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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 (Repeat)

Mathematics

- **TIME ALLOWED - THREE HOURS**

- **Answer ANY SIX Questions**

- **Date: 2023.02.24**   **Pass marks: 50%**

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

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1.

   a. Determine the partial fractions of $\dfrac{x}{(x+1)(x^2+1)}$ (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 $f(x) = 2x^2 + 4x + 5$ is positive for all real values of x and find its minimum value.   (10 marks)

2. A quadratic function is defined by $f(x) \equiv x^2 - 2x + 9$.

   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 $x^2 - 2x + 9 = (x + A)^2 + B$, 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)

3.

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

$$x + y + z = 3$$
$$x + 2y + 3z = 4$$
$$x + 4y + 9z = 6$$

     (10 marks)

   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. Express as complex number in the form a + bi

   i. $\left(4\angle\dfrac{\pi}{3}\right)\times\left(5\sqrt{2}\angle\dfrac{3\pi}{4}\right)$ ii. $\left(3\sqrt{2}\angle\dfrac{\pi}{4}\right)\Big/\left(4\angle\dfrac{\pi}{6}\right)$

                                                                                  (6 marks)

    Hint: $r\angle\theta \equiv r(Cos\,\theta + i\,Sin\,\theta)$

b. 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 $|\omega z_1|$.   (5 marks)

c. If $z_1 = Cos\,\alpha + i\,Sin\,\alpha$, $z_2 = Cos\,\beta + i\,Sin\,\beta$, show that $z_1 z_2 = Cos(\alpha + \beta) + i\,Sin(\alpha + \beta)$ and evaluate z_1^2 and $(z_1 z_2)^2$ (9 marks)

5.

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

   ii. $\sin^2\theta - \sqrt{3}\sin\theta\cos\theta = 0$ (5 marks)

6.

a. Differentiate the following functions with respect to x

   i. $y = \dfrac{\sin x}{2 + \cos x}$ (4 marks)

   ii. $y = \ln\left(x^2 + \tan^2 x\right)$ (4 marks)

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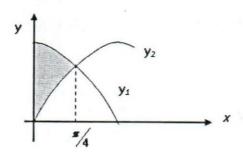
                                                           (6 marks)

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

7.

a. $\int \dfrac{1-\sin 2x}{x+\cos^2 x}\,dx$ (5 marks)

b. $\int \ln(2x+1)\,dx$ (5 marks)

c. $\int_0^1 \dfrac{2x+1}{x^2-2x-10}\,dx$ (5 marks)

d. Figure shows the sketches of the curves $y_1 = Cos\,2x$ and $y_2 = Sin\,3x$ in the range of 0 to $\pi/4$. Estimate the shaded area   (5 marks)

8.

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

b. Use 1/3 Simpson's rule to interpolate a value for the integration $\displaystyle\int_0^1 \dfrac{1}{1+x}\,dx$ for five ordinates (n = 5).   (10 marks)

c. Hence determine the value of $\ln 2$ for four decimal places.   (5 marks)
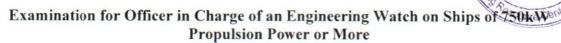
9.

a. If $z = \ln\left(y^2 + 4x^2 y\right)$, Determine $\dfrac{\partial z}{\partial x}$, $\dfrac{\partial z}{\partial y}, \dfrac{\partial^2 z}{\partial x^2}, \dfrac{\partial^2 z}{\partial y^2}, \dfrac{\partial^2 z}{\partial x \partial y}, \dfrac{\partial^2 z}{\partial y \partial x}$ (12 marks)

b. If $u(x,y,z) = e^{xyz}$, find the value of $\dfrac{\partial^3 u}{\partial x \partial y \partial z}$ (8 marks)

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

Thermodynamics

- **TIME ALLOWED - THREE HOURS**

- **Answer ANY SIX Questions**

- **Date: 2023.02.23** **Pass marks: 50%**

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

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. A quantity of air of volume **0.2 m^3** at **1.2 bar** and **27 ^0C** is heated at constant pressure until its temperature is **150 ^0C**, and then compressed to **7.15 bar** according to the law $PV^{1.3} =$ **constant**.

   a. Draw a **pv diagram** to represent the processes on air (4 marks)
   b. Determine
      i.   Mass of air in the vessel (2 marks)
      ii. The volume of air after the constant pressure process (3 marks)
      iii. The temperature and volume at the end of compression (5 marks)
   c. Determine the heat energy transferred to air and work transfer at constant pressure process (6 marks)

2. The walls of a cold chamber consists of an outer layer of wood of thickness **36 mm** and thermal conductivity **0.18 W/m K**, and cork lining of thickness **100 mm** and thermal conductivity **0.05 W/mK**. The rate of heat transfer from outer and inner exposed surfaces are **10 W/m^2K** and **12 W/m^2K** respectively. If the heat flow rate thorough the wall is **24 W/m^2**, determine

   a. The overall heat transfer coefficient including outer and inner layers (5 marks)

   b. The temperature difference across the thickness of the wood and cork (5 marks)

   c. The total temperature difference between the outside atmosphere and inside of room (5 marks)

   d. The temperature of the room when the external ambient temperature is **27 ^0C** (5 marks)

3. The pressure and temperature at the beginning of the compression of **Otto cycle** are **1 bar** and **25 °C** respectively. The maximum temperature of the cycle is **960 °C**. The compression ratio of the cycle is **6:1**. The cycle is repeated **3000 times/min**. Determine for the cycle

    a. Pressure and temperature of each cardinal point of the cycle   (6 marks)

    b. The thermal efficiency   (4 marks)

    c. The mean effective pressure   (4 marks)

    d. The theoretical output in kilowatts   (4 marks)

    e. The Carnot efficiency within the same temperature limits   (2 marks)

4. At the beginning of the compression of an ideal **Dual combustion cycle** the pressure and temperature of the gas are **90 kPa** and **20 °C**, respectively. The volume ratio of the compression is **16 : 1**. The heat added during the constant volume process is **200 kJ/kg** of gas. The constant pressure heat addition is for **5 %** of the expansion stroke. Determine

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

    b. The pressure and temperature at the end of the constant volume heating   (4 marks)

    c. The maximum temperature of the cycle   (6 marks)

    d. The efficiency of the cycle   (6 marks)

5. The analysis of an oil fuel burned in a furnace shows that **75%** of **Carbon**, **12.5%** of **Hydrogen**, 7% of **Oxygen**, **4%** 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 minimum mass of air required per kg of coal for perfect combustion   (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)

Hint : atomic mass of C, H, S and O are 12, 1,32 and 16 respectively.

6.

    a. Describe the followings of air compressors

        i. Effect of clearance on work of compression   (2 marks)

        ii. Volumetric efficiency   (3 marks)

        iii. Effect of isothermal compression   (3 marks)

    b. A single stage reciprocating air compressor is required to compress air at the rate of **0.45 kg/s** from **0.95 bar** and **295 K** to **8 bar**. Find **compressor power**, if the compression is **isothermal, isentropic** and **polytropic** with index as **1.25**.   (12 marks)

7. Steam is supplied to a turbine at *30 bar* and *350 ^0C* and the condenser pressure is *0.045 bar*. The power developed is *5 MW*. If cycle operating under ideal conditions,

    a. Find the dryness fraction of the steam after isentropic expansion in the turbine

        (5 marks)

    b. Draw the *T S diagram* assuming no sub cooling in the condenser. (5 marks)

    c. The Rankin efficiency of the cycle (5 marks)

    d. Actual efficiency of the plant (5 marks)

8. A six cylinder, single acting, four stroke oil engine, of *700 mm stroke* and *625 mm bore* runs at *95 rev/min* when the mean effective pressure is *8.5 bar*. The fuel consumption rate is *180 kg/h* and calorific value of the fuel is *44.2 MJ/kg*. If the mechanical efficiency is *85 %*, determine

    a. Indicated power (5 marks)

    b. Brake power (5 marks)

    c. Brake specific fuel consumption (5 marks)

    d. Brake thermal efficiency (5 marks)

9. In *Ammonia* refrigerant plant the ammonia leaves the condenser as a saturated liquid at *9.722 bar*. The evaporator pressure is *2.908 bar* and refrigerant leaves the evaporator as a *dry vapour*. and enters at *9.772 bar* and *74 ^0C*

    a. Draw the *T S* diagram for the refrigerant plant (4 marks)

    b. The dryness fraction at inlet to the evaporator (4 marks)

    c. The refrigerant effect (4 marks)

    d. The compressor work transfer (4 marks)

    e. The coefficient of performance (4 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 – II (Motor)

Time Allowed- Three Hours

Answer Six questions

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

Date: 2023.02.02   **Pass marks: 50%**

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1. a) Sketch A Section A Main Engine Holding Down Arrangement, Labelling the Main Parts.
                                                                    [6 Marks]

    b) Explain How A Holding Down System Is Checked.   [4 Marks]

    c) State The Function Of The Tie Rods   (2 Marks)

    d) Describe An Arrangement Of Engine Top Bracing, Explaining Its Function.   [4 Marks]

