35m aft of midship

   a. Find the new longitudinal location of the center of gravity (LCG) of the ship on completion of above operations. (08 Marks)
   b. If 5 tonnes of dry provisions, 150 t of fuel & 50 t of fresh water has been consumed during the sea passage to next port, calculate the LCG of the vessel on arrival. (08 Marks)

3.

   a. Explain following terms with reference to transvers stability of a ship.
      I. "Transvers Metacenter"   (03 Marks)
      II. "Free Surface Effect".   (03 Marks)

   b. A vessel of 5000 tonnes displacement having vertical center of gravity (VCG) 5.0 m when arriving at a port.
     Following items are now loaded.

        3700 tonnes of cargo at VCG 8.50 m above the keel

        600 tonnes of fuel at VCG 6.25 m above the keel

        230 tonnes of FW at VCG 7.5 m above the keel to **press up** the FW tank

     According to the stability information of the vessel, second moment of area of the water plane about the center line of the vessel is 40×10^3 m^4 & center of buoyancy is 3.2 m above the keel, and remain unchanged between 9000 t to 9600 t displacements.

     The length & the breadth of the F.W. tank is 12 m X 10 m.

     If the estimated consumption of fuel and F.W during her passage to next port are 400 t and 40 t respectively, find the metacentric height of the vessel on arrival at next port.

                                                           (10 Marks)

4. A ship 120 m long has a light displacement of 1850 tonnes and LCG 3.24 m aft of mid-ship. The following items are now loaded:
Cargo 2800 tonne, LCG 5.20 m forward of mid-ship
Fuel 120 tonne, LCG 35.50 m aft of mid-ship
Water 25 tonne, 36.25 m aft of mid-ship
Consumables 5 tonne, 38.0 m forward of mid-ship
Following hydrostatic particulars available in the vessel's stability booklet.

Mean Draft-m	Displacement - tonne	MCT 1 cm – tonne m	LCB from mid-ship m	LCF from mid-ship m
6.0	4400	48.80	1.25 F	1.20 A

Calculate the final end drafts of the vessel.

                                                         (16 Marks)

5.

   a. With reference to resistance exerted on ship's hull against her movement through seawater explain following terms.
      I. Frictional Resistance.   (02 Marks)
      II. Residuary Resistance.   (02 Marks)
      III. List the factors effecting the magnitude of Frictional Resistance.   (02 Marks)

   b. A 05 m long mild steel model of a ship has a wetted surface area of 6 m^2 and required 36 N force to tow it in fresh water at 04 knots. If the "Ship correlation Factor" (SCF) is 1.10, Calculate the effective power of a ship, 125 m long, at its corresponding speed.

   (10 Marks)

$$f = 0.417 + \frac{0.773}{L+2.862}$$ and where wetted surface area (S) in m^2 & speed (V) is in Knots, index of speed n = 1.825 density of seawater = 1.025

6.
  a. Define following terms with respect to marine propellers;
      I.   Theoretical Speed   (02 Marks)
      II. Wake Speed   (02 Marks)
      III. Wake fraction   (02 Marks)
      IV. Real Slip   (02 Marks)
  b. A propeller of 5.8 m diameter has a pitch ratio of 0.8. At service speed of the vessel, propeller
     rotates at 90 RPM. The wake fraction is found to be 0.28 & the real slip 32 %.
     Calculate;
      I.   Speed of advance   (04 Marks)
      II. The speed of the ship   (02 Marks)
      III. Apparent slip   (02 Marks)

Part B:

7. With the aids sketches briefly describe the main purpose of the following.
   (a) Bulbous bow.   (04 Marks)

   (b) Flare or Flam.   (03 Marks)

   (c) Bilge keel.   (03 Marks)

   (d) Sheer.   (03 Marks)

   (e) Camber.   (03 Marks)

8. With reference to the impressed current method of protecting a ship's hull from corrosion:
   (a) (i) Sketch a fully automated impressed current system.   (06 Marks)
       (ii) Describe the system.   (05 Marks)

   (b) State how are the propulsion and maneuvering systems protected from corrosion.
                                                                      (05 Marks)

