BRIDGE EQUIPMENT

2nd Mate written notes

Question wise

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: SMART MARINER

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26/01/2022

BRIDGE EQUIPMENT AND WATCHKEEPING

Duration : 3 hrs

Maximum Marks : 200

Pass Marks : 100

Note: Attempt any 8 out of 9 questions.

Q.2. ECHO SOUNDER, DOPPLER LOG, EM LOG, OTHERS (25 MARKS) → BNWAS, Steering gear

Page - 9 (1) Echo sounder: (i) With the help of a suitable diagram, explain the working of a echosounde

(OR) Explain, how an echosounder determines the depth of water

Page - 10 (ii) Describe the main component of echosounder with block diagram & state the function of each component.

Page - 10,11 (iii) Why does the echo sounder use short and long pulses for short and long ranges respectively?

Page - 11,12 (iv) With respect to echosounder, explain the effect of density, tempe -rature and pressure on depth indicated

Page - 12,13 (v) What are the errors associated with the equipment

Page - 13 (vi) What correction are to be made to echosounder reading before comparision with charts?

Page - 14 (vii) List the type of transducer used in echosounder. Describe their working, advantage & disadvantages.

Page - 15 (viii) What are the factors affecting the functioning of Echo sounder.

Page - 15 to 17 (ix) Operation of ranging & phasing type echograph

Page - 18 (2) Doppler Log: * (i) Describe the principle and working of doppler log and explain how doppler log determines speed of the ship?

Page - 18 to 20 (ii) What is Janus configuration and what is its purpose?

* (OR), Explain the advantage of [illegible] configuration of doppler log?

Page - 20 (iii) Explain the effect of various ship's condition and ship's motion

Page - 20,21 * (iv) Explain various errors associated with doppler log.

Page - 21 (v) Explain ground track & water track with respect to doppler log.

Page - 22 (vi) Differentiate beetween water track & ground track speed.

Page - 23 (vii) Differentiate beetween Doppler log & EM log.

Page - 23,24 (3) EM log: (i) Describe the principle & working of EM log with block diagram

Page - 25 (ii) Explain the limitation/errors of EM log

(iii) What are the advantages & disadvantages of EM log

Page - 26 (4) BNWAS: What are the purpose, modes and sequence of indication and alarms required to be generated by BNWAS system.

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Q.1. GYRO COMPASS, MAGNETIC COMPASS, AUTO PILOT, COURSE RECORDER, ROTI (25 MARKS)

Page 31,32 AUTO PILOT: (i) With a simple block diagram, describe the working of an AUTO PILOT

Page 32,33 *(ii) With simple sketch, describe proportional, integral & derivative control in an auto pilot.

Page 33,34 (iii) Explain various control units in Auto-Pilot

Page 34,35 (iv) Explain the procedure for testing off-course alarm in Auto-Pilot

Page-35 (v) On what occasions, auto-pilot should not to be used.

Page 35,36 (vi) With a simple block diagram, describe the working of an auto adaptive steering system.

Page 37 (vii) Explain the various modes of Auto adaptive steering system.

Page-38 GYRO COMPASS: *(i) Explain following terms w.r.t gyro compass (a) Precession of Axis (b) Tilt and drift

Page-38,39 (ii) What is a free gyroscope? Describe any two properties of a free gyroscope.

Page-40 (iii) Describe the errors of the Gyro compass

Page-41 (iv) What care & maintenance is to be carried out on Gyro Compass

Page-41 (v) How is the gyro compass system made north seeking?

Page-42 (vi) Explain the starting procedure of gyro compass.

Page-42,43 (vii) How will you convert a free gyroscope to a north seeking gyro compass

Page-44 MAGNETIC COMPASS: (1) Write short notes on Magnetic Compass

Page-44 *(2) What are advantage of wet compass card over dry compass card

Page-44 to 46 (3) Explain the function & various parts of wet card magnetic compass with diagram.

P-46,47 *(4) Draw a neat sketch of compass binnacle and label various arrangements provided on it.

P-47 (5) With the help of neat sketch describe various type of soft iron rods which could be present around the magnetic compass binnacle.

P-47,48 (6) Describe with a simple sketch, the optical system of a Magnetic compass binnacle. What is the main feature of this system with respect to the image seen by the helsman.

P-49 (7) What are the care and maintenance to be done for a magnetic compass.

P-49 (8) Describe the procedure for removing air bubble from Magnetic compass

P-49,50 (9) What is Dip? How compass card is kept horizontal in varying latitudes?

P-50 (10) Explain why the value of deviation changes with the change in ship's heading

P-51 *(11) Why the vessel is required to swung once a year to verify magnetic compass deviation card.

P-51 (12) Write short notes on variation & Deviation, True North & Magnetic north

P-52 Course recorder: (1) Explain purpose & working of a course recorder.

P-53 ROTI: *(1) Explain the use of Rate of Turn Indicator.

P-53 (2) Show with a neat sketch, how will you execute a constant radius turn?

17/03/2022

Q. 3 ELECTRONIC POSITION FIXING SYSTEM

P-51 GPS: (1) Describe the principle & working of GPS

P-54,55 (2) (a) How does GPS reciever determines ship's position and speed?
(b) What do you understand by Pseudo range & True range

P-56 (3) Explain how the frequency used by GPS satellite can also be used to determine the speed of the vessel

P-56,57 (4) Describe the contents of Navigational message in GPS.

P-57 (5) Why shipboard reciever need to track minimum of three satellite for position?

P-58 (6) What are the various alarms of the GPS

P-58,59 (7) What are the various errors of the GPS? (OR)
What factor affects the accuracy of a GPS position?

P-59,60 (8) Write the functions of various segments of GPS? What is clock-bias error?

P-61 (9) W.r.t GPS, write short notes on (a) P & C/A code (b) carrier frequency

P-62 (10) What is dilution of precision? Briefly explain the various type DOP's of the GPS system

P-62,63 (11) W.r.t GPS, write short notes on Precise positioning service (PPS) & Standard Positioning service (SPS)

P-63 DGPS (12)(a) Explain the functioning of DGPS & its limitations (OR)
How does DGPS enhance position fixing of GPS data

P-64 (b) What are two methods by which the DGPS system computes the correction to be applied to the position obtained by the GPS

P-64 (13)(a) What do you understand by Chart Datum? Which default datum is used in GPS

P-65 (b) Can a fix obtained from GPS reciever be plotted directly onto a navigational charts.

P-66 ECDIS: (1) Write short notes on ECDIS

P-66,67 (2) What are advantages & disadvantages of ECDIS over paper chart?

P-67 (3) Explain the difference beetween Raster and vector charts.

P-68 (4) Explain the methods of updating Electronic Navigation charts (ENC)

Q. 4 AIS, LRIT, VOYAGE DATA RECORDER, SEXTANT

P-69 AIS: (1) Explain the working principle of AIS & frequencies used? (OR) Short notes on AIS

P-70 (2) Explain the purpose & benifit of AIS (OR)
what are objective of AIS? What are the added advantage of AIS over ARPA w.r.t collision avoidance

P-71 (3) What are limitations of AIS in safe navigation due to which AIS cannot be used as a sole navigation aid?

P-71,72 (4) List the information transmitted by AIS device & at what interval?

P-72 (5) What is the use of AIS pilot plug?

P-73 (6) What are the different classes of AIS?

P-74,75 LRIT: (1) Write short notes on LRIT? (OR) How does LRIT system function

P-75 (2) (a) What is the purpose of the LRIT system?
(b) List the data transmitted by LRIT & time interval?

P-76 (3) List the authorised users/ recievers of LRIT information & state the condition under which LRIT information from ships can be realeased to the authorised users.

P-76 (4) Explain the function of LRIT data centre?

P-77 (5) Explain the difference b/w AIS & LRIT? (10 Times)

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P-78 VDR: (1) Write short notes on VDR.

P-78,79 **(2) What is the purpose of VDR? List the data recorded by VDR & S-VDR (8 times)

P-79 (3) Comparison between VDR & S-VDR.

P-80 *(4) With the help of simple block diagram, briefly explain the modules of VDR (3 times)

P-81 (5) Explain the data retrieving procedures in case of a collision.

P-82 Sextant: (1) How will you find the Index error of a sextant.

ECHO SOUNDER

26/01/2022

ECHO SOUNDER

Ques ①: With the help of a suitable diagram, explain the working of an echosounder.

Ans:- An echo sounder is an electronic equipment used on-board ship as an aid to navigation to measure depth of water under the ship.

PRINCIPLE:

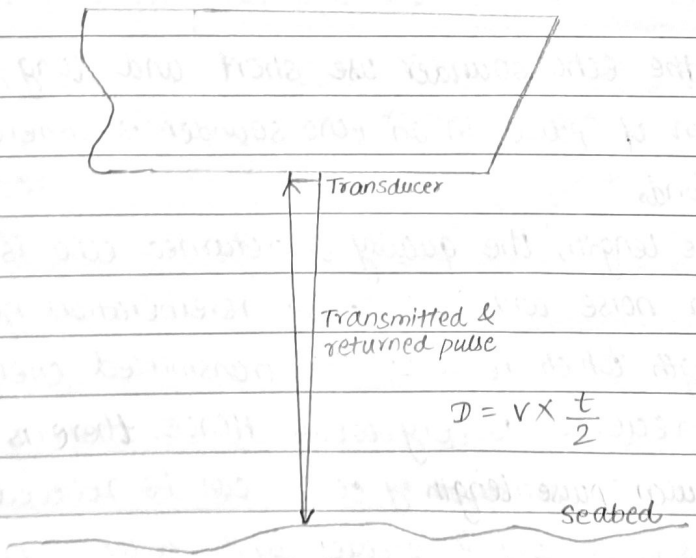
- Short pulses of sound waves are transmitted vertically downward from the transducer to the seabed at the rate of 500 to 600 per min.
- These sound waves strikes the seabed and get reflected back as echoes.
- These reflected waves are recieved by the transducer and time taken from the transmission to reception is measured (& depth can be determined.)