2. With Reference To Crank Case Explosions.

    a) Describe With A Simple Sketch Operation Of The Crank Case Oil Mist Detector.[8 Marks]

    b) State The Cause Of Actions As Watch Keeping Engineer You Would Take, In The Event Of Activation Of The Crank Case Mist Detector Alarm.   [4 Marks]

    c) What Do You Understand By The Term Scavenge Fire And Reasons For The Same And What Action You Will Take To Extinguish The Fire.   (4 Marks)

3. A) State What Clearances Are Required To Obtain During Piston Overhaul   (4 Marks)

    b) State The Functions Of Piston Rings   [4 Marks]

    c) Explain How The Rings Seal Against The Gas Pressure   [4 Marks]

    d) Explain The Purpose Of An Anti-Polishing Ring   [2 Marks]

    e) State The Function Of The Stuffing Box Fitted In A Slow Speed Diesel engine (2 Marks)

4. a) Explain Why Electrically Driven Scavenge Air Blowers Are Fitted To 2 Stroke large Bore Cross Head Diesel Engines. [4 Marks]

    b) Explain Why Scavenge Air Is Cooled After Leaving The Turbocharger Prior To Enters The Scavenge Air Space. [4 Marks]

    c) State, With Reasons, The Possible Consequences To The Engine If Water Droplets Are Not Removed From The Scavenge Air Before It Enters The Cylinders. [4 Marks]

    d) What Would Be the Ideal Temperature Range Of Scavenge Air Entering the Engine

    (2 Marks)

    e) What Type of Coolers Are Most Suitable To Use As Scavenge Coolers(2 Marks)

5. a) How Does A Scrubber Reduce Sulfur Oxide (Sox) Emissions (4 Marks)

    b) How Is It Ensured That The Water Discharged Into The Sea Does Not Pollute the Sea
    (4 Marks)

    c) Sketch The Arrangement Of Components In A Closed Loop Scrubber Used on Board
    (4 Marks)

    d) Explain The Arrangement Of Collection And Disposal Of Accumulated sludge
    (4 Marks)

6. a) Describe The Procedure Of Adjusting Tappet Clearance Of A Generator engine.
    (6 Marks)

    b) Explain The Importance Of Maintaining Proper Clearance During The operation Of The Engine. (4 Marks)

    c) Describe The Procedure Of Adjusting Timing Of A 'Jerk Type' Fuel Pump. (6 Marks)

7. a) Explain The Working Principle Of An Electronically Controlled Cam Less engine.
    (10 Marks)

    b) State Two Types Of Cylinder Lubricating Oil Systems Used In Electronically Controlled engines. (2Marks)

    c) State What Occasions The Slow Turning Function Activates And State The Benefit Of The System (4 Marks)

8. a) Name Two Types Of Turbocharging And Explain Advantages And disadvantages.

    (4 Marks)

    b) Explain The Basic Operation Of A Hybrid Turbocharger And State

    Advantages Of Fixing Them On Ships Main Engine.   (8 Marks)

    c) State Two Methods Of Cleaning The Turbine Side During Operation And State The Suitable
    Engine Condition In Each Operation.   (4 Marks)

9. a) What Are The Two Main Nox Reduction Technologies Used In Large Slow Speed Engines.
    (2 Marks)

    b) Explain The Operation Of One Of The Above Systems By Using A Simple Sketch Naming All
    The Important Parts.   (12Marks)

    c) State The Minimum Temperature Required To Combine N2 And O2 In The Combustion
    Chamber To Form Nox.   (2 Marks)

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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: 2023.02.01   Pass marks: 50%

Section A

1. (a) Describe the operation of a two – stage air compressor.   (06 marks)

   (b) What is Bumping Clearance?   (02 marks)

   (c) Explain why intercoolers and after coolers are fitted.   (02 marks)

   (d) State the safety features incorporated in the compressor and in the stating air system   (04 marks)

   e) state FOUR safety features fitted in compressed air systems   (02 marks)

2. With reference to ram type steering gears, explain how:

   a. Shock loading is absorbed,   [4 Marks]

   b. Rudder position corresponds to the helm position at all times,   [4 Marks]

   c. Rudder 'drop' is accommodated,   [4 Marks]

   d. Steering gear can be operated upon failure of the bridge telemeter system   [4 Marks]

3.

a. State how and why lubricating oil deteriorates in main engine lubrication systems. [4 Marks]

b. Describe simple shipboard tests to determine the degree of contamination. [3 Marks]

c. Give a reason in each case, why each of the following conditions of lubricating oil is unacceptable:

    i. High acidity, [3 Marks]

    ii. Significant fuel contamination, [3 Marks]

    iii. Significant freshwater contamination. [3 Marks]

4.

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 in the system. (2 marks)

b) Briefly explain, how two cool rooms can be operated at different temperatures by using a single set of refrigeration machinery (4 marks)

c) What are the signs of air in the system and explain how air can be removed from the system? (2marks)

d) What are the symptoms of undercharged system? (2 marks)

5.

a) What are the basic types of auxiliary steam boilers used on board ship. (2 marks)

b) Name the safety features incorporated on auxiliary boilers. (4 marks)

c) State why it is important to maintain the water level within recommended limits during boiler operation. (4 marks)

d) State the actions that you would take as a watch keeper if water level is not visible on a gauge glass during your watch. (4 marks)

e) State the suitable temperature of feed water tank (2 marks)

6.

a. State THREE modes of heat transfer. [2 Marks]

b. Sketch a longitudinal cross section of a tubular heat exchanger detailing the fixtures and expansion of the tube nest arrangement. [7 Marks]

c. Discuss the advantages and disadvantages of above in (Q5.b) compare with plate type heat exchanger. [7 Marks]

7.

a. Sketch a 4-ram hydraulic steering gear system and briefly explain safe operation. [4 Marks]

b. What is the indication of air in the steering system [1 Mark]

c. What is the function of a hunting gear in steering gear on a ship (1 Mark)

a) Describe the procedure of testing the ship's steering gear and associated equipment prior to departure from port. (4 marks)

Section B

8.

a. Sketch a circuit diagram of an emergency power supply system suitable for a large tanker vessel, include in your diagram essential services supplied. [8 Marks]

b. With reference to emergency generator discuss method of automatic starting and the time available for starting and connection of power to switch board. [8 Marks]

9. With reference to alkaline batteries used on board ship.

a. Describe the operation of a battery cell and state the material used; [4 Marks]

b. Describe how the cells are mounted to form a battery; [4 Marks]

c. State the advantages and disadvantages compared with lead-acid batteries. [4 Marks]

d. Explain the safety precautions to be observed during routine battery maintenance (4 marks)

Section C

10.

a. Compare the advantage between the sacrificial anodes and impressed current system [6 Marks]

b. Describe with aid of sketch(s), the impressed current system suitable to be used in a ship with the aid of a diagrammed [8 Marks]

c. What are the circumstances that a ICCP system is kept switched off [2 Marks]

11.

With reference to large container carriers.

a. Sketch a transverse section of a modern container carrier. [7 Marks]

b. Describe the designs that have evolved to minimize the possibility of failures. [9 Marks]

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

Marine Engineering Drawing and Design

- **TIME ALLOWED - FOUR HOURS**

- **Answer ALL questions**

Date: 2023.01.31   Pass marks: 50%

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

The figure shows details of a **control valve**. Draw the following views of the assembled control valve in **first angle projection**. Select a suitable scale.
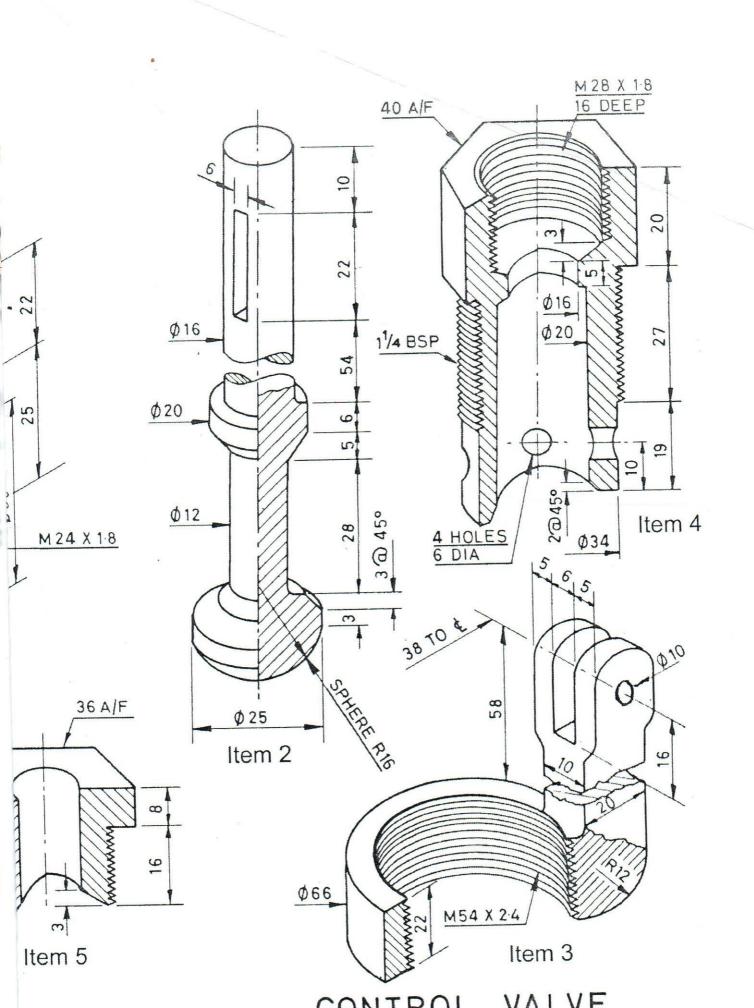
(a) Longitudinal section through assembled valve with fulcrum- pin (item 7) vertically above right-hand branch. Valve should be in closed position.