9. With reference to double plated hollow rudders:
       (a) State the advantages of this type of rudder compared to the single plate rudder.
                                                                      (06 Marks)
       (b) State methods of protecting the rudder from internal corrosion.   (04 Marks)
       (c) Describe how the ship and its performance would be affected by a cracked rudder plate which
           allows the ingress of seawater.   (06 Marks)
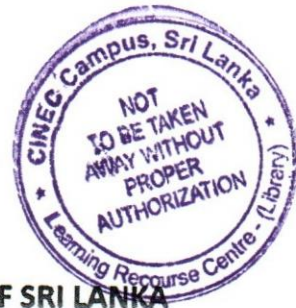
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Applied Mechanics

- **TIME ALLOWED - THREE HOURS**

- **Answer ANY Six questions only**

- **Date:**   **Pass marks: 50%**

Answers with clear sketches/diagrams, neat handwriting and clear expression will get full marks

Density of water – 1000 kgm^{-3} Gravitational acceleration – 9.81 ms^{-2}
Density of sea water – 1100 kgm^{-3}

1.

1.1 What are the conditions for equilibrium under three coplanar forces?   (4 marks)

1.2 P and Q sits on a *non-uniform* plank AB of mass 25kg and length 4 m as shown in the diagram below. the plank is pivoted at M, the midpoint of AB. The center of mass of AB is at C where AC is 1.8m. Q has a mass of 35kg while P has a mass of 25kg and sits at A. Where must Q sit for the plank to be horizontal?
(8 marks)

1.2 Suppose the plank was replaced with another one with same dimensions and weight. However when P and Q sits at A and B corners, the plank was seen to be horizontal. Calculate the new distance to the center of mass of the plank, form A.   (8 marks)
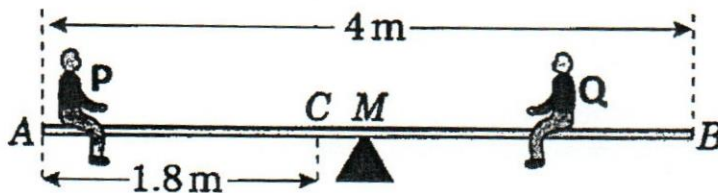
2.

2.1 Prove that the moment of inertia of a rectangular section about the axes X-X and Y-Y passing through its center of gravity is given by $I_{xx} = \frac{bd3}{12}$ and $I_{yy} = \frac{db3}{12}$ (8 Marks)

2.2 Below figure shows a composite "L" section area. Compute the center of gravity of the section and moment of intertie of section about axis A-A. (All dimensions are in mm) (12 Marks)
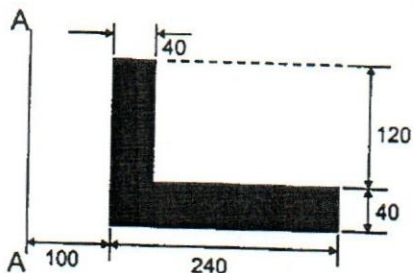
3.

3.1 A ball **A** falls vertically from rest from the top of a tower 63 m high. At the same time as ball **A** begins to fall, another ball **B** is projected vertically upward from the bottom of the tower with a starting velocity of 21 m/s. After sometime two balls collide with each other. Find the distance to the point where the balls collide, from the bottom of the tower. (10 marks)

3.2 If the ball A lost half of its velocity due to the collision, calculate the speed at which the ball A hit the ground. (10 marks)

4

4.1 A block rests on an inclined plane of $\mu = 1/\sqrt{3}$, determine the angle of inclination when the block just slides down the inclined plane (6 Marks)

4.2 A uniform ladder of 4m length rests against a vertical wall with which it makes an angle of 45°. The coefficient of friction between the ladder and the wall is 0.4 and that between ladder and the floor is 0.5. If a man, whose weight is half of that of the ladder, climbs it, how high will it be when the ladder slips? (14 Marks)

5

5.1 Define "radian" and derive equations for angular displacement, angular velocity, and angular acceleration showing its relationships to its linear motion counterparts. (6 Marks)

5.2 A flywheel is rotating at 200 rpm and after 10 seconds of uniform retardation it was observed that the value has reduced to 160 rpm. Determine the number of revolutions made by the flywheel during this period and the time it will take for the flywheel to come to rest from the speed of 200 rpm.