Formula used :- $\text{depth} = \text{speed of sound in water} \times \frac{\text{time taken}}{2}$

Speed of sound waves through seawater at a temperature of 16°C and salinity of 3.4% is 1500 m/sec. For example, if the time taken by sound waves from transmission to reception is 1 sec, that means the depth of water under the ship is 750 m.

How it is recorded:

The recieved echoes are then converted into electric signals by the recieving transducer and after passing through different stages of reciever, the current is supplied to the stylus (rotating at a speed equal to half the speed of sound waves) which burns out the coating of thin layer of aluminium pouder and produces a black mark on the paper indicating the depth of water under the ship.



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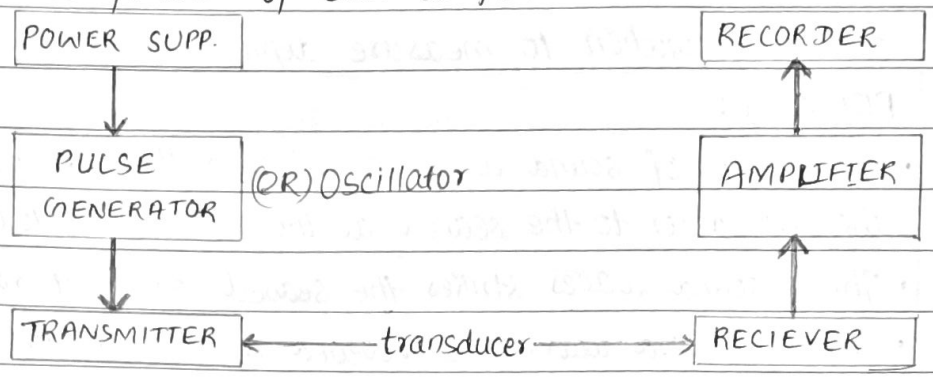
Ques ②: Describe the main components of echo sounder with block diagram & state the function of each components.

Ans:-



Power supply:- This unit gives the required voltages to the different stages of the echo sounding equipment.

Pulse generator:- This unit produces a high voltage oscillation of desired frequency and the output is given to transmitter.
or oscillator

Transmitting transducer:- It converts the electrical signals into acoustic sound waves and transmit them towards the seabed.

Recieving transducer:- The recieving transducer recieve the echoes from the seabed and converts them into electrical signals, which are sent to the amplifier unit.

Amplifier: This unit amplifies the weak electric signals recieved from the transducer and gives to the recorder unit.

Recorder: This unit controls the transmission of acoustic pulses and records the depth on the paper.

Ques ③: Why does the echo sounder use short and long pulses for short and long ranges respectively?

Ans:- The duration of pulse in an echo sounder is generally beetween 0.2 to 2.0 milliseconds.

In short pulse length, the quality of returned echo is good because reverberation noise will be less. The reverberation noise reduces the signal strength which reduced the transmitted energy. The echoes which will recieved is very weak. Hence, limiting the maximum depth from which satisfactory echoes can be recieved. For shallow depth, short pulse is used and in greater depth, a longer pulse is used.

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For a given pulse length, the PRF (Pulse repetition frequency) determines the maximum range that can be indicated.

Formula used ⇒ Max^m range indication (r) = $V \times \frac{t}{2}$

V = velocity of sound in sea water

t = time beetween pulses in minutes.

For Example :- 1) PRF is one pulses per second, find max^m depth that can be recorded

$t = \frac{1}{1} = 1$

$r = 1500 \times \frac{1}{2} = 750$ meters

The maximum depth that can be recorded is 750 meters.

2) PRF is two pulses per second, find max^m depth that can be recorded

$t = \frac{1}{2} = 0.5$

$r = 1500 \times \frac{0.5}{2} = 375$ meters

The maximum depth that can be recorded is 375 meteres.

3) PRF is five pulses per second, find max^m depth that can be recorded

$t = \frac{1}{5} = 0.2$

$r = 1500 \times \frac{0.2}{2} = 150$ meters

The maximum depth that can be recorded is 150 meters

Hence, as the PRF increases, the maximum depth that can be recorded decreases and vice-versa. Higher PRF is used for lower range & lower PRF is used for higher range.

Ques ④ :- With respect to echosounder, explain the effect of density, temperature and pressure on depth indicated.

Ans :- Velocity of propogation in water :- The depth is calculated by formula $d = V \times \frac{t}{2}$, where t is time taken by sound waves to travel to and fro from the seabed. The velocity of sound waves through seawater at temperature of 16°C & salinity of 3.4% is 1505 m/sec but for all calculation purpose it is taken as 1500 m/sec.

ⓐ The velocity of sound waves also varies with change in salinity resulting in change in density, which practically will not be greater than 0.5% except if transition is from SW to FW, where indicated depth will be approximately 3% greater than actual depth. which

is very crucial in shallow water.

(b) The velocity of sound waves also varies with change in temperature. The velocity increases with increase in temperature and vice versa.

(c) The velocity of sound waves slightly varies with change in pressure. The increase in velocity due to increase in pressure is marginal.

The velocity of acoustic waves changes if temperature, density or pressure changes & if velocity is not correct, the depth recorded with be inaccurate. The change in pressure has very little effect whereas temperature & density influence more. The depth can be corrected to true depth from table of velocity of sound in purewater & seawater - Refer NP 139.

Ques ⑤ :- What are the errors associated with this equipment. What measures do you take to eliminate the error when using the equipment.

Ans :- 1. Stylus speed error: The stylus is rotating with a certain constant speed and speed of the stylus is such that time taken by stylus to travel from the top to bottom on the paper is exactly equal to time taken by sound waves to travel twice the distance of the range selected.

2. Pythagoras error: This error is found when dual transducer are used, one for transmission and one for reception. Due to the angle of beam, the measured depth is greater than actual depth. This error is Calc-ulated using Pythagoras principle.

Formula used :- $e = d - \sqrt{d^2 - x^2/4}$

where, e is error

d is recorded depth

x is space beetween transducer.

This error becomes more prominent, when space beetween two trans-ducer is more than 2 meters. In that case, manual should be refered in order to use the corrections.

3. Multiple echoes: Some strong echoes may bounce back and forth several times beetween ship's hull and seabed, and hence providing multiple

depth marks on the paper.

4. Thermal and density layers: Density of water varies with change in salinity and temperature of seawater which affect velocity of sound waves in seawater and causes error in depth recorded.

5. zero line Adjustment Error: If the zero is not adjusted properly it will give error in reading.

6. Cross noise: If sensitivity of amplifier is high, just after the zero marking, a narrow line along with several dots and dashes will appear. This is due to cross noise which occurs when small part of transmitted signal is picked up by reciever. This is controlled by swept gain control.

7. Aeration: When sound waves are reflected from air bubbles, it will appear as a dots on paper. This is known as aeration. This is due to pocket of air bubbles created during heavy weather, large alteration, pitching in ballast condition or astern propulsion.

Ques ⑥: What correction are to be made to echo sounder reading before comparision with charts?

Ans:- same as paragraph 1 of 2.7

- The depth is calculated by formula $d = V \times \frac{t}{2}$ where t is time by sound waves to travel to and fro from the seabed. The velocity of sound waves varies with change of density. The velocity of soundwaves through seawater at temperature of 16°c & salinity of 3.4/. is 1505 m/sec but for all calculation purpose, it is taken 1500 m/sec.
- The velocity of sound waves increases with increase in temperature and/or increase in salinity. The increase in velocity due to increase in pressure is marginal. The depth can be corrected to true depth from table of velocity of sound in purewater & seawater - Refer NP 139.
- An increase in air pressure by 1 hpa decreases the sealevel by 1 cm and decrease in air pressure by 1 hpa increases the sealevel by 1 cm. This is called inverse barometric effect which need to be considered.
- Height of tide will have to be taken into account.
- The decrease/increase of water level due to force & direction of wind is to be taken into account.

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Ques (7):- list the type of transducer used in echo sounder. Describe their working, advantage & disadvantages.

Ans:- There are two types of transducer:-

1) Electrostrictive transducer or Piezoelectric transducer.
2) Magnetostrictive transducer.

(1) Electrostrictive transducer

- This type of transducer work on the principle of piezoelectric effect. It make use of the special properties of crystals such as quartz, rochelle salt etc. The crystal is firmly fixed beetween two plates so that they act as a single unit. When alternating voltage is applied beetween steel plate, the crystal beetween two plates will expand and contract, then the crystals and the steel plates starts vibrating together, hence creating the sound waves.
- The lower of two steel plates is in direct contact with seawater.

Advantages: (a) They are smaller, lighter & cheaper
(b) One transducer can be used for both tramission & reception

Disadvantages: (a) The hull need to be pierced & integrity of hull is compromised.
(b) These can be serviced only during dry-dock or under-water.

(2) Magnetostrictive transducer

- This type of transducer works on the principle of magnetostriction. It make use of Ferro-magnetic bar such as nickel etc. which is wounded with a coil.
- When alternating voltage is applied & passed through the winding of the coil, the contraction & expansion of nickel takes place circumferentially along the path of the magnetic field produced by the coil causes vibration, and hence creating the sound waves.
- The sound waves are then directed downward by reflector.

Advantages: (a) It is fitted as internal installation which makes them ideal for use in heavy seas
(b) The integrity of hull is maintained as hull doesn't need to be pierced
(c) It can be easily serviced as it is fitted internally.

Disadvantages: (a) Two transducer are used, one for transmission & other for reception.
(b) There are about 85% loss in power due to hull plate & power loss means more power needed. Hence, can be used only on large vessels.

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Ques ⑧: What are the factors affecting the functioning of Echo sounder?

Ans:- The factors which are affecting the functioning of echo sounder are listed:

ⓐ Velocity of sound waves: The velocity of sound waves through seawater at temperature of 16°c & salinity of 3.4‰ is 1505 m/sec but for all calculation purpose it is taken as 1500 m/sec. The velocity of sound waves also varies with change in temperature and salinity.