(b) End elevation projected to the right of view (a)
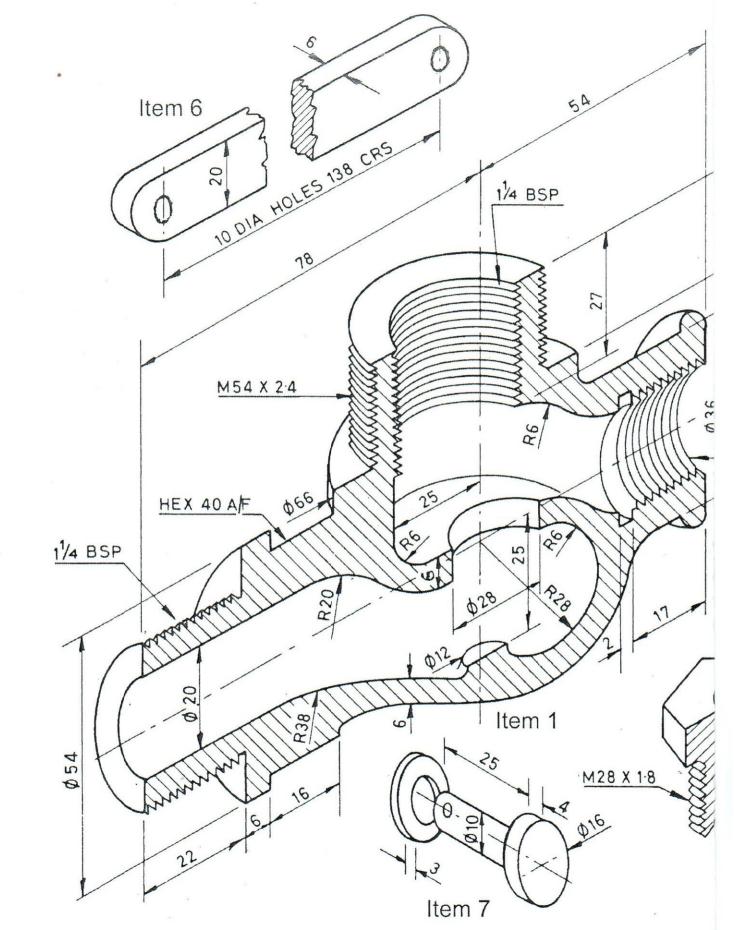
(c) Plan view projected from view (a)

Suitable dimensions should be estimated where not provided. Hidden details are not required in any view.

Complete the drawing by including the title, projection symbol and dimensions.

Marking System

(1) Assembling accuracy of view (a)	(35 marks)
(2) Assembling accuracy of view (b)	(25 marks)
(3) Assembling accuracy of view (c)	(20 marks)
(4) Optimization of space	(05 marks)
(5) Dimensioning (at least 12 dimensions correctly)	(05 marks)
(6) Title block, projection symbol, lettering	(05 marks)
(7) Final appearance	(05 marks)

6

$1\tfrac{1}{4}$ BSP

Ø16

Ø20

Ø12

Ø25

10

22

54

6

5

28

3

$3@45°$

SPHERE R16

M24 X 1·8

22

25

Item 2

36 A/F

8

16

3

Item 5

M28 X 1·8
16 DEEP

40 A/F

3

5

Ø16

Ø20

20

27

19

10

4 HOLES
6 DIA

$2@45°$

Ø34

Item 4

5 6 5

38 TO ₵

58

10

20

Ø10

16

R12

Ø66

22

M54 X 2·4

Item 3

CONTROL VALVE

Item 6

6

10 DIA HOLES 138 CRS

20

54

1¼ BSP

27

78

M54 X 2·4

R6

Ø36

HEX 40 A/F

Ø66

25

R6

R6

1¼ BSP

25

R20

R28

Ø28

Ø12

17

2

Ø20

R38

6

Item 1

Ø54

16

6

22

25

M28 X 1·8

Ø10

4

Ø16

3

Item 7

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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: 2023.01.30**   **Pass marks: 50%**

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

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1. Referring to Risk Management on board ships,
   a. Name the four (04) main steps of risk management process.   **(04 Marks)**
   b. Briefly explain above four (04) steps.   **(08 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.
      (13 Marks)

2. With Reference to International Maritime Organization (IMO).
   a. Illustrate the basic organizational structure of IMO.   **(10 Marks)**
   b. Briefly define following,
      I.   "Contracting Government".   **(05 Marks)**
      II. "Ratification".   **(05 Marks)**
      III. "Tacit Approval".   **(05 Marks)**

3. 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.   **(03 Marks)**
   b. State five (05) parties interested in ship certification.   **(05 Marks)**
   c. Differentiate the various categories of certificates carried on board ships. **(06 Marks)**
   d. State the advantages of the Harmonized system of Survey & Certification system (HSSC).   **(05 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.   **(06 Marks)**

4. With reference to SOLAS requirements State,
   a. The test carried out to verify the capacity of the steering gear system of a cargo ship. **(10 Marks)**
   b. the routine inspection & tests required to carried out on steering gear system of a ship. **(10 Marks)**
   c. State the frequency of above routine inspection & tests to be carried out.
   (05 Marks)

5. With reference to SOLAS convention
   a. State the areas covered by Chapter II-2. **(06 Marks)**
   b. What are the types of bulkheads used on ship building to fulfill the requirements of above chapter? **(05 Marks)**
   c. Briefly explain two main types of bulkheads stated in section (b) above.
   (10 Marks)
   d. State what is meant by a "Non-Combustible" material. **(04 Marks)**

6. With reference to the International Load Line Convention.
   a. What is meant by "Free Board" & "Reserve Buoyancy" of a ship? **(03 Marks)**

   b. What are the 04 main types of Freeboards assigned for the ships under this convention. **(04 Marks)**

   c. List 06 different types of items included in "Record of Conditions of Assignment for International Load Line" for a ship. **(18 Marks)**

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

Thermodynamics

- **TIME ALLOWED - THREE HOURS**

- **Answer ANY SIX Questions**

- **Date: 2023.01.27**   **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. 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*

2. A side wall of reefer container consists with *1.2 mm* thick stainless steel sheet for outer cladding and *0.7 mm* thick Aluminum sheet for inner lining. The gap between the outer cladding and inner lining is filled with Polyurethane of *0.4 W/m^2 K*. If the ambient temperature is *35 ^0C* and the inside temperature is *-15 ^0C*. Estimate

   a. The overall heat transfer coefficient   (4 marks)

   b. The heat transfer per hour from unit area of the side wall (6 marks)

   c. The temperature difference across the each material of the wall (10 marks)

   Thermal conductivities of Stainless steel and Aluminum are *14.4* and *237 W/m K* respectively.

3. The pressure and temperature at the beginning of the compression of *Otto cycle* are *1 bar* and *25 ⁰C* respectively. The maximum temperature of the cycle is *960 ⁰C*. The compression ratio of the cycle is *6:1*. The cycle is repeated *3000 times/min*. Determine for the cycle

    a.   Pressure and temperature of each cardinal point of the cycle   (6 marks)

    b.   The thermal efficiency   (4 marks)

    c.   The mean effective pressure   (4 marks)

    d.   The theoretical output in kilowatts   (4 marks)

    e.   The Carnot efficiency within the same temperature limits   (2 marks)

4. At the beginning of the compression of an ideal *Dual combustion cycle* the pressure and temperature of the gas are *90 kPa* and *20 ⁰C*, respectively. The volume ratio of the compression is *16 : 1*. The heat added during the constant volume process is *200 kJ/kg* of gas. The constant pressure heat addition is for *5 %* of the expansion stroke. Determine

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

    b. The pressure and temperature at the end of the constant volume heating   (4 marks)

    c. The maximum temperature of the cycle   (6 marks)

    d. The efficiency of the cycle   (6 marks)

5. 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 minimum mass of air required per kg of coal for perfect combustion   (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)

    Hint : atomic mass of C, H, S and O are 12, 1,32 and 16 respectively.