(14 Marks)

6

6.1 Define *relative density* and *specific gravity* (4 Marks)

6.2 State and prove Archimedes Principle (4 Marks)

6.3 A Block of wood having a mass of 12 Kg floats on fluid. Find the volume of the block inside the fluid if the relative density of the fluid is 0.7. And also find the extra weight that should be placed on the object for it to immerse another100 cm³ in the water. (12 Marks)

7

7.1 A beam ABCD is simply supported at A and C. A load of 30 kNm⁻¹ is uniformly distributed over the portion AB of 6 m long. Concentrated loads of 100 kN and 80 kN act at B and D respectively where D is on an overhang of 2m from C.

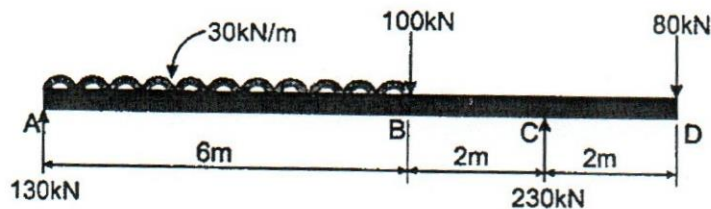Draw,

    a. Shear force diagram (8 marks)
    b. Bending moment diagram (8 marks)
    c. Determine the maximum bending moment and point where it occurs. (4 marks)

8

8.1 Define "work done" and hence derive equations for "potential energy" and "kinetic energy" using suitable notations. (6 marks)

8.2 A body weighing 20N is projected up And along a 20^0 inclined plane with a velocity of 12m/s. If the coefficient of friction is 0.15, find;

    a.   The maximum distance, that the body will move up the inclined plane,
    b.   Velocity of the body when it returns to its original position. (14 marks)

9.

9.1 What is center of pressure? (5 marks)

9.2 Figure shows a rectangular sheet, ABCD immersed in the water such that it makes 600 inclination with free surface. The center of gravity of the sheet is at a vertical depth of 6 m from the free surface.

    a.   Determine the total pressure force acting on the plate (8 marks)
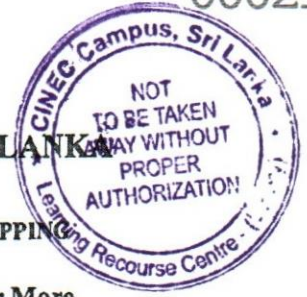   b.   Position of center of pressure (7 marks)
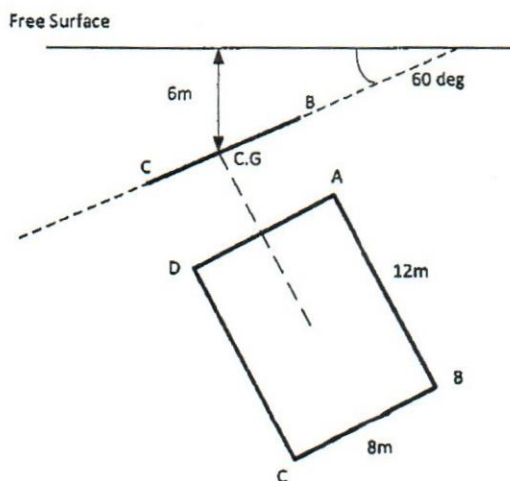
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MATHEMATICS

- **TIME ALLOWED - THREE HOURS**

- **Answer SIX questions only**

- **Date:**   **Pass marks: 50%**

Answers with clear sketches/diagrams, neat handwriting and clear expression will get full marks

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1.

   i.   Show that $12x^3 + 16x^2 - 5x - 3$ is devisable by $2x + 3$ and hence find the factors of the expression.   (6 marks)

   ii.   Solve the equation $\log_5 x - 4\log_x 5 - 3 = 0$ (6 marks)

   iii.   Express in partial fractions $\dfrac{x^2 - 2x + 2}{(x+1)^2(x^2+3)}$ (8 marks)