ⓑ Pulse repetition frequency: It is number of pulses produced per second. It is changed automatically when range is changed. Higher PRF is used for lower range and lower PRF is used for higher range.

ⓒ The reflective nature of seabed: It affects the reflected signals. Hard, rocky seabed are good reflectors whereas soft mud, sand or clay are poor reflectors.

ⓓ Noise: It is the most problematic factor. Error is caused on picking up the reflected echoes due to the noise. Cross noise:- It occurs when small part of transmitted signals is picked by the reciever. Thermal noise:-

Sea noise:-

ⓔ Beam width: Greater the depth, more the beam spread resulting in a drop in returned energy. When beam is closer to vertical, more will be the energy reflected by the seabed.

Ques ⑨:- Describe Ranging & Phasing.

9(a) Ques:- Explain with block diagram, the operation of phasing type echograph.

9(b) Ques: What are the problems encountered in ranging method of echosounder? How it is minimized by phasing method.

Ans:- ⓐ Ranging type echograph:

- A Stylus is mounted on a circular belt driven by a stylus motor. The Stylus is rotating with certain speed and the transmission take place only when stylus passes the zero mark.
- A magnet is fixed on belt which triggers the transmitter to transmit a pulse every time when stylus passes the zero mark.
- The sound waves are reflected from the seabed & echoes are recieved by the recieving transducer.

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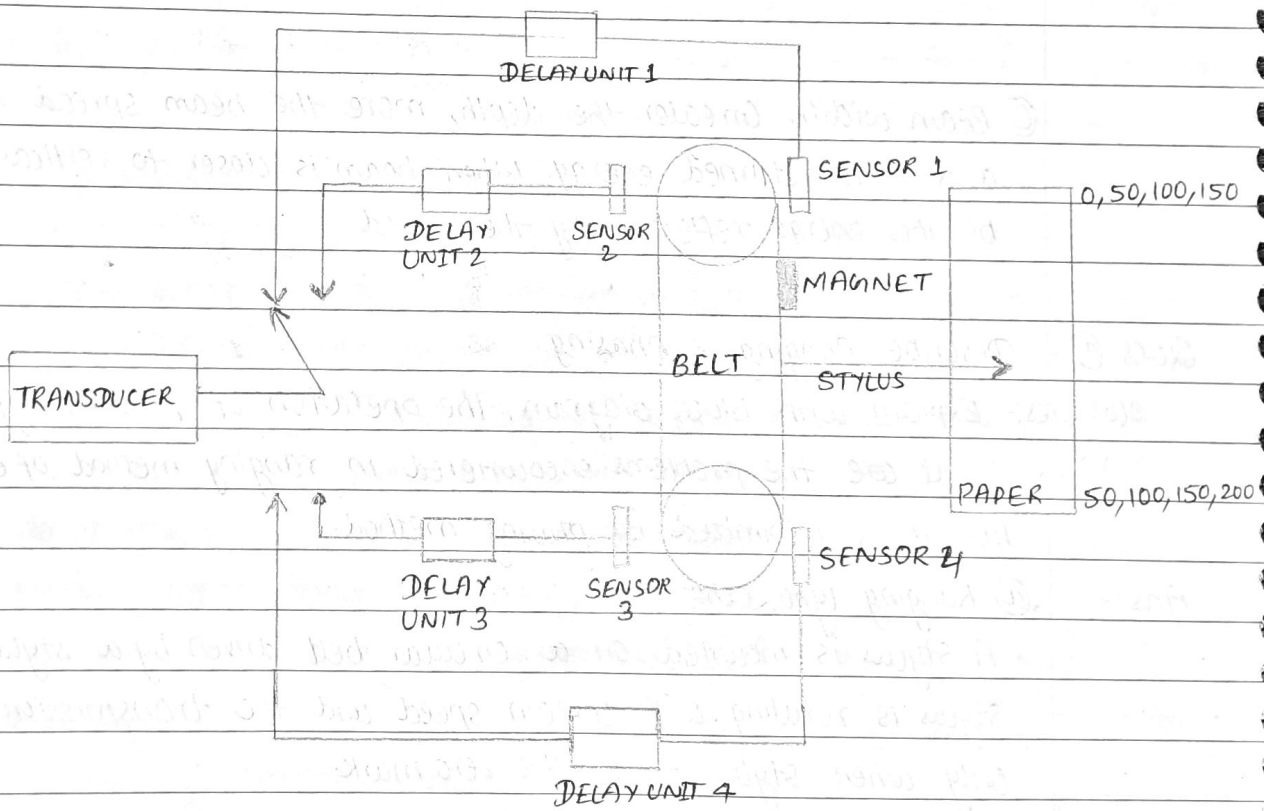
- After passing through various stages of reciever, the current is supplied to the stylus which burns out the coating of thin layer of aluminium powder which produces a black mark on the paper indicating the depth of water under the ship.
- This cycle is repeated for every rotation of stylus and as paper is pulled across, the profile of seabed can be obtained on paper.

Ans 9(b) Part 1 :-

- When higher range is selected, the tramission will still take place when the stylus comes at zero, only the stylus speed is reduced because the stylus has to remain on paper for longer period since the echoes are taking longer time to return back from greater depth. This system is known as Ranging & range scale generaly provided is 0-50 mtrs, 0-100 mtrs, 0-200 mtrs and so on.

However, with this, scale magnification is lost as scale becomes congested. To overcome this problem, so echosounder works on phasing technique

(b) Phasing Type Echograph



PHASING TYPE ECOGRAPH

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- In phasing, speed of the stylus motor remain constant. Instead of changing speed of stylus, the transmission point is advanced. i.e. transmission occurs just before the stylus reaches the top of the paper.
- Range scale provided are 0-50m, 50-100m and not 0-100m as in ranging.

(Refer diagram)

- Various sensors are positioned around the stylus belt. The magnet when passes the sensors will generate the pulse which activates the transmitter.

(Refer diagram)

- In the diagram, when range is 0-50m, the magnet activates sensor 1 when stylus passes the zero mark.
- When 50-100m range is selected, the magnet activates sensor 2 & transmission take place early. & stylus will not pass the 50m mark at the time of transmission. In other words, delay is caused by Delay unit 2 and stylus will reach 50m mark (top of the paper) after a delay.
- In same way, delay will be more for the next range and stylus will pass the 100m mark (top of the paper) after a longer delay.
- Thus, the paper have a constant range of 50m (like 0-50, 50-100 etc.) and hence range resolution is not affected as in Ranging system. The problem of loss of scale magnification is eliminated.

Ques 9(c)- Difference beetween phasing & ranging.

RANGING	PHASING
Stylus speed change	Stylus speed same/ transmission advance
PRF change	PRF same
Scale always start from zero	Scale does not always start from zero

DOPPLER LOG & EM LOG

15/02/2022

DOPPLER LOG

Ques①:- Describe the principle and working of doppler log and explain how doppler log determines the speed of ship.

Ans:- Doppler log works on the principle of doppler effect which is a shift of frequency beetween a transmitted signal and a recieved signal caused by the motion of the vessel.

The acoustic sound waves is transmitted in the forward direction and gets reflected off & returns to the vessel. It will suffer an apparent frequency shift. This frequency shift is also known as the "doppler shift".

The degree of shift in the frequency is proportional to the speed of the vessel.

* Principle of working

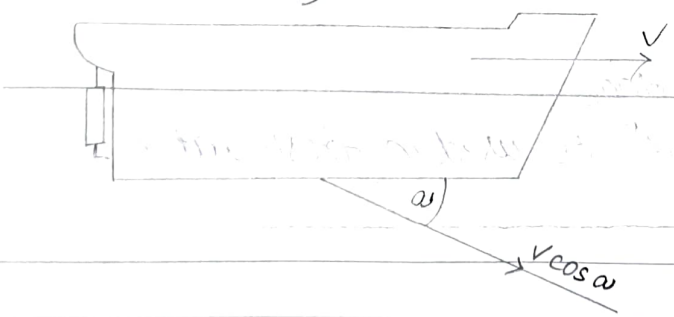
- A transducer is fitted on the ship's keel which transmit a beam of acoustic wave at an angle α usually 60 degree to the keel in forward direction, this gives $V \cos\alpha$ of the ship's velocity towards the seabed thus causing the doppler shift and the recieved frequency (F_r) is equal to

$$F_r = f_t(c + v\cos\alpha)/(c - v\cos\alpha)$$

Not imp for exam

Note:- If the waves are transmitted towards the seabed perpendicular to the keel, there will be no doppler shift and transmitted & recieved frequency will be the same.

i.e. $v \cos 90° \Rightarrow V \cdot 0 \Rightarrow 0$



Ques②:- What is Janus configuration and what is its purpose?

(OR)

Explain the advantage of Janus configuration of Dopper log?

Ans:- See next page

When using a single transducer, if the angle 'α' changes during pitching or due to trim, there will be an error in the speed indicated because calculation of speed is done with angle as 60°.

This problem is overcome by installing two transducer, one transmitting in the forward direction and another in the aft direction at the same angle. This arrangement is known as Janus configuration

- In this case, forward transducer will give dopper shift

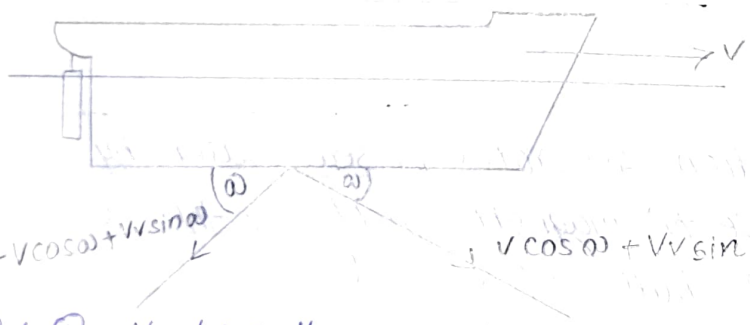
i.e. $Fr(f) - Ft = \frac{2 \cdot V \cdot Ft \cdot \cos\alpha + 2 \cdot Vv \cdot Ft \cdot \sin\alpha}{C}$ — (II)

where Fr(f) is the frequency recieved by the forward transducer

- The aft transducer will have the component $V \cos\alpha$ with negative sign since the transducer is moving away from the reflecting surface i.e. the seabed & hence doppler shift is measured by

$$Fr(a) - Ft = \frac{-2V \cdot Ft \cdot \cos\alpha + 2Vv \cdot Ft \cdot \sin\alpha}{C} \quad \text{— (III)}$$

where Fr(a) is the frequency recieved by the aft transducer



In equation (II) & (III), Vv have the same sign since both transducer move upwards & downwards together.