6. A single stage, single-acting, reciprocating compressor has a bore and stroke of *50.8 mm* and *49.2 mm*. The refrigerant intake conditions are *1.6393 bar* and *-15 ⁰C* and the delivery conditions are *8.8672 bar* and *45 ⁰C*. The compressor runs at standard speed of *1750 rpm* and its clearance volume is *4.5 %* of the swept volume. Assuming refrigerant behave like a gas in the given conditions, estimate the followings.

    a.   Polytropic index of the compression   (4 marks)

    b.   The volumetric efficiency   (4 marks)

    c.   The volume of air delivered per minute   (6 marks)

    d.   The power of the compressor   (6 marks)

7. A steam plant operates between a boiler pressure of **40 bar** and a condenser pressure of **0.05 bar**. Steam enters to the turbine at **40 bar, 400 ^{0}C** and an isentropic expansion of steam can be observed in the turbine. There is no sub cooling in the condenser and feed pump work can be neglected.

    a. Sketch the **T-S diagram** for the cycle   (4 marks)

    b. Determine

        i.   The quality of the steam after expansion   (3 marks)

        ii.   Work done by the turbine   (3 marks)

        iii. Heat transfer in the boiler and   (3 marks)

        iv. Rankine efficiency of the cycle   (3 marks)

    c. If the steam production of the boiler is **7.3 kg of steam per kg of fuel** burned, determine the thermal efficiency of the boiler. Calorific value of the oil fired in the boiler is **40.2 MJ/kg**.   (4 marks)

8. A test on a six-cylinder, 2 stroke engine resulted in the following data: average brake power per cylinder **1.18 MW**. The engine has a bore of **910 mm** and stroke of **2030 mm** and the mechanical efficiency is **90 %**. At full load speed of **107 rev/min**, the engine uses **850 kg** of fuel per hour and calorific value of fuel is **42.3 MJ/kg**.

Estimate

    a. The brake power, indicated power, and friction power   (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. **Refrigerant -134a** uses to operate a reefer container in the temperature range of **– 15 ^{0}C** and **35 ^{0}C**. The refrigerant enters the compressor as dry saturated vapour and leaves at **8.8672 bar** and **45 ^{0}C**. There is no undercooling in the condenser.

    a. Draw the **T-S** diagram for the refrigeration process.   (4 marks)

    b. Estimate the followings

        i.   The dryness fraction of the refrigerant at the entrance of the evaporator.

                 (3 marks)

        ii.   The coefficient of performance   (6 marks)

        iii. The refrigerant flow rate if the cooling capacity is **3.6 kW**   (3 marks)

        iv. Compressor power   (4 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: 2023.01.26**   **Pass marks: 50%**

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

1.

   a. If $\log_b a + \log_c a = 2\log_b a . \log_c a$, show that $a^2 = bc$ (4 marks)

   b. If $6(9^x) + 3^x - 2 = 0$, find the real values of x (6 marks)

   c. The following values in the table represent the function, $y = \log_{10}(a + bx)$ where a and b are constant.

x	1	2	3	4	5	6
y	0.857	0.924	0.982	1.033	1.079	1.121

   i.   Plot a graph 10^y vs x (6 marks)

   ii. Hence find the constant a and b (4 marks)

2.

   a. Resolve into partial fractions

   i. $\dfrac{x+18}{(x-3)(2x+1)}$

   ii. $\dfrac{4x^2 - 3x + 5}{(x-1)^2 (x+2)}$

   (2x5 marks)

   b. If $x^3 - 5x^2 + 7x - a$ has a factor $x - 2$, find a (5 marks)

   c. Solve the inequality $\dfrac{2}{x-1} \ge x$ (5 marks)

3. If $A = \begin{pmatrix} 6 & 9 & 8 \\ 3 & 5 & 4 \\ 2 & 4 & 3 \end{pmatrix}$,

    a. Find B such that BA = I. (Hint: Use Gauss Jordan elimination)   (10 marks)

    b. If $v = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$, $w = \begin{pmatrix} 1 \\ 3 \\ 2 \end{pmatrix}$, show that the system of equations

$$\begin{cases} 6x + 9y + 8z = 1 \\ 3x + 5y + 4z = 3 \\ 2x + 4y + 3z = 2 \end{cases}$$

       can be written in the matrix form $Av = w$ (4 marks)

    c. Pre-multiply both sides of equation, $Av = w$ by B and hence, solve the equations
       (6 marks)

4.

    a. Express as complex number in the form a + bi

      i. $\left(2\angle\dfrac{\pi}{2}\right) \times \left(3\sqrt{2}\angle\dfrac{\pi}{4}\right)$ ii. $\left(2\sqrt{2}\angle\dfrac{3\pi}{4}\right) \Big/ \left(2\angle\dfrac{\pi}{3}\right)$

                                                                   (6 marks)

      Hint: $r\angle\theta \equiv r(Cos\,\theta + i\,Sin\,\theta)$

    b. find the square root of 1 - 5i   (5 marks)

    c. If $z_1 = Cos\,\alpha + i\,Sin\,\alpha$, $z_2 = Cos\,\beta + i\,Sin\,\beta$, show that $z_1z_2 = Cos(\alpha + \beta) + i\,Sin(\alpha + \beta)$

      and evaluate z_1^2 and $(z_1z_2)^2$ (9 marks)

5.

    a. Show that

      i. $\dfrac{Sin(A-B)}{Cos\,A\,Cos\,B} = \tan A - \tan B$

                                      (3 marks)

      ii. $\dfrac{Sin\,2x}{1 + Cos\,2x} = Tan\,x$

                                      (3 marks)

b. If $Sin\theta = 3/5$ and $Tan\phi = 5/12$, where θ is an obtuse angle and ϕ is an acute angle. Find the value $Sin(\theta + \phi)$ (6 marks)

c. From a ship the bearing of a lighthouse is due south and the angle of elevation from sea level to the top of the lighthouse is 7.5^0. The ship then sails 300 meters due west. The angle of elevation from sea level to the top of the lighthouse is then 5^0. Calculate the height of the lighthouse.   (8 marks)

6.

  a. Differentiate the following function with respect to x

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

    ii. $y = 2x \ln\left(\dfrac{2}{x}\right)$ (10 marks)

  b. A curve is given, parametrically, by

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

  c. 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)

7.

  a. $\displaystyle\int \frac{1+\sin 2x}{x+\sin^2 x} dx$ (5 marks)

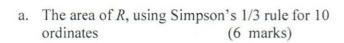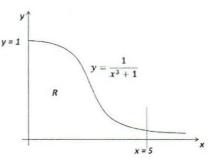 b. $\displaystyle\int x \ln(x+1)\, dx$ (5 marks)

  c. $\displaystyle\int_0^1 \frac{2x+1}{x^2+x-6} dx$ (5 marks)

  d. Figure shows the sketches of the curves $y_1 = Cos\, x$ and $y_2 = Sin\, x$ in the range of 0 to $\dfrac{\pi}{4}$. Estimate the shaded area   (5 marks)

8. The diagram shows the region R which is bounded by the curve $y = \dfrac{1}{x^3 + 1}$, the x-axis, and the lines $x = 0$ and $x = 5$. Determine

   a. The area of R, using Simpson's 1/3 rule for 10 ordinates (6 marks)

   b. The centre of gravity of the region about the x-a: (10 marks)

   c. The volume of the solid formed when R is rotated completely about the x-axis. (Hint: use the **Pappus theorem**) (4 marks)

9. A quadratic function is defined by

$$f(x) = x^2 + kx + 9$$

   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. Plot the function $\dfrac{1}{f(x)}$, expressing the singular values. (6 marks)

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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: 2023.01.25**   **Pass marks: 50%**

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

Part A

1.

a) i.   Define the resistance   (02 marks)

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

           Resistivity, Electrical energy and voltage

b) A copper wire is stretched so that its length is increased by 0.1%. What is the percentage change in its resistance?   (05 marks)

c) i.   Determine the equivalent resistance between the terminals *a* and *b* of network shown in fig.1   (05 marks)
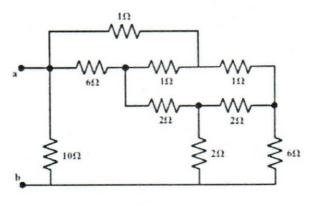
Figure 1

   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 voltage law and Kirchhoff's current law. (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)
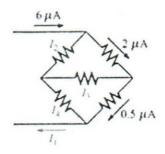

Figure 2

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)
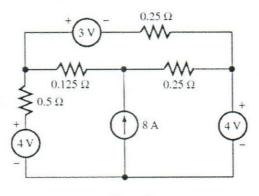

Figure 3

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

3.

a) Define magnetic flux. (04 marks)

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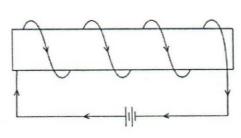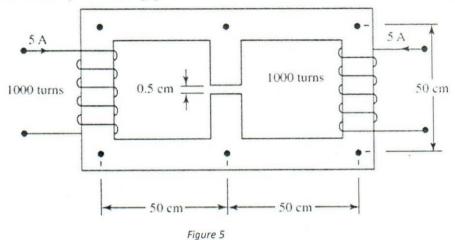

Figure 4

c)   The configuration of a magnetic circuit is given in Figure 5. Assume the permeability of the ferromagnetic material to be $\mu = 1000\mu_0$. Neglect leakage but correct for fringing by increasing each linear dimension of the cross-sectional area by the length of the air gap. The magnetic material has a square cross-sectional area of 4 cm^2. Find the air-gap flux density, and the magnetic field intensity in the air gap.   (12 marks)

Figure 5

4.
a) Define the term frequency.   (4 marks)

b) Determine the frequencies for periodic times of 2ms.   (4 marks)

c) A coil of resistance 60 Ω and inductance 0.6 H is connected in series with a 30μF 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)

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 motor and shunt DC motor with label all key parameters. (6 marks)

b) A 240V shunt motor takes 5A at no load. The resistances of the armature and field circuit are 0.25 Ω and 120 Ω respectively. If the motor is loaded so as to carry 40A, determine

    i.   iron and friction losses   ii.   Efficiency   (14 marks)

Part B

7.

a) What is the meaning of a Navigational & Signal lights? (06 marks)

b) Draw and indicate different navigational & signal lights position at the ship with a sketch.