2. The diagram shows the region R which is bounded by the curve $y = \dfrac{1}{x+1}$, the x-axis, and the lines $x = 0$ and $x = 5$. Determine

   i.   The area of R, giving your answer as a single logarithm,   (6 marks)

   ii.   The centre of gravity of the region about the x-axis   (6 marks)
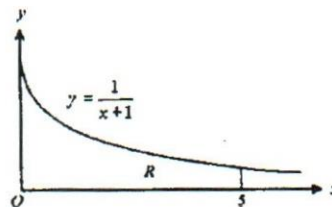
   iii.   The volume of the solid formed when R is rotated completely about the x-axis. (Hint: use the *Pappus theorem*)   (8 marks)

3. A quadratic function is defined by

$$f(x) = x^2 + kx + 2$$

where k is a constant. It is given that the equation f(x) = 0 has two distinct real roots.

i. Find the set of values that k can take.

(6 marks)

For the case where $k = 4$,

ii. express $f(x)$ in the form $(x+a)^2 + b$, stating the values of a and b, and hence write down the least value taken by $f(x)$,

(8 marks)

iii. Solve the equation $f(x) = 0$, expressing your answer in terms of surds, simplified as far as possible.

(6 marks)

4.

a. Prove the identity

$$\frac{\sin 2x}{1+\cos 2x} = \tan x \qquad\qquad \frac{1-\cos x}{\sin x} = \tan \frac{x}{2}$$

(10 marks)

Hint: $\quad \sin 2\theta = 2\sin\theta\cos\theta \qquad\qquad \cos 2\theta = \cos^2\theta - \sin^2\theta$

b. Prove the identity

$$\sin(x+30^0) + \sqrt{3}\cos(x+30^0) = 2\cos x \qquad \text{where } x \text{ is measured in degrees.}$$

Hence express $\cos 15°$ in surd form.

(10 marks)

Hint: $\quad \cos(A-B) = \sin A \sin B + \cos A \cos B$

$\sin 30^0 = 1/2$, $\cos 30^0 = \sqrt{3}/2$, $\cos 45^0 = \sin 45^0 = \sqrt{2}/2$

5.

a. Differentiate the following function with respect to x

i. $y = 5x^{-3} + \dfrac{7}{x} + \dfrac{2x^6}{3} - 9x + 26$

(5 marks)

ii. $y = 2x \ln\left(\dfrac{2}{x}\right)$

(5 marks)

b. A curve is given, parametrically, by

$$x = t - \sin\left(\frac{\pi t}{2}\right), \qquad y = \cos\left(\frac{\pi t}{2}\right) - t^2$$

Find the x- and y−coordinates of the point P which corresponds to the parameter $t = 1$ and find the value of $\dfrac{dy}{dx}$ at P.

(10 marks)

6. Find the integrals

    i. $\int \dfrac{2}{(x-3)(x+2)}\,dx$

                                                      (5 marks)

    ii. $\int \theta \sin(\theta)\,d\theta$

                                                      (5 marks)

    iii. $\int_{-1}^{2}\left(4x^3 - x + 1\right)dx$

                                                      (5 marks)

    iv. $\int_{0}^{1}\tan^{-1}x\,dx$

                                                      (5 marks)

7. Let $f(x) = x^2 - 4x + 9$ and $g(x) = 3 + 4x - x^2$

    i.   Sketch $f(x)$ and $g(x)$ in a same grid   (4 marks)

    ii.   Find the values of x when $f(x) = g(x)$ (4 marks)

    iii.   Using the **Simpson's 1/3 rule** find the area of the region bounded by the two curves. Taking n=10.   (12 marks)

8.