By measuring the difference beetween two doppler shift frequencies, the vertical component will cancel out while the horizontal will add

i.e. (II) − (III)

$$[Fr(f) - Ft] - [Fr(a) - Ft] = \frac{(2VFt\cos\alpha + 2VvFt\sin\alpha)}{C} - \frac{(-2VFt\cos\alpha + 2VvFt\sin\alpha)}{C}$$

$$Fr(f) - Ft - Fr(a) + Ft = \frac{2VFt\cos\alpha}{C} + \frac{2VvFt\sin\alpha}{C} + \frac{2VFt\cos\alpha}{C} - \frac{2VvFt\sin\alpha}{C}$$

$$Fr(f) - Fr(a) = \frac{4VFt\cos\alpha}{C}$$

$$V = \frac{C[Fr(f) - Fr(a)]}{4VFt\cos\alpha}$$

V is the speed of the ship that can be calculated.

With Janus configuration and 3° trim, the error is reduced to 0.2%. as compared to 5% error if single transducer arrangement is used.

Ques ③ Explain the effect of various ship condition and ship's motion.

Ans:-

- Heaving: Any vertical movement has got no effect on the speed of the vessel.
- Trim: The trim of the vessel has very less affect on the fore & aft speed and no effect on athwartship's speed.
- Pitching: The effect of pitching is similar to a vessel with trim changing continuosly. When the vessel is pitching, the indicated speed fluctuate beetween actual speed & a value lower than actual speed depending on angle at which pitching. Pitching does not effect athwartship's speed.
- List & rolling: It does not effect the fore & aft speed.

Ques ④:- Explain various errors associated with Doppler log.

Ans:-

- Error in transducer orientation :- The transducer should make a perfect angle of 60° with respect to the keel or else the speed indicated will be inaccurate.
- Error in oscillator frequency :- The frequency generated by oscillator must be accurate & constant, any deviation will result in error in speed.
- Error in propogation velocity of acoustic waves: the velocity of acoustic wave at the temp of 16°c and salinity of 3.3% is 1505 m/sec but it is taken as 1500 m/sec for calculation.
- Error due to ship's motion: During the gap beetween transmission and reception, the ship's may marginaly roll or pitch, causing angle of transmission & reception to differ. & the for two degree difference, there will be an error of 0.1% of the indicated speed which is marginal and can be neglected.
- Error due to effect of rolling and pitching: Pitching will cause an error in forward speed, but it has no effect on athwartship speed. Rolling will cause an error in athwartship speed, but it has no effect on forward speed.

In Pitching, actual speed = Indicated speed / cos θ

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For example, ship is pitching at an angle of 10° & indicated speed is 15 knots.

Actual speed = $15/\cos 10°$

= 15.23 Kts.

- Error due to inaccuracy in measurement of comparision frequency :- The difference in the frequency recieved by the forward and aft transducer must be measured accurately because any error will affect the ship's speed
- Error due to side lope (sloppy seabed) : This error is caused due to sloppy bottom. This error cannot be eliminated with the help of Janus configuration and to reduce the error, the beam of the transmitted acoustic wave is reduced by minimum beam width of 4 to 6°

Ques ⑤:- Explain ground track and water track with respect to Doppler log

Ans :-

Ground track:

The acoustic sound waves is transmitted at an angle of 60° and gets reflected off from seabed. The ship's velocity caused the shift in frequency known as "doppler shift". This degree of shift is proportional to the speed of the vessel.

The speed of the ship is speed over ground, affected by set and drift because echoes are coming from seabed. This is also known as bottom track or ground track.

Water track:

- The transmitted pulse has certain power and can go upto limited depth usually 200 mtrs. Beyond this depth, the echoes from seabed becomes very weak and the strength is not sufficient to calculate the doppler shift.
- In such cases, echoes are also available from water layers beetween 10 and 30 metres below the keel and hence doppler shift is possible. This will give us speed over water & referred as water track.

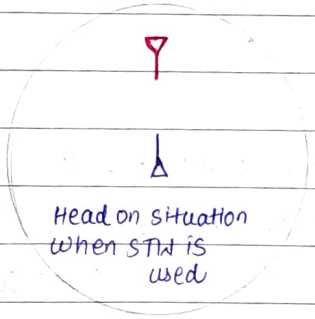
Note :- The equipment automatically changes over to water track when the echoes from the seabed are not strong enough.

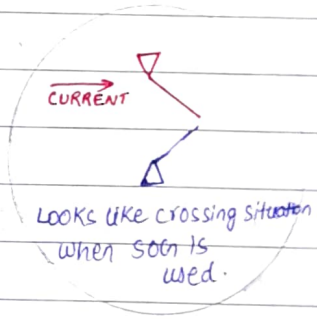
- Depth of about 10 to 30mtrs below the keel, the water is still and there is a distinct seperation b/w the two layers of water which provides the echoing surface of the acoustic waves.

Ques ⑥:- Differentiate beetween water track speed & ground track speed.

Ans:-

Water Track Speed	Ground Track Speed
• It can be obtained by doppler log in water track mode and EM log	• It can be obtained by doppler log in ground track mode and GPS
• Speed through water is the distance travelled in one hour with respect to water	• Speed over ground is the distance travelled in one hour with respect to ground
• Water track speed is given to ARPA for collision avoidance maneouvre.	• Ground track speed input helps in finding the actual drift in areas of strong currents while anchoring/berthing.
• While using water track speed, in PPI, the actual aspect of the target vessel is seen as it is seen visualy outside	• While using ground track speed, in PPI, conflicting aspect of the target vessel is seen as compared to the actual scenario outside
• The movement of own vessel, fixed object & moving object is their movement through the water.	• The movement of all moving object is their movement over ground (COG & SOG)
• This is ideal for collision avoidance	• It is used for collision avoidance with fixed object





As we can see in above RADAR image with an easterly current, a target vessel in head on situation, in water track mode the actual aspect of the vessel is seen while in ground track mode the conflicting aspect of the vessel is seen. Hence, it is important to use water track speed & speed through water for collision avoidance for correct application of COLREGs. However, there will be no change in CPA & TCPA in either case.

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Ques ⑦:- Differentiate between Doppler log and EM log.

Ans:-

Doppler Log	Electromagnetic log
• Doppler log works on doppler shift principle & used acoustic sound waves	• EM log works on Faraday's principle and works on electromagnetic induction
• Doppler log gives both speed over ground (SOG) & speed through water	• EM log gives speed through water (STW).
• Speed shown will not be affected by currents because there will be no doppler shift due to no change in transmitter & reflective surface.	• Speed shown get affected by currents i.e when vessel is not moving but flow of water passes the sensor, speed through water get displayed
• Change in salinity & temperature affects the speed measurment. Corrections can be applied by using thermostat	• Induced EMF varies with conductivity of water which varies with the salinity of water.
• Doppler log can be used to measure fore & aft, athwartship speed by use of Janus configuration.	• EM log can be used to measure fore and aft speed only.
• Doppler log maintenance can be done only in drydock.	• EM log checks & maintenance can be done without going into the drydock

EM LOG

Ques ①:- ⓐ Explain the principle of EM log with block diagram (OR) Sketch and describe working of EM log } working principle

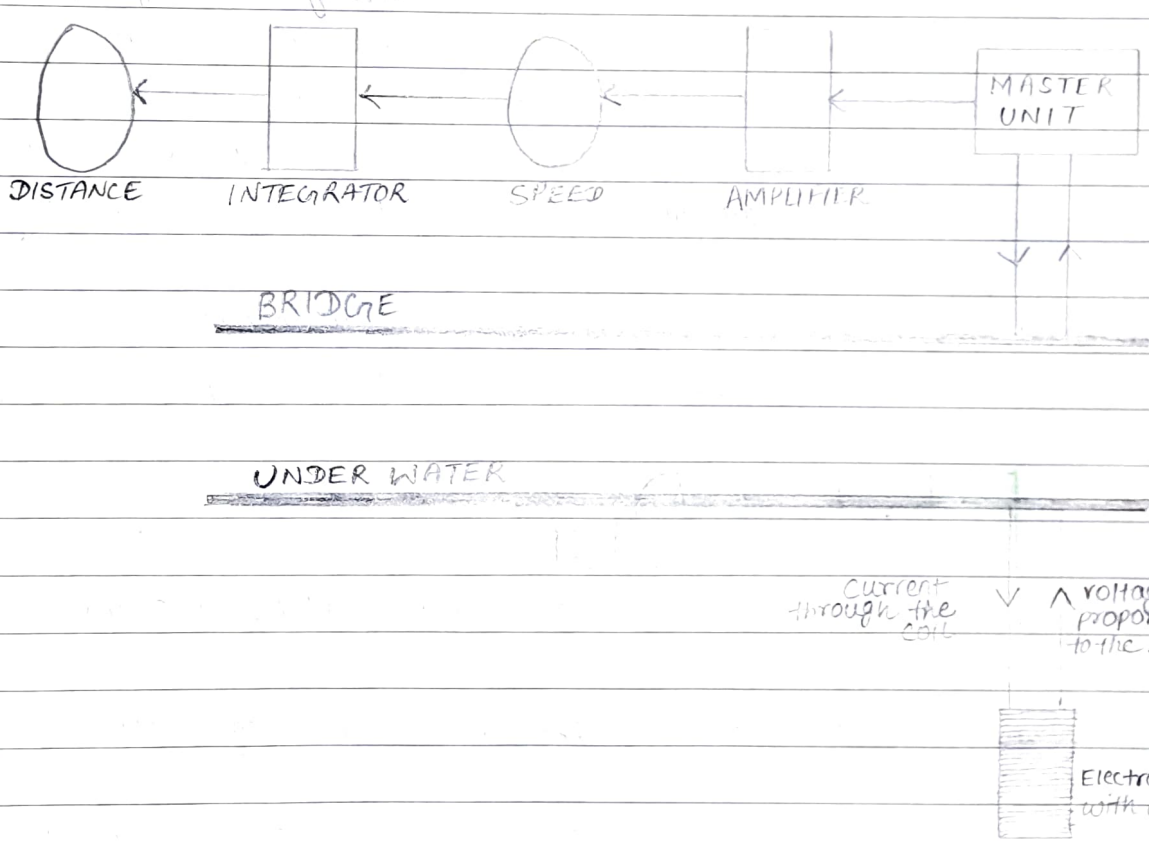
(OR)