(06 marks)

c) Indicate the navigational light alarm circuit by a single line sketch. (08 marks)

8. a) State the safety precautions necessary before commencing maintenance work in a Brushless generator. (10 marks)

b) State types of field excitation provided in Alternators, explain one in detail with a suitable diagram.

(10 marks)

9. a) Write short notes about the following motor enclosures explaining how cooling is provided in each case

- Drip Proof   (4 marks)
- Totally enclosed   (4 marks)
- Deck Watertight   (4 marks)
- Flame proof   (4 marks)

b) State the type OF Starting arrangements which are fitted Induction motor starting. (4 marks)

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

<u>Applied Mechanics</u>

- **TIME ALLOWED - THREE HOURS**

- **Answer ANY SIX Questions**

- **Date: 2023.01.24**   **Pass marks: 50%**

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

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

Density of sea water – 1025 kgm^{-3}

1.

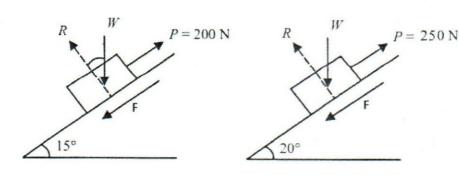1.1 Friction is a self-adjusting force, describe briefly.   (4 marks)

2.2 A force of 200N acting parallel to the plane is required to just move a box up an incline plane of angle 15^0. If the angle of inclination is increased to 20^0, then the force required just move the box up in the plane increase to 250N. Find;

    a.   The weight of the box   (10 marks)
    b.   Coefficient of friction between the inclined plane and the box   (6 marks)

2.

2.1 Modify and write three Newton's laws for linear motion to rotational motion. Using second law, derive the equation relating the torque and angular acceleration applied to a rotating object.   (6 marks)

2.2 A large cylindrical pulley of mass 800kg, and 2m diameter has a radius of gyration of 0.8m. It is rotating fixed to an electric motor, which provides a uniform torque of 60kNm. The pulley is used to lift a body of mass of 3 Tons using a steel wire wrapped round the pulley. Assuming no resistive torques find the;

    a.   acceleration of the body during its lift   (6 marks)

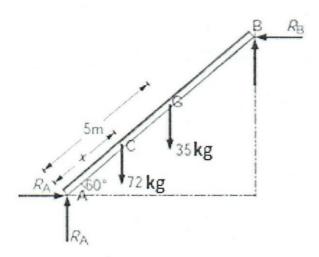   b.   tension in the cable   (8 marks)

3

3.1 Differentiate between static friction and dynamic friction and limiting friction   (4 marks)

6.2 A ladder of mass 35 kg and length 10 m rests against a vertical wall and is inclined at 60° to the horizontal. The coefficient of friction between the ladder and the wall as well as between the ladder and the ground is 0.25. How far up the ladder can a 72 kg person climb before the ladder begins to slip?

                                                                      (16 marks)

4.

4.1 Write Bernoulli theorem and identify variables with units of each   (4 marks)

4.2 Fresh water is flowing in a smooth pipe system having a uniform diameter of 120 cm. It is recorded that at elevation 'A' having pressure of 50 kPa and it is at a height of 20 m from the reference level. The section B having an elevation of 15 m recorded a pressure of 30 kPa. The water flow rate through a pipe is 12 m^3/s.

    a.   calculate the speed of water flow   (4 marks)

    b.   Determine the direction of flow between section A and B.   (6 marks)

    c.   What is the total head loss?   (6 marks)

5.

5.1 Write the advantages and disadvantages of using a clutch mechanism compare to other power transmission mechanisms (4 marks)

5.2 Multi disc clutch has four discs on the driving shaft and three discs on the driven shaft and makes total of six contact surfaces. The outside diameter of the contact surface is 500 mm and inside diameter of that surface is 250 mm. Assuming uniform pressure condition, find the maximum axial thrust acting on the clutch, when it is running at 1500 rpm and transmitting 35kW. Take coefficient of friction as 0.45. (16 marks)
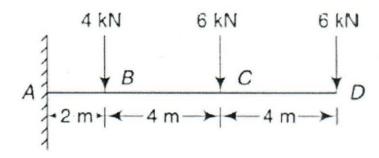
6.

6.1 Sketch a suitable beam loading system which can represent a pure bending stress using shear force and bending moment diagrams. (6 marks)

6.2 Calculate the maximum stress induced in a cast iron pipe of external diameter 40 mm, of internal diameter 20 mm and of length 4 meter when the pipe is supported at its end and carries a point load of 80 N at its center. (14 marks)

(The area moment of inertia for a _solid_ circular cross-section with D diameter is given by $\frac{D^4}{64}$)

7.

7.1 Draw shear force and bending moment diagram for below cantilevered beam AB. Note the sign convention you use and clearly indicate critical values in the diagrams. (20 marks)

8.

8.1 What is center of pressure   (4 marks)

8.2 A rectangular plane surface 2m wide and 3m deep lies in water in such a way that its plane makes an angle of 30^0 with the free surface of water. Consider that its upper edge is 1.5 m below the free water surface. Determine;

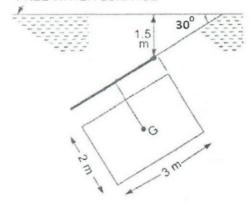   a.   The total pressure   (6 marks)
    b.   Position of center of Measured from water surface   (10 marks)

FREE WATER SURFACE

9.

9.1 A piston moves harmonically and has a velocity of 12m/s when displaced 50mm from the origin. A velocity of 3m/s was seen in the oscillation when the displacement is 100mm from the center. Considering above details, calculate;

    a.   The oscillating frequency of the piston   (8 marks)
    b.   The amplitude of the oscillations   (6 marks)
    c.   Acceleration when the displacement is 75mm from the origin   (6 marks)

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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: 2022.01.23**   **Pass marks: 50%**

Part A: NAVAL ARCHITECTURE

Q 1. A load water plane of a ship 180 m in length has ½ ordinates sections indicated in the following table.

Section	AP	1	2	3	4	5	6	7	8	9	FP
½ width of water plane	1	7.5	12	13.5	14	14	14	13.5	12	7	0

(i)	Water plane area	(9 Marks)
(ii)	TPC	(4 Marks)
(iii)	Water plane area coefficient	(3 Marks)

Q 2. (i) Define the term " Virtual loss of metacentric height "   (4 marks)

(ii)   A vessel of 10,000 tone displacement has a second moment of the water plane around the centerline of 60×10^3 m4. The center of buoyancy is 2.75m above the keel. The following are the masses on board

4000 tonne   6.30m above the keel
2000 tonne   7.50m above the keel
4000 tonne   9.15m above the keel
Calculate the metacentric height   (12 marks)

Q 3 (a) Explain the meaning of fresh water allowance. (4 Marks)

(b) 215 tonne of oil fuel and stores are used in a ship while passing from sea water of 1.026 t/m3 into river water of 1.002 tonne/m3 . If the mean draught remains unchanged, calculate the displacement in the river water. (12 Marks)

Q4. A ship 135m long, 18m beam and 7.6 m draught has a displacement 14000 tonne. The area of the load water plane is 1925 m^2 and the area of the immersed mid-ship section 130m^2 calculate

(a) C_w (b) C_m (c) C_b (d) C_p (16 Marks)

Q5. Define following terms with respect to marine propellers;

     a. Theoretical Speed (Vt) (02 Marks)
     b. Wake Fraction (w) (02 Marks)
     c. Speed of Advance (Va) (02 Marks)
     d. Real Slip (02 Marks)

II. The diameter & the pitch ratio of a propeller fitted on 130 m long, 10,000 tonne displacement vessel is 6.0 m & 0.8 respectively. The beam of the vessel is 12.0 m and propeller rotate at 120 RPM at 8.0 m design draft in 1.025 tonne/m^3 seawater density.
The wake fraction w = $0.5C_b$ - 0.05 and the real slip is found 36 %.
Calculate;

     a. Speed of advance (04 Marks)
     b. The speed of the ship (02 Marks)
     c. Apparent slip (02 Marks)

Q6. An oil tanker of 17000 tonne displacement has its centre of gravity 1m aft of mid ships and has 250 tonne of oil fuel in its forward deep tank 75m from midships. This fuel is transferred to the after oil fuel bunker whose centre is 50m from midships.

200 tonne of fuel from after bunker is now burned.

Calculate the new position of the centre of gravity.