    i.   If $z_1 = 1 + 3i$, $z_2 = 3 - 2i$ and $z_3 = 2 + i$, find

        a. $2z_1 - z_2 + 3z_3$

        b. $\dfrac{iz_1 + z_3}{z_2}$ (8 marks)

    ii.   Given that $z_1 = 2 + i$ and $z_2 = 1 - 6i$ find the complex number ω such that $\omega z_1 + \bar{\omega} z_2 = 5$ and find $|\omega z_1|$.   (6 marks)
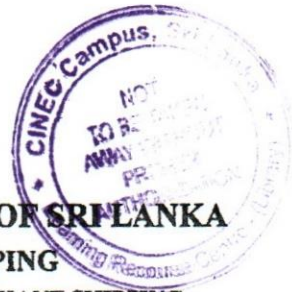
    iii.   Find the square root of $3 + i$ (6 marks)

9.

    i.   If $A = \begin{pmatrix} 2 & 3 \\ 2 & 3 \end{pmatrix}$ and $B = \begin{pmatrix} -1 & 3/2 \\ 1 & -1 \end{pmatrix}$ show that $AB = BA = I$ where $I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

                                                      (10 marks)

    ii.   Find the inverse of $A = \begin{pmatrix} 1 & -1 & 1 \\ 1 & -2 & 3 \\ 2 & 1 & -3 \end{pmatrix}$ (10 marks)

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DIRECTOR GENERAL'S OFFICE OF MERCHANT SHIPPING
Merchant Shipping Secretariat
Officer in Charge of an Engineering Watch of 750 kW or More
(Unlimited)

THERMODYNAMICS

- **TIME ALLOWED - THREE HOURS**

- **Answer SIX questions only**

- **Date:**   **Pass marks: 50%**

Answers with clear sketches/diagrams, neat handwriting and clear expression will get full marks

For air $c_p = 1.005 kJ/kg\ K$, $c_v = 0.717 kJ/kg\ K$, $\gamma = 1.4$

Composition of air (mass proportions): *77 % of Nitrogen* and *23 % of Oxygen*

Specific heat capacity of water *4.2 kJ/kg K*, Latent heat of evaporation of water *2.256 MJ/kg*

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1. A vessel of volume *0.80 m³* contains air and wet steam having *0.96* dryness fraction at a total pressure of *0.50 bar* and temperature *70.6 °C*. Then the temperature has dropped to *24.1 °C* under constant volume by increasing the coolant flow rate. Taking *R* for air = *0.287 kJ/kgK*. Determine

    i. The *initial partial pressure of steam* and *air* in the vessel   (3 marks)

    ii. The *mass of steam* in the vessel   (3 marks)

    iii. The *mass of air* in the vessel   (3 marks)

    iv. The *final partial pressure of steam* and *air* in the vessel   (3 marks)

    v. The *enthalpy change of steam* and *air* in the vessel   (8 marks)

2. The analysis of an oil fuel burned in a furnace shows that *78.5% of Carbon, 11.5%* of *Hydrogen, 6%* of *Oxygen, 3%* of *Sulphur.* and the remainder *ash*. Calorific values of C, H and S are *33MJ/kg, 144 MJ/kg* and *9.3 MJ/kg* respectively. Determine

    a. The *calorific value* of the fuel   (4 marks)

    b. The *theoretical mass of air required per kg of coal* for perfect combustion taking the molecular mass of *C, H, S* and *O 12, 1,32* and *16* respectively   (4 marks)

    c. The *percentage* of *excess air* if the actual air supplied is *20 kg* per kg of fuel   (4 marks)

    d. The *percentage mass analysis* of the flue gases   (8 marks)

3. A cool room panel is made up of an external thickness of foam material *75 mm* thick, inside which is a layer of fiberglass *10 mm* thick. The fiberglass is faced internally by an insulating board *5 mm* thick. The coefficients of thermal conductivity for the three materials are

Foam material	*0.6 W/m K*
Fibreglass	*0.04 W/m K*
Insulating board	*0.06 W/m K*

The surface transfer coefficient of the inside wall is *2.34 W/m² K*, that of the outside wall is *4.21 W/m² K*. Take the internal ambient temperature as *25 °C* and the external ambient temperature as *-15 °C*. Determine

    a. The overall transfer coefficient for the wall and using the coefficient (6 marks)

    b. The heat lost per hour through unit area (4 marks)

    c. The temperature at each interface of the wall (10 marks)