ⓑ With a simple clearly labelled sketch, describe how an EM log displays speed and distance

Ans:- ⓐ • The EM log works on the principle of electromagnetic induction (as stated in Faraday's Law of electromagnetic induction). When a moving conductor cuts a stationary magnetic field or moving magnetic field cuts a stationary conductor, an electromotive force (EMF) is induced in the conductor which is directly proportional to the speed of the movement of the conductor.

• In case of EM log, conductor is sea water and the magnetic field is created by an electromagnet consisting of a coil carrying A.C current

- Since sea water is a conductor of electricity, when it cuts through the magnetic field of the coil, a small voltage (EMF) is induced which is measured by two sensor(electrodes) which are in contact with the water.
- This induced EMF is directly proportional to the speed of the ship through the water.
- However, the induced EMF varies with the conductivity of water (bcz sea water is good conductor but fresh water is not such a good conductor of electricity).
- The speed is integrated with the time to display distance.



- The log extends upto about 20cm outside the hull. It can be retracted when required.
- Sensors are fitted to obtain the water flow.
- Master unit is fitted to calculate speed & distance.
- The induced EMF is very small which need amplification. Hence, amplifier is also provided.
- Two electrodes are provided to pick up the induced E.M.F.
- Indicators/displays are provided to display the speed & distance.

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Ques ②:- Explain the limitations/errors of EM log.

Ans:- Following are the limitations/errors of EM log:-

ⓐ Sitting of the probe:- It is very critical because wrong sitting of the probe will lead to wrong representation of ship's speed. This can be minimized by carefully sitting of sensors & calibration of instrument during installation.

ⓑ Rolling and Pitching: There may be slight error in speed calculation during rolling and pitching. However, they are reduced by having an electronic time constant that is longer than a period of vessel's motion.

ⓒ Sign of speed: The EM log can show the astern speed as well but without sign when AC current is used. It will show sign, if DC current is used.

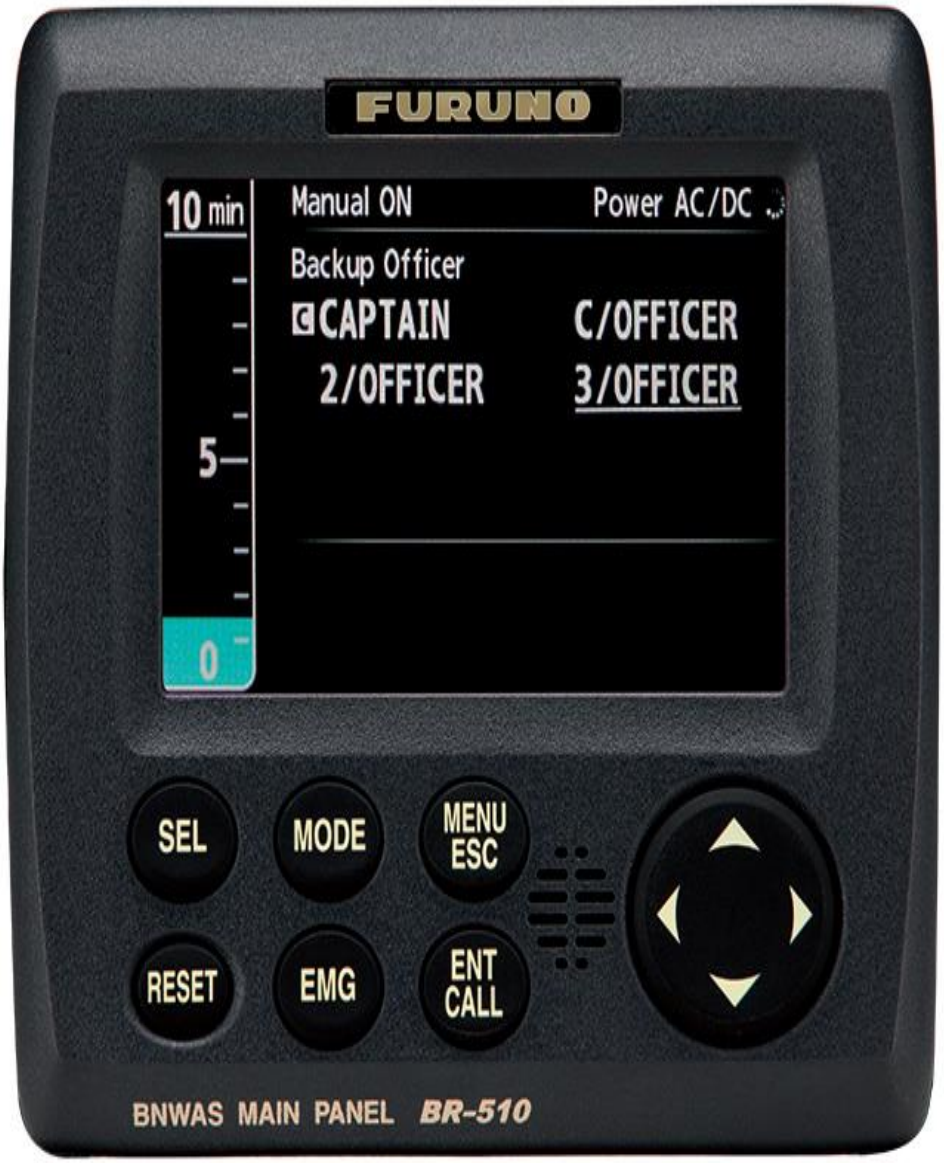
ⓓ Other limitation: EM log shows only speed through water (STW). So, speed is affected by current flowing under the ship. While navigating in heavy current area, one must exercise precaution.

Ques ③ What are the advantages & disadvantages of EM log.

Ans:- Advantages: ⓐ No moving parts
ⓑ Not affected by marine growth
ⓒ Simple & reliable
ⓓ Easy to calibrate & maintain

Disadvantages: ⓐ Only reads speed through water
ⓑ Ocean current affects speed measurement
ⓒ Induced EMF varies with conductivity of the water.
ⓓ Measurement affected by uneven flow of water below the hull
ⓔ Sensor extended below the hull & subject to damage
ⓕ Rolling & pitching leads to error.

BNWAS


FURUNO
10 min
Manual ON
Power AC/DC
Backup Officer
CAPTAIN
C/OFFICER
2/OFFICER
3/OFFICER
5
0
SEL
MODE
MENU ESC
RESET
EMG
ENT CALL
BNWAS MAIN PANEL BR-510

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BNWAS

Ques:- What are the purpose, modes and sequence of indication and alarms required to be generated by BNWAS system?

Ans:-

@Purpose:

- The purpose of BNWAS is to monitor bridge activity and operator disablity which can lead to marine accidents.
- It monitors the alertness of OOW & automaticaly alert the Master & other qualified officer, in case of OOW becomes incapable to perform his duties.
- The purpose is achieved by a series of indications and alarms to alert first the OOW & if not acknowledged, then it alert the Master & other qualified officer.

@Modes:

The BNWAS works on one of the following modes at any time:

(i) AUTOMATIC: Automaticaly brought into operation when ship's heading or track control system is activated & automaticaly inhibited when system is not activated.

(ii) MANUAL ON: The BNWAS is turned off completly.

(iii) MANUAL OFF: The BNWAS is always in operation.

© Sequence of Indications & alarms:

(i) Once operational, the alarm system should remain dormant (निष्क्रिय) for a period of 3 to 12 min.

(ii) At the end of dormant period, the alarm system should initiate visual indication on the bridge. (Flashing)

(iii) If not reset, in 15 sec, BNWAS should sound a first stage audible alarm on the bridge.

(iv) If not reset in 15 sec, BNWAS should sound second stage audible alarm in the back-up officer's cabin and/or Master's location.

(v) If not reset in 90 sec, BNWAS should additionaly sound third stage audible alarm at the various location like CCR, Officer's recreation room etc. such that further crew member should take corrective actions.

(vi) The vessels other than passenger vessel, the second stage audible alarm may be sounded in the way third stage audible alarm is sounded & third stage alarm may be omitted.

(vii) In larger vessel, delay beetween 2nd & 3rd stage may be kept upto 3 min, to allow sufficient time to backup officer or Master to reach the bridge.

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Regulation for BNWAS:

SOLAS Chapter V Regulation 19 states:

- Cargo ship greater than 150 GRT & passenger ship irrespective of size constructed on or after 1st July 2011. must have BNWAS.