(i)   After the oil has been transferred (10 Marks)

(ii)   After the oil has been used. (06 Marks)

Part B:

Answer to any four (02) questions only

7. State the two main category of forces acting on the ship's hull structure.   **(02 Marks)**

    a.   Explain how "Hogging" & "Sagging" moments created on the hull girder. **(04 Marks)**

    b.   Name various structural members used on hull girder construction to resist to longitudinal bending moment.   **(10 Marks)**

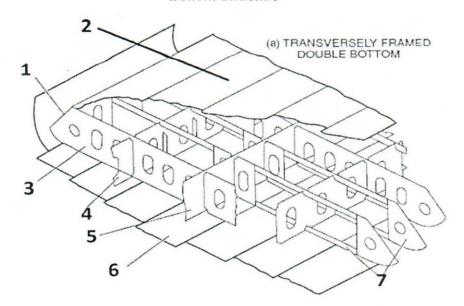8. With the use of suitable sketch, Identify followings of a Marine Propeller,

I.	Face	**(01 Marks)**
II.	Back	**(01 Marks)**
III.	Leading Edge	**(01 Marks)**
IV.	Trailing Edge	**(01 Marks)**
V.	Hub	**(01 Marks)**
VI.	Rake	**(01 Marks)**

    a. Briefly explain how the propeller convert torque in to thrust.   **(05 Marks)**

    b. State the kinds of defects that you could find on the propellers when the vessel is in drydock.   **(04 Marks)**

9.

    a. Identify the component numbered from 1 to 7 of a bottom construction of a ship shown below.   **(04 Marks)**

    b. Briefly Explain the function of any six components stated in above part 'a'
                         (12 Marks)

Bottom Structure

(a) TRANSVERSELY FRAMED DOUBLE BOTTOM

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%**

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

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1. According to the International Safety Management Code it is required to assess all the identified risk to its ship, personnel and environment and establish appropriate safeguards by the management company.
   a. Define terms "Hazard" & "Risk".   (04 Marks)
   b. What are the 04 principle elements of Hierarchy of Control measures?   (04 Marks)
   c. Identify 04 numbers of Hazards & Risk involved with them when carrying out Major Overhaul of an Air Compressor.   (08 Marks)

2. With reference to the Convention of Law of Sea (UNCLOS),
   a. State various sea areas with applicable ranges with an aid of simple sketch.

      (04 Marks)
   b. Briefly explain the following.
      I.   Innocent Passage.   (03 Marks)
      II. International Straight.   (03 Marks)
      III. Archipelagic State.   (03 Marks)

3. International Maritime Organization (IMO) is the main organization which governs the international maritime activities.
   a. Briefly state the functions of 02 out 05 main committees of IMO.   (06 Marks)
   b. What are the five (05) instruments that IMO uses to adopt the various legislations.

      (05 Marks)
   c. What is meant by the rule "No more favorable Treatments" regarding IMO conventions.

      (04 Marks)

4.
   a. What are objectives of adopting International Load Line Convention for merchant ships.

      (03 Marks)
   b. Which ships are covered under International Load Line Convention?   (01 Marks)
   c. What are the 04 types of ships defined by this convention.   (04 Marks)
   d. List 04 items which comes under the Conditions of Assignment for assigning Load Line for a commercial vessel.   (08 Marks)

5. Certification is an essential part for maintaining the standards in commercial shipping.
   a. State the three main parties which are involving in ship certification. (03 Marks)
   b. What is mean by "Statutory Certificates". (02 Marks)
   c. What is mean by "Mandatory Certificate". (02 Marks)
   d. State the Items/Areas covered by classification societies of a ship on certification.
   (05 Marks)
   e. State 04 advantages of Harmonized Survey & Certification system. (04 Marks)

6. SOLAS convention has been amended many times and many new chapters included into it, since it was introduced by IMO in 1948 to minimize accident & casualty at sea.

   State the areas regulating under each of following chapters in SOLAS.

   a. Chapter II-1 of this convention. (03 Marks)
   b. Chapter II-2 of the convention. (03 Marks)
   c. Chapter III of the convention. (03 Marks)
   d. Chapter IX of the convention. (03 Marks)
   e. State the statutory Certificates required to carry on board cargo ships to indicate the compliance with above chapters. (04 Marks)

7. As per the Marpol convention of IMO

   a. State the requirement to be fulfilled by the data recording device fitted on oily water separators on board ship as per the Marpol Annex I. (05 Marks)
   b. What is mean by "Mandatory Prewash" with reference to Marpol Annex II.
   (03 Marks)
   c. Briefly describe the IMO ship types as per Marpol Annex II. (06 marks)
   d. State the complete name of the Certificate issued to ship to indicate the compliance with IBC code. (02 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. What is meant by EEDI and state the measuring units of EEDI. (04 Marks)
   d. What are the certificates & documents required to carry on board ships to comply with annex VI requirements? (05 Marks)

9. STCW convention was subjected to a major amendment in year 2010.
   a. Briefly explain why it was required to amend several times in the past. (04 Marks)
   b. State most significant seven (07) amendments carried out to STCW during Manila 2010 convention. (07 Marks)
   c. What is the Rest Hours & Work Hours requirement for seafarers according to the new amendments to the STCW? (05 Marks)

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA 13 MAR 2023

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)

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*

_____

1. A quantity of air of volume *0.5 m³* at *2 bar* and *27 ⁰C* is heated at constant pressure until its temperature is *87 ⁰C*, and then cooled under constant volume to temperature *47 ⁰C*. Finally it is compressed to the initial condition using a polytropic process.

   a. Draw a *P-V diagram* to represent the processes on air   (4 marks)

   b. Determine

      i.   Mass of air in the vessel   (2 marks)

      ii. The volume of air after the constant pressure process   (3 marks)

      iii. The index of the compression   (5 marks)

   c. Determine the *heat energy transferred* to air and *work transfer* during the compression process   (6 marks)

2.

   a. Describe each of the following

      i.   Clausius statement

      ii. Kelvin statement

      iii. Carnot heat engine   (6 marks)

   b. A refrigerator working on reversed Carnot cycle absorbs heat at the rate of *1 kW* from a cold chamber maintained at *250 K* and discharges it to the atmosphere at *300 K*. Find the work required for the refrigerator and heat rejection.   (6 marks)

c. Heat is supplied from two constant temperature source at *1000 K* and *800 K* to a reversible engine and rejects heat to a constant temperature sink at *310 K*. the engine develops work equivalent to *100 kW* and rejects heat at the rate of *60 kW*. Find the heat supplied by each source and thermal efficiency of the engine. (8 marks)

3. A cold store is to be made from fiber glass wool sandwiched between two layers of timber. The inner layer of timber will *35 mm* thick and the outer layer of timber will be *40 mm* thick. The refrigeration equipment available is capable of removing *40 W/m²* of wall area. The cold store is to be maintained at *-10 °C* in an ambient temperature of *30 °C*. Calculate

   a. The minimum thickness of insulation (5 marks)

   b. The interface temperature between the inner layer of wood and insulation (5 marks)

   c. The interface temperature between the outer layer of wood and insulation (5 marks)

   d. The outer surface temperature (5 marks)

   Thermal conductivities of fiber glass and timber *0.04* and *0.14 W/m K* respectively. The surface transfer coefficient for inner and outer surface is *14 W/m² K*.

4. The following results were obtained during a test on a *two-cylinder, four stroke* cycle, oil engine over a period of one hour

Cylinder diameter	*108 mm*
Piston stroke	*136 mm*
Speed	*17.5 rev/s*
Brake torque	*91 N m*
Fuel consumption	*2.5 kg*
Calorific value of fuel	*45.5 MJ/kg*
Mechanical efficiency	*81 %*

   One leaving the cylinders, the exhaust gases were passed through an exhaust gas calorimeter and raised the temperature of *215 kg* of water from *15 °C* to *60 °C*. Determine

   a. The brake thermal efficiency (4 marks)

   b. The energy carried away by the cooling water, friction and radiation (6 marks)

   c. The indicated mean effective pressure (5 marks)

   d. The indicated specific fuel consumption (5 marks)

5. Steam is supplied to a turbine *20 bar* and *400 °C* and exhausts at *0.04 bar* and *0.85* dry. Using a feed heater, the temperature of the condensate was increased to *90 °C*. Then the feed water passed to the boiler using a pump and neglect the pump work.

    a. Draw the *TS diagram* for the processes in the cycle   (4 marks)

    b. Neglecting the pump work, determine for the cycle

        i. The *dryness fraction* of the steam if the expansion is isentropic in the turbine

                                                        (4 marks)

        ii. The *enthalpy drop* through the turbine per kg   (4 marks)

        iii. The *heat supplied* to steam in the boiler per kg   (4 marks)

        iv. The thermal efficiency   (4 marks)

6. In an ideal *Dual combustion cycle* the heat transfer during combustion is equally shared between the constant pressure and constant volume parts of the cycle. The volume compression ratio is *12:1* and the pressure and temperature at the begging of compression are *0.95 bar* and *45 °C* respectively. The maximum temperature reached during the cycle is *1950 °C*. Calculate

    i. The heat transfer to the cycle under constant volume and pressure   (8 marks)

    ii. The heat rejection   (8 marks)

    iii. Work transfer by 1 kg of air per cycle   (2 marks)

    iv. The mean effective pressure   (2 marks)