4. In an ideal **Dual combustion cycle**, the heat transfer ratio during combustion under the constant volume and pressure is *2 to 1*. The isentropic compression ratio is *13:1* and the pressure and temperature at the beginning of compression are *1.03 bar* and *40 °C* respectively. The maximum temperature reached during the cycle is *1800 °C*. Calculate

    a. The temperature and pressure at the end of compression (4 marks)

    b. The temperature and pressure at the end of constant volume combustion

        (4 marks)

    c. Work transfer by 1 kg of air per cycle (8 marks)

    d. The mean effective pressure (4 marks)

5. An engine working on an ideal **Diesel cycle** has a clearance volume of *0.00025 m³*. It has a bore and stroke of *152.5 mm* and *200 mm*, respectively. At the beginning of adiabatic compression the air in the cylinder has a pressure of *100 kPa* and temperature of *20 °C*, respectively. The maximum temperature of the cycle is *1090 °C*. Determine

    a. The temperature and pressure at the end of the adiabatic compression (8 marks)

    b. The temperature and pressure at the end of the adiabatic expansion (3 marks)

    c. The thermal efficiency of the cycle (4 marks)

    d. The fraction of the stroke at which combustion is theoretically complete

        (5 marks)

6. In an air compressor, air is compressed according to the law $PV^{1.3} = constant$. The initial conditions of the air is *1.0 bar*, and *27 °C*. The compressor has a bore of *200 mm* and the stroke 0f *300 mm*. the clearance volume is *5%* of the swept volume. If the final pressure is *10 bar*,

    a. Draw the PV diagram representing all the processes (2 marks)

b. calculate

 i. For what length of the stroke air is delivered (5 marks)

 ii. The volume of air delivered per stroke (4 marks)

 iii. The final temperature and change of internal energy after the compression

   (4 marks)

 iv. The volumetric efficiency (5 marks)

7. A steam power plant which operates on an ideal Rankine cycle and has a net power output of *42 MW*. Steam enters the turbine at *7 MPa* and *500 °C* and is cooled in the condenser at a pressure of *10 kPa* by running cooling water from a lake through the tubes of the condenser at a rate of *2000 kg/s*.

 a. Draw the T-S diagram to represent processes in the cycle (4 marks)

 b. Determine

  i. The condition of the steam after the expansion in the turbine (4 marks)

  ii. The thermal efficiency of the cycle (4 marks)

  iii. The mass flow rate of the steam (4 marks)

  iv. The temperature rise of the cooling water (4 marks)

8. A test on a seven-cylinder, 2 stroke engine resulted in the following data: average brake torque per cylinder is *148 kNm*. The engine has a bore of *600 mm* and stroke of *2050 mm* and the mechanical efficiency is *72 %*. At a full load speed of *104 rev/min*, The engine uses *1900 kg* of fuel per hour and calorific value of fuel is *40.3 MJ/kg*.

Estimate

 a. The brake power, indicated power, and friction power per cylinder (6 marks)

 b. The indicated mean effective pressure (6 marks)

 c. Brake specific fuel consumption and indicated specific fuel consumption

   (4 marks)

 d. Indicated thermal efficiency and brake thermal efficiency (4 marks)

9. In a Freaon-12 refrigerator, the Freon leaves the condenser as saturated liquid at *6.516 bar*. The evaporator temperature is *-10 °C* and the Freon leaves the compressor as a dry vapour at *6.516 bar*.

 a. Determine,

  i. Enthalpy before the refrigerant passes through the throttling valve (2 marks)

  ii. Dryness fractions at the evaporator inlet and outlet (4 marks)

iii. The cooling effect per kg of refrigerant (4 marks)

iv. The compressor work (4 marks)

v. COP of the cycle (2 marks)

b. Draw the $T - S$ and $P - H$ diagram for the refrigeration cycle (4 marks)

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

MINISTRY OF PORTS AND SHIPPING

DIRECTOR GENERAL'S OFFICE OF MERCHANT SHIPPING

Merchant Shipping Secretariat

Officer in Charge of an Engineering Watch of 750 kW or More (Unlimited)