AUTO PILOT


AUTO PILOT
FACIA PANEL
RC Selection
270.5
270.
COURSE
SET
LAMP
TEST
ALARM
ACK
DATA
CHANGE
DIMMER
MODE
HAND
AUTO
No.1
OFF HEADING PILOT WATCH

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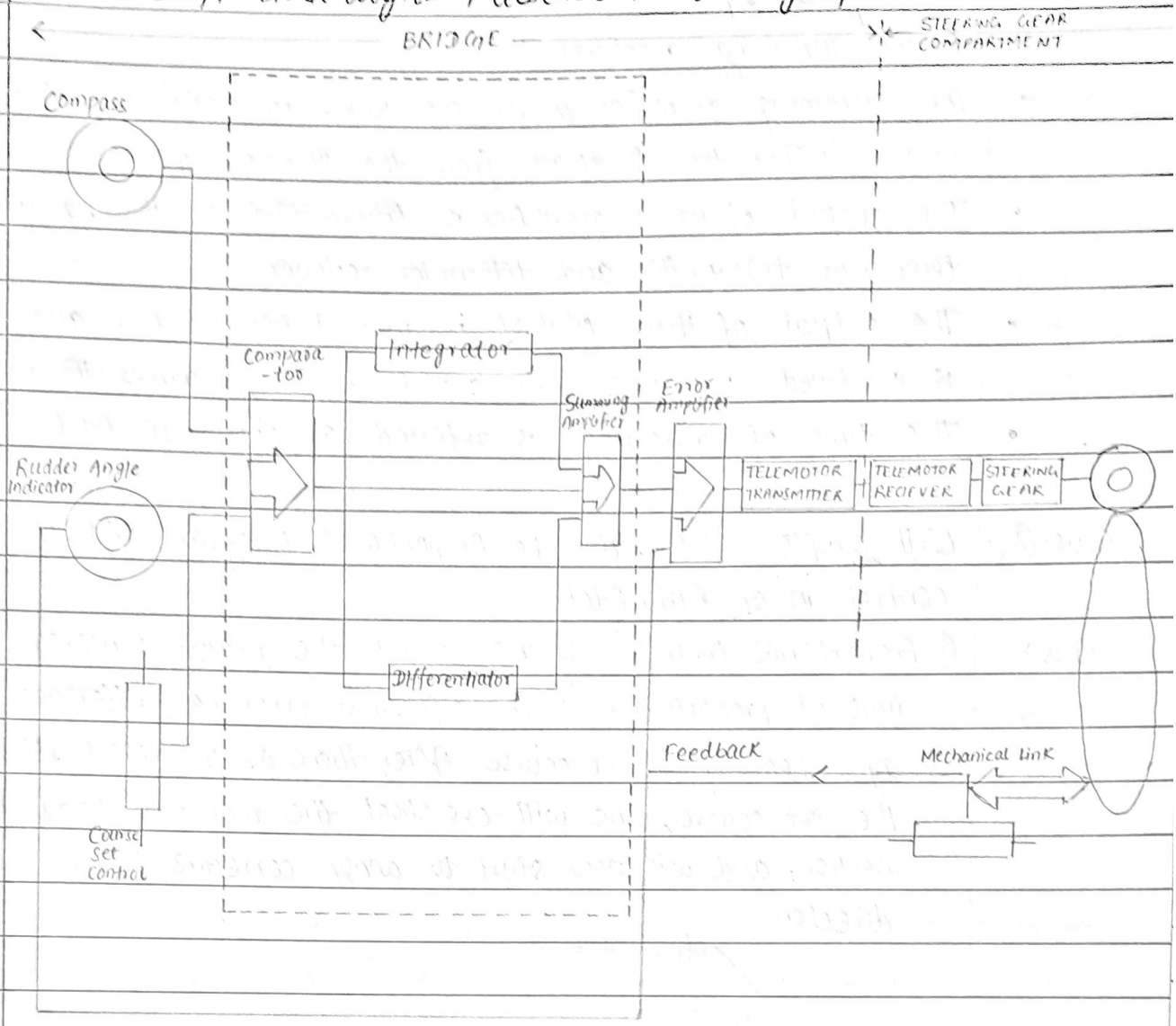
AUTO PILOT

Ques①:- With a simple block diagram, describe the working of an Auto Pilot



- The course is selected manualy by course set control. Present heading is indicated by compass. The output from the compass & signal from the course selector is fed to the comparator.
- Any difference beetween the two signals causes an output error signal whose magnitude is proportional to the difference beetween two signals. and hence comparator is also referred as proportional control which determines the amount of rudder angle to be used.
- This proportionate error signal is further fed through derivate control which take into account the rate of change of ship's deviation from set course and integral control which consider the effect of ship's parameter and external factors and set a small permanent helm when required.

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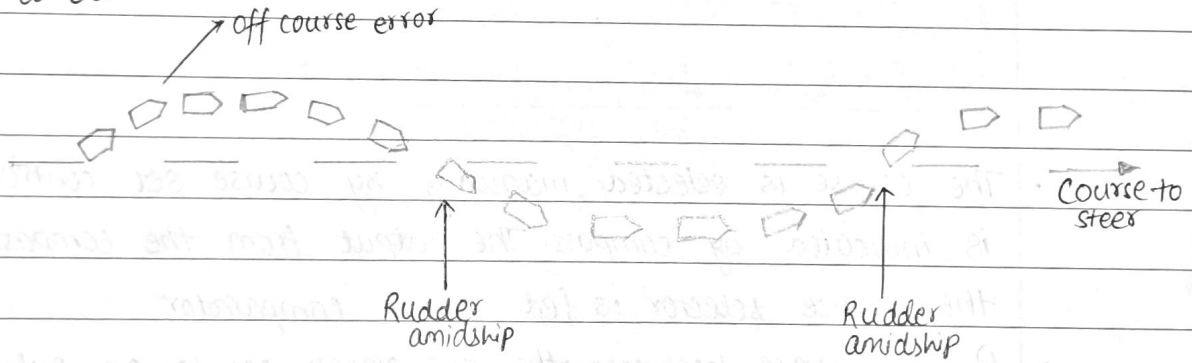
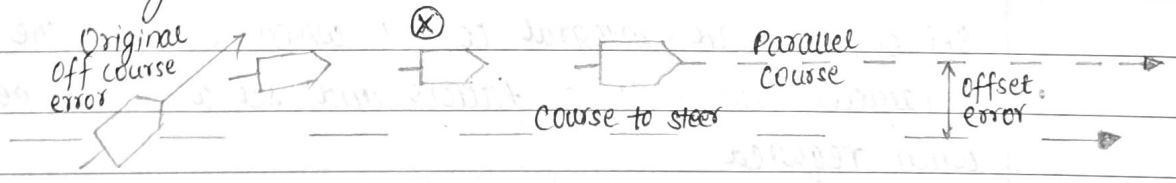
- The resultant error signals from the PID controls are then fed to the summing amplifier.
- The summing amplifier passes the signal to error amplifier which also recieves the feedback from the steering gear.
- The output of error amplifier is transmitted to steering gear via telemotor transmitter and telemotor reciever.
- The output of three controls i.e. proportional, integral and derivative is combined and resultant signal eventualy drives the rudder. This type of auto pilot is referred as PID Auto-Pilot.

Ques ② :- With simple sketch, describe Proportional, Integral and Derivative control in an Auto Pilot.

Ans :- ⓐ Proportional Control :- By this control, the rudder is moved by an amount proportional to the off-course error i.e. difference beetween gyro heading & set course. After then, as the vessel returns towards the set course, she will overshoot the required heading due to inertia, and will now start to apply corrective helm in opposite direction.



ⓑ Derivative Control :- By this control, the rudder is moved by an amount proportional to the rate of change of the ship's deviation from the set course. Any deviation of course to port cause correcting rudder to be applied to starboard.



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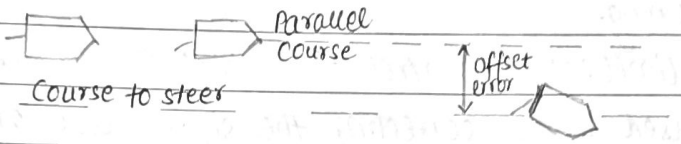
At point X, the vessel is on the same heading as the original course and the rudder will return to midship. Thus, the vessel will make good a course parallel to the original but will a small offset & will continue to do so.

© Integral control :- • There are certain errors due to design parameter of the ship like shape of hull, bow going to port when ship is making headway due to transverse thrust etc. & due to external factors like wind, current, draft, trim etc. which have to be corrected
• Data signals are produced by continuosly sensing the heading applying the appropriate degree of permanent helm.



Vessel constantly pushed off-course to Port due to wind/current etc. By Integral control, a small permanent helm to starboard will correct the offset and keep the vessel on course.

Finaly,
the output of three controls i.e. proportional, derivative, integral is combined and resultant data signals drives the rudder. This type of autopilot is referred as PID Auto-Pilot.

Ques ③:- Explain various control units in Auto-Pilot.
(OR)
Describe the function of Auto-Pilot controls. Why do they need to be adjusted for optimum performance of the Auto Pilot?

Ans:- • Course selector: is used to set the course to steer.
• Rudder control: This control is for setting the rudder response speed i.e. how quickly the rudder react to correct the deviation from set course. If the setting is too high, it will cause overshoot, and if it is too low, steering response will be sluggish.
• Counter rudder: This control determines the amount of counter action by the rudder to be used to keep the vessel steady on set course. If the setting is too high, it will cause overshoot, and if the setting is too low, it will take long time to bring the ship back on set course.

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- Yaw/weather: Sea and swell may keep physicaly tossing the vessels head to and fro. The auto-pilot apply corrective helm each time the heading deviates from set course. In bad weather, higher value should be selected which allow the vessel's head to swing through a larger arc before applying corrective helm. This prevent too frequent application of rudder while in calm weather, a low value is preferred.
- Permanent Helm: This control is used to counteract external factors which tends to push the vessel to one side. If left at zero, Integral control will apply calculated permanent helm. Manual setting allows fine tuning.
- Rudder limit: This control specifies the maximum amount of rudder to be used while correcting the ship's head or when altering the course on auto-pilot.
- Off-course alarm :- This alarm gets activates when ship deviates from the set course by a pre-decided limit, which can be fed to the equipment.
- Synchronization control: This control is to synchronize Master gyro and the repeater for auto-pilot. Normaly, it is required only if the repeater system is switched off.
- Auto/Follow up/Non-follow up :- In follow-up mode, select automatic steering or manual (hand) steering. And in case of steering failure, non-follow up mode is to be used.