7. In an *open-cycle gas turbine* plant working on the ideal constant pressure cycle, air is taken into the compressor at *1.013 bar, 15 °C*, and delivered at *6.4 bar*. If the temperature at turbine inlet is *800 °C*,

    i. Draw the *T-S* diagram   (4 marks)

    Determine

    ii. The temperature at the end of compression   (2 marks)

    iii. Temperature at exit from the turbine   (2 marks)

    iv. The compressor work per kg of air   (4 marks)

    v. The work transfer in the turbine per kg of air   (4 marks)

    vi. The ideal thermal efficiency   (4 marks)

8.

   a. Describe the followings of air compressors

      i.   Effect of clearance on work of compression   (2 marks)

      ii.   Volumetric efficiency   (3 marks)

      iii. Effect of isothermal compression   (3 marks)

   b. A single stage reciprocating air compressor is required to compress air at the rate of *1 kg/s* from *0.95 bar* and *298 K* to *10 bar*. Find **work done** by the compressor, if the compression is *isothermal, isentropic* and *polytropic* with index as *1.35*. (12 marks)

9. In *R134a* refrigerating plant the refrigerant leaves the condenser as a saturated liquid at *7.710 bar*. The evaporator pressure is *1.337 bar* and the refrigerant leaves the evaporator as a vapour *0.9711 dry*. If the circulation of the refrigerant through the plant is *4 kg/min*,

   a. Determine

      i.   The *dryness fraction* at inlet to the evaporator   (3 marks)

      ii.   *Refrigerant effect per minute*   (3 marks)

   b. Show that the refrigerant will be *fully dried* when it enters the condenser (3 marks)

   c. Draw the *TS* and *PH diagram* for the cycle   (5 marks)

   d. Determine the compressor *work done per minute* and *coefficient of performance* of the plant   (6 marks)

Pressure, bar	Saturation temperature, K	Enthalpy, kJ/kg		Entropy, kJ/kg K	
		h_f	h_g	s_f	s_g
1.337	-20	173.74	386.08	0.9007	1.7395
7.710	30	241.79	415.08	1.1437	1.7153

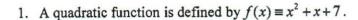## MATHEMATICS

- **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

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)

$$\begin{aligned} x + y + z &= 3 \\ x + 2y + 3z &= 4 \\ x + 4y + 9z &= 6 \end{aligned}$$ (10 marks)

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 $y^3\dfrac{d^2y}{dx^2} + 1 = 0$

(6 marks)

7.

   a. Determine the integrals with respect to x

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

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

   b. Show that $\int_{0}^{\pi/2} x \sin^2 x \, dx = \dfrac{1}{16}\left(\pi^2 + 4 \right)$ (10 marks)

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

8.

   a. Show that $\int_{0}^{1} \dfrac{1}{1+x} dx = \ln 2$ (5 marks)

   b. Use 1/3 Simpson's rule to interpolate a value for the integration $\int_{0}^{1} \dfrac{1}{1+x} dx$ 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)

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)

<u>Electrotechnology</u>

- **TIME ALLOWED - THREE HOURS**

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

- Date: Pass marks: 50%

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

Part A

1. a) State and explain Kirchhoff's laws in electricity.   (4 marks)

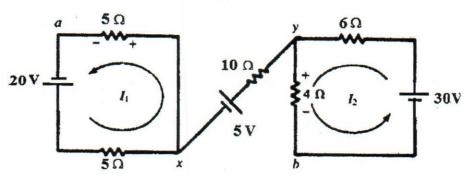   b) Using Thevenin's theorem, find current through 4 Ω resistor in the circuit.   (6 marks)

   c) Find the voltage between 'a' and 'b' (Vab).   (10 marks)

2. a) Define the term frequency.   (4 marks)

b) An alternating voltage is given by $v_{(t)} = 283\sin 314t$ volts. Find the r.m.s. voltage, the frequency and the instantaneous value of voltage when $t = 4ms$. (4 marks)

b) A coil having a resistance of $10\,\Omega$ and an inductance of 125mH is connected in series with a $60\mu F$ capacitor across a 120V supply.

    i.   At what frequency does resonance occur? (6 marks)

    ii.   Find the current flowing at the resonant frequency. (6 marks)

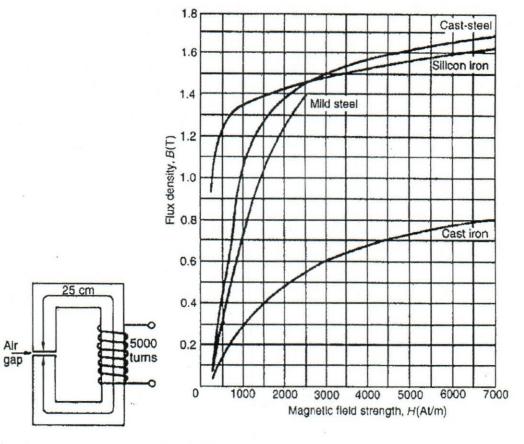3. a) Draw the circuit diagram of a DC shunt motor. (5 marks)

  b) A 250 V, DC Shunt machine has an armature resistance and shunt resistance 0.65 Ω and 125 Ω respectively. If the armature current is 100 A, find the induced emf and electrical efficiency when the machine is working as,

    i)   a generator (5 marks)

    ii)   a motor (5 marks)

  c) An ideal transformer has an input voltage of 480 V. The output current and voltage are 10A and 120 V. Determine the value of input current. (5 marks)

4. a) State Faraday's laws of electromagnetic induction. (5 marks)

  b) Calculate the e.m.f. induced in a coil of inductance 12 H by a current changing at the rate of 4 A/s. (5 marks)

  c) When two coils are connected in series, their effective inductance is found to be 10 H. When the connections of one coil are reversed, the effective inductance is 6 H. If the coefficient of coupling $k = 0.6$ and mutual inductance given by $M = k\sqrt{L_1 L_2}$, calculate the self-inductance of each of coil and the mutual inductance. (10 marks)

5. a) State Ampere's work rule (6 marks)

  b) A section through a magnetic circuit of uniform cross-sectional area 2 cm^2 is shown in following figure. The cast steel core has a mean length of 25 cm. The air gap is 1 mm wide and the coil has 5000 turns. Using the B–H curve for cast steel, Determine the current in the coil to produce a flux density of 0.80 T in the air gap, assuming that all the flux passes through both parts of the magnetic circuit. (14 marks)

6. a) Draw the electric circuit diagrams to show star connected load and relevant phase diagram.

(4 marks)

b) What is the relationship between

    i. line voltage and phase voltage

    ii. line current and phase current

in star-connected power system. (6 marks)

c) Three loads, each of resistance $30\,\Omega$, are connected in star to a 400V, three-phase supply.
Determine (10 marks)

    i. the system phase voltage

    ii. the phase current

    iii. the line current.

Part B

7. a) Explain with diagram how fluorescent tubes are started and explain how power factor is improved.

    (10 marks)

   b) Explain the dangers which may exists in battery rooms and explain how they ae overcome.

    (10 marks)

8. With reference to Induction Motors.

   a) State four reasons for winding overheating.

    (10 marks)

   b) Describe with an aid of a sketch a device to protect the overload.

    (10 marks)

9. a) Sketch a direct on line starter suitable for a three phase Induction Motor briefly explaining each part.

    (14 marks)

   b) Explain why the starter sketched above is limited to moderately sized motors.

    (6 marks)

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

MINISTRY OF PORTS AND SHIPPING

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<u>Applied Mechanics</u>

- **TIME ALLOWED - THREE HOURS**

- **Answer ANY Six questions only**

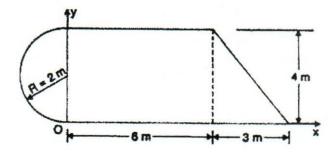- **Date: 2020.............**   **Pass marks: 50%**

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

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1.

1.1 Determine the centroid of the area shown in the figure below with respect to the axes shown. Assume 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)

2.

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

2.2 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.
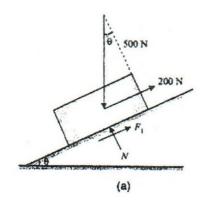
(14 marks)

3.

3.1 A block weighing 500 N just about to moving down a rough inclined plane when it is subjected to 200 N force acting up the inclined plane (see figure a). It is at the point of moving up the plane when pulled up by a force of 300 N parallel to the plane (see figure b). Find;
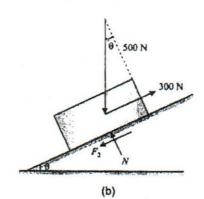
a.   The inclination of the plane (θ)   (10 Marks)

b. The coefficient of friction (μ) between the inclined plane and the block. **(10 Marks)**

(a)   (b)

4.

4.1 Show that the total pressure force (F) acting on a vertical surface of arbitrary shape having an area of A, immersed in a liquid of w specific weight is equal to $F = Awh$ **(6 Marks)**

Where h = distance to the center of gravity of the shape from the free surface

4.2 A circular plate of radius 100 mm is vertically immersed on water touching free surface.

 a. What is the total pressure force acting on one side of the plate? **(7 Marks)**
 b. Also determine the position of center of pressure of plate. **(7 Marks)**

5.