Maritime Law

- **TIME ALLOWED - THREE HOURS**

- **Answer SIX questions only**

- **Date:**

Pass marks: 50%

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1. Referring to Risk Management on board ships,
   a. Name the four (04) main steps of risk management process. (02 Marks)
   b. Briefly explain above four (04) steps. (06 Marks)
   c. Make a risk assessment and state the control measures that you would propose when team of riding technicians boarded the vessel for carrying out essential generator repair, taking into consideration the present Corona pandemic. (08 Marks)

2. Referring to United Nations Convention of the Law of Sea – III (UNCLOS-III), regulations for sharing ocean areas & its resources briefly explain following,
   a. Various sea areas as define by the convention using a suitable sketch. (04 Marks)
   b. "Port State Jurisdiction". (03 Marks)
   c. "Flag State Jurisdiction". (03 Marks)
   d. "Innocent Passage". (03 Marks)
   e. "International Strait". (03 Marks)

3. With Reference to International Maritime Organization (IMO).
   a. Illustrate the basic organizational structure of IMO. (07 Marks)
   b. Briefly define following,
      I. "Contracting Government". (03 Marks)
      II. "Ratification". (03 Marks)
      III. "Tacit Approval". (03 Marks)

4.
   a. State the four (04) main objectives of the International Load Line Convention, assigning a minimum "Free Board" for a sea going ship. (04 Marks)
   b. What is meant by "Floodable Length" of a ship. (03 Marks)
   c. What is meant by "Permeability of a Compartment"? (03 Marks)
   d. State various items on board ship which are subjected to examine during load line survey. (06 Marks)

5. Survey & Certification is one of the important process of a merchant ships.
   a. Briefly explain why it is required to carry out surveys and issue a certificate for sea going vessels. (02 Marks)
   b. State five (05) parties interested in ship certification. (05 Marks)
   c. Differentiate the various categories of certificates carried on board ships. (03 Marks)
   d. State the advantages of Harmonized Survey & Certification system (HSSC). (02 Marks)
   e. State the maximum validity period of certificates issued under above system and the surveys require to carry out during that period in order to keep the validity of the certificates. (04 Marks)

6. With reference to SOLAS Ch-II-2,
   a. State the various classes of bulkheads use in ship building industry. (04 Marks)
   b. Define "Category A Machinery Space". (04 Marks)
   c. Define "Non-Combustible Material". (04 Marks)
   d. State the reasons for using different classes of bulkheads between different compartments of the ship's structure. (04 Marks)

7. Regarding the Marpol Convention,
   a. State the requirements to be fulfilled (with regard to equipment & procedures) by a ship for when pumping out bilge water accumulated in a machinery space while the ship is in a special sea area as defined by Marpol Annex I. (08 Marks)
   b. What are the categories of hazardous Cargo as per the Marpol Annex II. (02 Marks)
   c. Briefly define the categories stated in section "b". (06 Marks)

8. Emission of various gases from the ships are required control to protect the atmosphere.
   a. Explain the effect of "Green House Gasses" on global warming. (03 Marks)
   b. State five (05) gases comes under control of Marpol Annex VI. (05 Marks)
   c. What are the present limitations applicable for the Sulphur content of the fuel used on board ships? (02 Marks)
   d. If a ship owner wishes to use the fuel exceeding the present limitations of Sulphur content, state the alternate arrangement accepted by Marpol annex vi. (03 Marks)
   e. If any alternate arrangement used as stated in section "d", state how does quantity of Sulphur dioxide in exhaust is measured & set limits to meet with applicable requirements. (03 Marks)

9. International Ballast Water Management convention was adopted by IMO & is in force since 2017/Sept.
   a. State the reasons urged for IMO to introduce this convention. (02 Marks)
   b. What are the ships that require to comply with regulations of the convention during seawater ballast operation? (01 Marks)
   c. What are the ships that may be exempted from the requirements of this convention? (03 Marks)
   d. What are the documents to be carried on board ships to comply with the requirement of this convention? (04 Marks)
   e. What are the two standards for Ballast Water Management as per the BWM Convention. (06 Marks)

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Faculty of Marine Engineering

Department of Marine Engineering

Examination for Officer in Charge of an Engineering Watch on Ships of 750kW Propulsion Power or More

ENGINEERING KNOWLEDGE – I (GENERAL)

TIME ALLOWED - THREE HOURS

Attempt SIX questions only as follows:

FOUR questions from Section A

ONE question from Section B

ONE question from Section C

Marks for each part of the question are shown in the brackets.