Ques④:- Explain the procedure for testing "Off-course alarm" in auto-pilot.

Ans :-
- An off-course alarm is fitted in the Auto-Pilot. The off-course alarm limit angle value is to be set by OOW, usualy 10 to 15° degress.
- If the difference beetween actual course and the course set by OOW is more than the set limit value, then alarm will sound.
- The testing of the "off-course alarm" varies from maker to maker.
- In general, set the off-course alarm time, usualy 20 to 30 seconds. Change the course in auto-pilot very more from present set course.

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- The auto-pilot tries to apply the rudder and get the vessel to changed course, when there is a delay in time duration (more than 20 or 30 seconds), the off-course alarm sound.
- This process can be easily tried out when vessel is moored, when movement of rudder is ineffective.

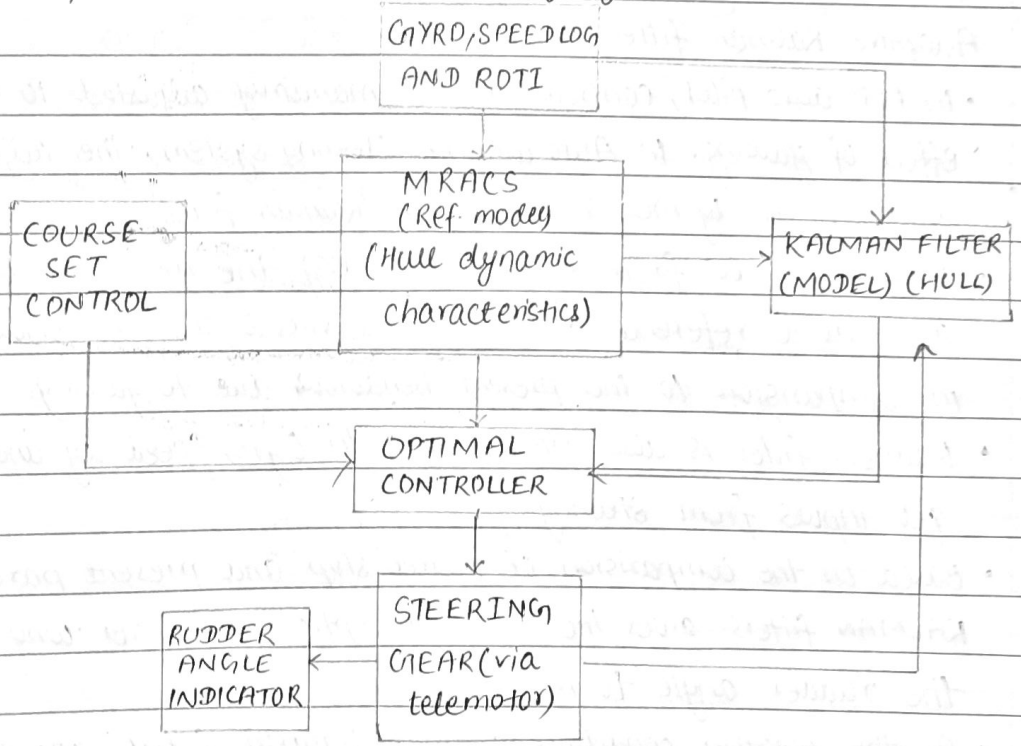
Ques ⑤:- On what occasions, auto-pilot should not to be used?

Ans:- Auto-pilot should not to be used in following condition:-

- In narrow channels
- At slow speeds
- During manoeuvring
- During pilotage
- During heavy weather condition.
- During large alteration of course.
- Near or in areas of restricted visibility.
- When passing close to vessels etc.

Ques ⑥:- With a simple block diagram, describe the working of an "adaptive auto-pilot / Auto-adaptive steering system.

Ans:-



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This is an advanced version of the PID control, which adapts to the steering capabilities of the ship as well as the weather conditions.

- Unlike of PID auto-pilot, in auto adaptive steering, the optimum steering is achieved without any manual adjustment.

UNITS OF AUTO ADAPTIVE STEERING SYSTEM:

1. Estimation unit.
   - Estimation algorithm is based on Model Reference Adaptive Control System (MRACS) which consist of reference model of the ship.
   - MRACS gets input from Gyro, Speed log and ROTI.
   - The dynamic characteristics of the hull are estimated on the basis of these inputs and signals are fed to optimum controller.
   - The feedback from steering gear is also received by MRACS.
2. Optimum controller.
   - The optimum controller calculates the rudder angle to be order based on inputs recieved by MRACS in comparison to the course selected by OOW.
   - In case of yawing, the output from Adaptive Kalman filter is also recieved, and the rudder angle is re-calculated and signals are sent to steering gear via telemotors.
3. Adaptive Kalman filter
   - In PID auto-pilot, controls have to manualy adjusted to reduce the effect of yawing. In Auto adaptive steering system, the adjustment is done automaticaly by means of adoptive Kalman filter.
   - It gets inputs from MRACS regarding the model of the ship. This acts as a reference as to how the vessel should behave normaly in comparision to the present behaviour due to yawing.
   - Kalman filter is also interfaced with Gyro, Speed log and ROTI, also get inputs from steering gear.
   - Based on the comparision of model ship and present parameters, the KALMAN filters gives the output to optimal controller who further calculates the rudder angle to be ordered.
   - As the weather condition changes, Kalman filters adapts these change and output will vary accordingly. Thus, human intervention is not required.

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Ques⑦:- Explain the various modes of Auto adaptive steering system.

Ans:- Auto adaptive steering system has the following modes:-

- Course Keeping mode
- Course changing mode

ⓐ Course Keeping mode

- In this, there is open sea mode and confined mode
- In open sea mode, it is preferred for course keeping with least use of rudder, even permitting a little meandering (झीलदार)
- In confined mode, it is preferred for course keeping with accuracy of maintaining the ship on course line, even if by using large rudder angles.
- The switching beetween them can be done with the help of couse keeping knob on the Auto control Unit

ⓑ Course changing mode

- The MRACS is used in the course changing control algorithm.
- The important feature is that the course changing is achieved with constant rate of turn technique using minimum rudder angle and hence speed reduction will be minimun.

Auto adaptive steering can be interfaced with GPS or ECDIS & alteration of the course can be achieved automaticaly.

GYRO COMPASS

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GYRO COMPASS

Ques①:- Explain following terms with respect to gyro compass:-

@ Precession of Axis

It is the angular displacement of the spin axis of the gyroscope when a torque is applied to the spin axis. When a torque is applied to it's spin axis, the resulting displacement of the spin axis will not be in the direction of the applied torque, but in direction perpendicular to it. The direction in which spin axis will precess will depend on the following factors:-

- Direction of the spin of the wheel
- The point at which the force is applied to the spin axis
- The direction in which the force is applied

The torque works along the direction of rotation at a point, 90° away from the point of application of torque

Precession ∝ Applied Torque/~~Angular momentum~~

** ⓑ Tilt & drift

It is the result of precession of the axis

When a torque is applied in the vertical axis, the resultant precession is in the horizontal plane. This horizontal movement of the spin axis is called as drift of the axis

When a torque is applied in the horizontal axis, the resultant precession is in the vertical plane. This vertical movement of the spin axis is called as tilt of the axis

The rate of tilt & drift is given by formula:

Tilting = 15' cos lat x sin Azimuth per minute of time

Drifting = 15' sin lat per minute of time.

Ques②:- ~~Describe any two properties of a free~~ What is a free gyroscope? What are the important properties of a free gyroscope?

Ans:- Gyroscope having three degrees of freedom is called free gyroscope.

i.e. (i) It is free to spin about spinning axis i.e. spin

(ii) It is free to rotate about vertical axis i.e. drift

(iii) It is free to rotate about horizontal axis i.e. tilt

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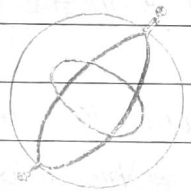
A heavy metal rotor is mounted on a circular ring in the same plane as its spin axis. This ring is connected to the vertical ring at points perpendicular to the spin axis. This vertical ring is connected to the outer ring at points perpendicular to the horizontal axis.
The whole system is balanced so that the center of gravity is the point of interaction of the three axis.

Properties of a free gyroscope are :-

(a) Gyroscopic inertia or rigidity in space

A freely spinning gyroscope will maintain its axis of spin in the same direction with respect to space irrespective of how its supporting base is turned. It resists any attempt to change its direction of spin. Thus, a free gyroscope has high directional stability.
This property of the free gyroscope is known as gyroscopic inertia or rigidity in space. This is due to the law of conservation of momentum.



(b) Gyroscopic Precession

- It is the angular displacement of the spin axis of a gyroscope when a torque is applied to spin axis. When torque is applied to it's spin axis, the resulting displacement of the spin axis will not be in the direction of the applied torque, but in direction perpendicular to it.
- Any external force which acts on the rotor may be resolved into components about three axis i.e. spin axis, horizontal axis & vertical axis. So, when a torque is applied to vertical axis will create precession and cause horizontal movement of the spin axis. When a torque is applied to the horizontal axis will create precession and cause vertical movement of the spin axis.
- The vertical movement of the spin axis is called as tilt of the axis & the horizontal movement of the spin axis is called as drift of the axis.