5.1 A train travelling at uniform velocity had to stop before the next station due to an emergency. After the application of breaks the train comes to rest after a uniform retardation of 0.2 ms^{-2} within one minute and 15 seconds. Using a velocity time curve find;

 a. Train velocity in kmh^{-1} at the moment the breaks were applied **(6 Marks)**
 b. The distance it travelled after application of breaks before coming to rest **(6 Marks)**

5.2 After the brief stop, the train accelerates back to a constant speed of 72 kmh^{-1}. After some time the train again apply breaks planning to stop at the next station. If the maximum breaking force of the train is sufficient to give a uniform retardation of 4 ms^{-2} find at what shortest distance from a station should the breaks be applied in order to stop there. **(8 Marks)**

6.

6.1 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 $\mu = 0.2$, calculate the velocity of the body after moving 6m, only using work-energy principles? (14 Marks)

7.

7.1 A pipeline carrying oil of specific gravity 0.8, changes in diameter from 300mm at a position A to 500 mm diameter at a position B which is 5 meters at a higher level. If the pressure at A and B are 19.62 N/cm² and 14.91 N/cm² respectively, and the discharge is 150 liters/s, determine the loss of head and direction of flow. (20 Marks)

8.

8.1 A power driven fly-wheel, during its acceleration, is observed to have made 100 revolution during its increase of velocity from 120 rpm to 160 rpm. If the flywheel originally started from rest, determine,

    a. The value of acceleration (5 marks)
    b. The time taken to increase the velocity from 120 rpm to 160 rpm (4 marks)
    c. Revolution made in reaching a velocity of 160 rpm starting from rest (4 marks)

8.2 Power supply was cut off to the wheel when it was rotating at a speed of 900 rpm. After making 360 revolutions the wheel came to complete stop. Determine its angular retardation and time it took to come to rest after power supply was cut off. (7 Marks)

9.

9.1 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 2 m from C.
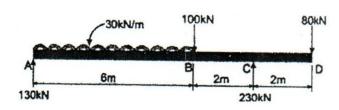
Draw,

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

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
07 MAR 2023
MINISTRY OF PORTS AND SHIPPING
DIRECTOR GENERAL'S OFFICE OF MERCHANT SHIPPING
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Officer in Charge of an Engineering Watch of 750 kW or More (Unlimited)

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 of a water plane of 192 m long vessel are as follows. The area of the water plane (Aw) at this draft is 2281.6 m^2.

Section	AP	1	2	3	4	5	6	7	8	9	10	11	FP
½ Ordinates(m)	2.5	3.6	5.8	7.2	7.8	8.3	"B"	7.4	7.0	6.2	4.7	3.1	0

a. Calculate the half breadth (B) the vessel at this draft.   (08 Marks)
b. Find the longitudinal center of floatation (LCF) at this draft.   (08 Marks)

2.
   a. State the reasons for carrying out the Inclining Experiment on newly build ships.
      (02 Marks)
   b. List down 05 important factors to be checked when preparing a vessel for above and 03 conditions to be observed during the experiment.   (04 Marks)

   c. The Estimated metacentric height of a new ship having 7900 tonne light weight displacement is 1.2 m. The vessel is being prepared for inclining experiment and it is required minimum of 150 mm deflection on a 06 m long plumb line to comply with the statutory requirement. The distance that the mass could shift across the ship is 15.0m. Find the minimum mass to be shifted across the deck to meet above conditions.
      (10 Marks)

3.
   a. Explain the effect of metacentric height & Free Surface Effect on transvers stability of a ship.
      (06 Marks)
   b. Lightship displacement of a ship is 5000 tonnes & vertical center of gravity (VCG) is 4.4 m. Following masses are now loaded.

      3000 tonnes of cargo at VCG 14.95 m above the keel

      1850 tonnes of cargo at VCG 9.75 m above the keel

At 10050 tonne displacement second moment of area of the water plain about the center line of the vessel is 70×10^3 m^4 & center of buoyancy is 3.5 m above the keel.

Calculate the amount of fresh water to be taken into tank located at 5.8 m VCG(average) having 200 tonne capacity, length X Breadth; 12.0m x 10.0m, to maintain vessel's Metacentric Height (GM) at 2.00m. (10 Marks)

4. A ship of 130 m long floating at 4800 tonne displacement with 3.20 m LCG aft of mid-ship. Following operations took place while the vessel is in a port:
1800 tonne of Cargo loaded @ LCG 5.20 m forward of midship
1250 tonnes of Cargo **discharged** @ 3.43 m forward of midship
20 tonne of fuel consumed @LCG 36.00 m aft of mid-ship
15 tonne of Fresh water consumed @ 34.60 m aft of mid-ship
5 tonne of stores loaded @ 36.00 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
7.50	5320	47.05	0.60 F	3.50 A

Calculate the final end drafts of the vessel. (16 Marks)

5.

I. Define following terms with respect to marine propellers;
   a. Theoretical Speed (Vt) (02 Marks)
   b. Wake Fraction (w) (02 Marks)
   c. Speed of Advance (Va) (02 Marks)
   d. Real Slip (02 Marks)

II. The diameter & the pitch ratio of a propeller fitted on 130 m long, 10,000 tonne displacement vessel is 6.0 m & 0.8 respectively. The beam of the vessel is 12.0 m and propeller rotate at 120 RPM at 8.0 m design draft in 1.025 tonne/m^3 seawater density.
The wake fraction $w = 0.5C_b - 0.05$ and the real slip is found 36 %.
Calculate;
   a. Speed of advance (04 Marks)
   b. The speed of the ship (02 Marks)
   c. Apparent slip (02 Marks)

6. Resistance exerted by the water on a ship when moves through the water at a speed could be divided into two main components as Frictional Resistance & Residuary Resistance.
   a. List the factors effecting the magnitude of each of above component. (06 Marks)
   b. A 5.0 m mild steel model of a ship has a wetted surface area of 6.0 m^2 and when towed in Sea water at 04 knots, has a total resistance of 48 N.
   Calculate the effective power required for a similar ship having 120 m length, at its corresponding speed, If the "Ship correlation Factor" (SCF) is 1.15. (10 Marks)
   $$f = 0.417 + \frac{0.773}{L+2.862}$$, index of speed (n) = 1.825 when V in Knots.

Part B:

7. (a) Describe the following and explain their function:
   (i)   Hawse pipe.   (02 Marks)
   (ii)   Spurling pipe.   (02 Marks)
   (iii)   Cable lifter.   (02 Marks)
   (iv)   Cable stopper.   (02 Marks)
   (b) With the aid of a sketch of a ship bow, show the arrangement of anchor cable, from anchor to chain locker.   (08 Marks)

8. Regarding the ship construction details for transverse watertight bulkheads:
   (a) State the purpose of this type of bulkhead.   (03 Marks)
   (b) State how the bulkheads are tested for water tightness.   (03 Marks)
   (c) If it is necessary to penetrate the watertight bulkhead, using simple sketches, describe how the following are pass through bulkheads:
   (i)   Main transmission shaft.   (05 Marks)
   (ii)   Electric cables.   (05 Marks)

9. With reference to the prevention of hull corrosion discuss:
   (a) Design of the ships structure and its maintenance.   (07 Marks)
   (b) Surface preparation and painting of new ship plates.   (05 Marks)
   (c) Cathodic protection by sacrificial anodes of the internal and external areas of the ship.
                                                                          (04 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)

Time 04 hours Marine Engineering Drawing and Design (ED 287)

Details of a **Plug cock** are shown in the figure. **Plug Cock** is a valve where full flow is through a hole in a tapered plug. Rotating the plug 90° completely stops the flow. By using the **First Angle Projection**, draw the following two views of the assembled **Plug cock**:

(a) A view in **half section** showing the outside view on the left of the vertical centre line and a section on the right hand side, the position of the valve body being similar to that shown on the given detail. The valve should be in **closed** position.

(b) An outside end view projected to the right of (a)

Suitable dimensions should be estimated where not provided. Hidden details are not required in either view. Include on your assembly suitable nuts and bolts and washers where applicable. Between the valve body and cover include a joint ring of thickness 2 mm. The gland should be positioned entering 10 mm into the valve cover.

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

Marking System

(a) Assembling accuracy of view (a)	(45 marks)
(b) Assembling accuracy of view (b)	(30 marks)
(c) Optimization of space	(05 marks)
(d) Dimensioning (at least 12 dimensions correctly)	(05 marks)
(e) List of materials of parts	(05 marks)
(f) Title block, projection symbol, lettering	(05 marks)
(g) Final appearance, neatness	(05 marks)

PLUG COCK

1ST ANGLE PROJECTION

(1) Valve body - Cast Steel

(2) Plug - Monel Metal

(3) Valve body cover - Cast Steel

(4) Gland - Bronze

(5) Cover stud - Mild Steel

(6) Gland stud - Mild Steel

4 holes Ø4.5 on 70 P.C.D.

25 square

2 holes Ø13

Drill 4 holes Ø15 equally spaced off centres on 120 P.C.D.

Tap 4 Holes M12 × 1.5 × 16 deep

2 holes M12 × 1.5

4 Holes Ø13

M12 × 1.5