Pass mark 50 % of total **AND** also need to obtain the minimum of **8** Marks in each Section B and C.

Answers with clear sketches/diagrams, neat handwriting and clear expression will get full marks.

Date: 2023.06.12   Pass marks: 50%

Section A

1.

a) What is the Ballast Water Management Convention.   (4marks)

b) When did the BWM Convention enter into force   (2 marks)

c) Which ships does the convention apply to   (2 marks)

d)What do ships need to do, now the treaty is in force.   (2 marks)

e) What are the ballast water management standards   (6 marks)

2. a) Briefly explain the following heat treatment processes

      i) Annealing   (3 marks)
      ii)Tempering   (3 marks)
      iii)Hardening   (3 marks)

    b) Name one engine component from each category, utilizes the above heat treatment processes during manufacturing of large slow speed engine parts.   (3 marks)

    c) State the advantages of heat treatment of engine components   (4 marks)

3. With reference to engineering material, briefly explain the following conditions.

                        i) Fatigue   (4 marks)

                        ii) Creep   (4marks)

                        iii) Brittleness   (4marks)

                        iv) Brinelling   (4marks)

4. With reference to shell and tube type coolers

        a) Sketch a longitudinal section of a cooler   (6marks)

        b) Explain how expansion is accommodated   (2marks)

        c)State the locations of cavitation and erosion taking place.   (2marks)

        d)State the safety precautions to be observed during routine cleaning of the cooler (4 marks)

5. With reference to centrifugal pumps:

       a) state the operating principle of a centrifugal pump and why it is unnecessary to fit a priming device.   (4 marks)

        b) state two impeller types and which types of application they would be best suited for.   (2 marks)

        c) explain why cavitation occurs and how to possibly reduce by design.   (6 marks)

        d) What is NPSH of pump   (4 marks)

6.

a) Describe the safety precautions necessary when working with deck machinery.   (2 marks)

b) Describe the maintenance requirements for anchor windlass and winches.   (6 marks)

c) State two important properties required for the hydraulic oil used for deck machinery.(2 marks)

d) Briefly describe the routine maintenance carried out for deck cranes   (6 marks)

7.

With reference to a vapor compression refrigeration system.

a) Make a line diagram of a refrigeration circuit showing the relative positions of the main components and safety devices in the system.   (6 marks)

b) Briefly explain, how two cool rooms can be operated at different temperatures by using a single set of refrigeration machinery   (8 marks)

c) State two different methods being used to de-frost the evaporator.   (2 marks)

Section B

8. Describe with aid of a diagram the operation of the following components of electrical equipment & explain the purpose of each.

  a. Under voltage protection.   (3 Marks)
  b. Miniature circuit breaker.   (3 Marks)
  c. Electronic overcurrent relay   (5 Marks)
  d. Reverse power relay.   (5Marks)

9. a) State TWO indications that single phasing has occurred in the circuitry of a large 3-phase induction motor   (2 marks)

b) Explain how the effects of single phasing may differ in EACH of the following.

  i) Star   (4 marks)

  ii) Delta   (4 marks)

c) Explain why single phasing in delta configuration is more serious than in star configuration, describing a means to overcome this disadvantage   (6 marks)

Section C

10.

State with reasons, the main purpose of EACH of the following.

  i) bulbous bow   (4 marks)

  ii) flare   (4 marks)

  iii) sheer   (4 marks)

  iv) camber   (4 marks)

11.
With reference to the prevention of hull corrosion briefly explain the following:

  a) Cathodic protection by sacrificial anodes   (4 marks)

  b) Briefly explain protection provided by ICCP system   (8 marks)

  c) State the purpose of shaft earthing system   (2 marks)

  d) State the purpose of MGPS system