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Ques ③:- Describe the errors of the GYRO compass

(OR)

Using sketches, describe how the following errors of gyro compass are calculated & compensated for:-

ⓐ Course, speed & latitude error ⓑ Latitude or damping error

Ans:- There are two main errors of gyro compass for which compensation must be made for the use.

a) Latitude error (Damping error) (Tangent error)

b) Course, speed and latitude error (steaming error)

(A) Latitude error (Damping error)

- Damping error is applicable for gyro compass damped in tilt which settle with a displacement from the meridian. The gyro compass damped in azimuth will not have this error. The magnitude of this error determined by design and construction of individual compass.
- Damping error is proportional to the tangent of the latitude.
- Damping error will be easterly in the NH & westerly in the SH and nil at the equator.
- The errors are generaly controlled by a potentiometer knob on the gyro compass control panel & has to be set depending on the latitude the vessel is in.

(B) Course, speed and latitude error (steaming error)

(i) When ship is stationary, gyro compass settles in N/S direction.

(ii) When ship is moving the gyro compass will settle in false meridian not true meridian depends on ship's course, speed & latitude.

(iii) This ship's velocity produce a false tilting of spin axis. If the course is E-W, there will be no such false tilting due to earth rotation from west to east.

(iv) For a vessel steaming northwards, false tilting will be upward & compass will settle to the west of true meridian.

(v) For a vessel steaming southwards, false tilting will be downward & compass will settle to the east of true meridian.

(vi) This error increases with latitude.

(vii) In exactly E-W courses, error is NIL. In exactly N-S courses, error is maximum.

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(viii) This error can be corrected automatically by a mechanism which moves the lubber line by an amount equal to the error, or it can be found from correction tables provided by manufacturer.

Ques ④:- What care and maintenance is to be carried out on Gyro Compass.

Ans:- Care and maintenance of the gyro compass is to be carried out as per manufacturer's manual. Few of the points are listed below:

(i) Ensure all gyro repeaters are synchronized with the master gyro atleast every watch.

(ii) If in manual mode, speed and latitude correctors are to be applied properly during every watch.

(iii) Gyro errors are to be obtained every watch.

(iv) Check all alarms, electrical connections are in good working order

(v) Check gyro compass for any abnormal operation.

(vi) Annual servicing of gyro compass to be done by shore based authorised service technician.

Ques ⑤:- How is the gyro compass system made north seeking?

Ans:- (i) In order to damp unwanted oscillation, we need to achieve damping in tilt

(ii) This is done by means of offset slight to the east of vertical, resulting in same force producing the required torque

(iii) The magnitude and direction of this force is pre-calculated to achieve the required damping oscillation.

(iv) The amplitude of each oscillation is reduced to $1/3^{rd}$ of previous oscillation

(v) The spin axis reaches equilibrium and settles in a position at which control precession counteracts drifting & damping precession counteracts tilting.

(vi) Finally the gyro settles in the meridian & becomes north seeking

Ques ⑥: Explain the starting procedure of a Gyro Compass.

Ans:- ⓐ A gyro needs time to settle on meridian. Time taken will depend on make, model and geographical location of the gyro.

ⓑ The settling time may be beetween one & several hours.

ⓒ Refer to the manufacter's manual before switching on the gyro. Note Gyro once switches off, take atleast 4 hours to bring it in use.

Procedures:-

- Check that all supply switches are open.
- When power on, prior entering the settling mode, system performs automatic procedure to determine wheather equipment is operating within specified parameters. Adjust the latitude & speed setting accordingly.
- If gyro is stationary, the system opt for cold start & if rotating, hot start is programmed.
- During a cold start, if the heading data is not entered within 5 minutes, the gyro switches to an auto level process. In that case, gyro will settle within 5 hours

If the heading data is fed, the rotor automati-cally revolve. The rotor is brought upto required speed & gyro will settle within 1 hour.

- Once gyro is settled, synchronize the repeaters.
- Gyro errors to be obtained every watch.

Ques ⑦:- How will you convert a free gyroscope to a north seeking gyro compass?

Ans:- For converting a free gyroscope to gyro compass:-

- 1° of freedom has to be trimmed down from it.
- To restrict the free gyro from drifting & tilting, there are two ways:
  - Liquid ballistic arrangement
  - Top or bottom heavy arrangement

In liquid ballistic arrangement, it comprises of pair of pots and a pipe interconnecting them which is mounted on gyro case which tilts with the gyro spin axis. This pots contains liquids having great specific

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gravity such as mercury. With such a ballistic, a north-seeking action of gyro is carried out by flow of the liquid between two pots.

In bottom or top heavy arrangement, simply we can do so by adding extra weight to lower part

- It is still unsuitable for use a gyro compass, because it does not indicate North continuosly. To make the gyro settle and point to a fixed direction on earth, it is necessary to introduce further precession which will dampen the gravity controlled elliptical path.

There are 2 methods of damping used:

(i) Damping in tilt: In this method, a force is applied in the horizontal plane which causes precession in vertical plane, reducing the tilt. There is also some damping error in this. i.e. equal to Tan(Latitude)

(ii) Damping in azimuth: In this method, the damping precession opposes the movement of the gyro spin axis when it is moving away from the meridian and assists the movement when moving towards the meridian

- When these stuffs are added to the freegyroscope, it is then ready to act as a gyro compass.

MAGNETIC COMPASS

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MAGNETIC COMPASS

Ques ① :- Write short notes on Magnetic compass.

Ans :-

- The magnetic compass is an instrument used on-board ship for determining direction on the surface of Earth by means of a magnetic pointer that aligns with Earth's magnetic field.
- It is exactly on the centre line of the ship fitted on monkey island.
- It is used as a primary means of direction indication & hence also known as standard compass
- They are of two types:

ⓐ Dry card compass : is used in olden days.

ⓑ Wet card compass : is used now-a-days. For steering, an optical projector system is fitted through which compass can be seen by helsman one deck below in the bridge, clear enough to steer the ship.

Ques ② :- What are advantage of wet compass card over dry compass card?

Ans :-

- The dry compass card is sensitive to rowing and pitching & even the small movement of vessel cause dry card to oscillate and vibrate. It is very difficult to take the reading.
- In wet compass card, these problems are rectified. The oscillation & vibration are damped, without loss of accuracy, by immersing the card in liquid.
- The liquid helps to support the mica card, which pivots about its centre and floats in the liquid.

The liquid reduces pivot friction & thus reducing the vibration of the card caused by the motion of the vessel.

Ques ③ :- Explain the function and various parts of a wet card magnetic compass with diagram?

Draw a neat sketch of magnetic compass bowl & level different parts of it.

Ans :- Function of wet card magnetic compass :

Same as in Q.2

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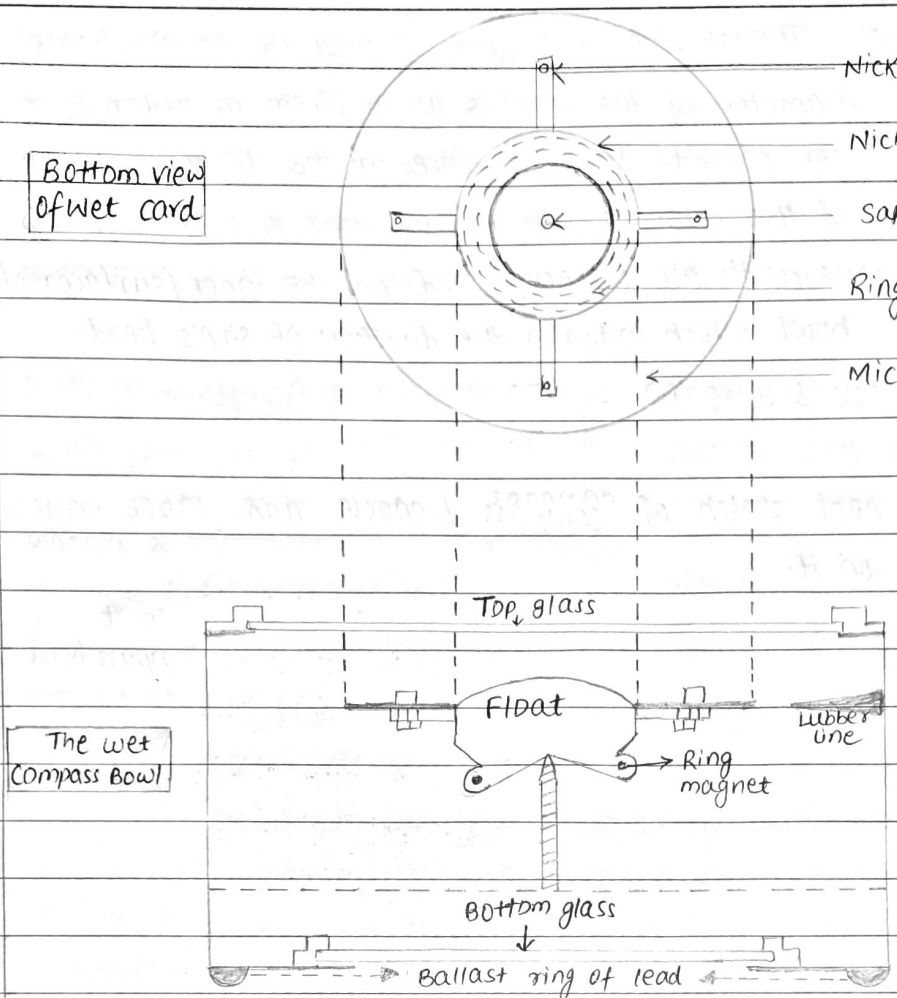

Parts of wet card magnetic compass:

- The card: The wet card is made up of mica & is only about 15 cm in diameter. The card is attached to nickel-silver float chamber that has a sapphire cap. The sapphire has a polishing effect which gives frictionless support & smooth rotation of compass card.
- The directive element: It is a ring magnet fitted around the base of the float. The ring magnet offers less resistance to movement and causes less turbulence.
- The liquid: The oscillation & vibration of card are damped by immersing the card in liquid consist of distilled water and pure ethyl alcohol. This mixture has the following properties:
  (a) Low freezing point i.e. about -30°C
  (b) Small coefficient of expansion.
  (c) Does not discolour the card
  (d) Low relative density i.e. about 0.93

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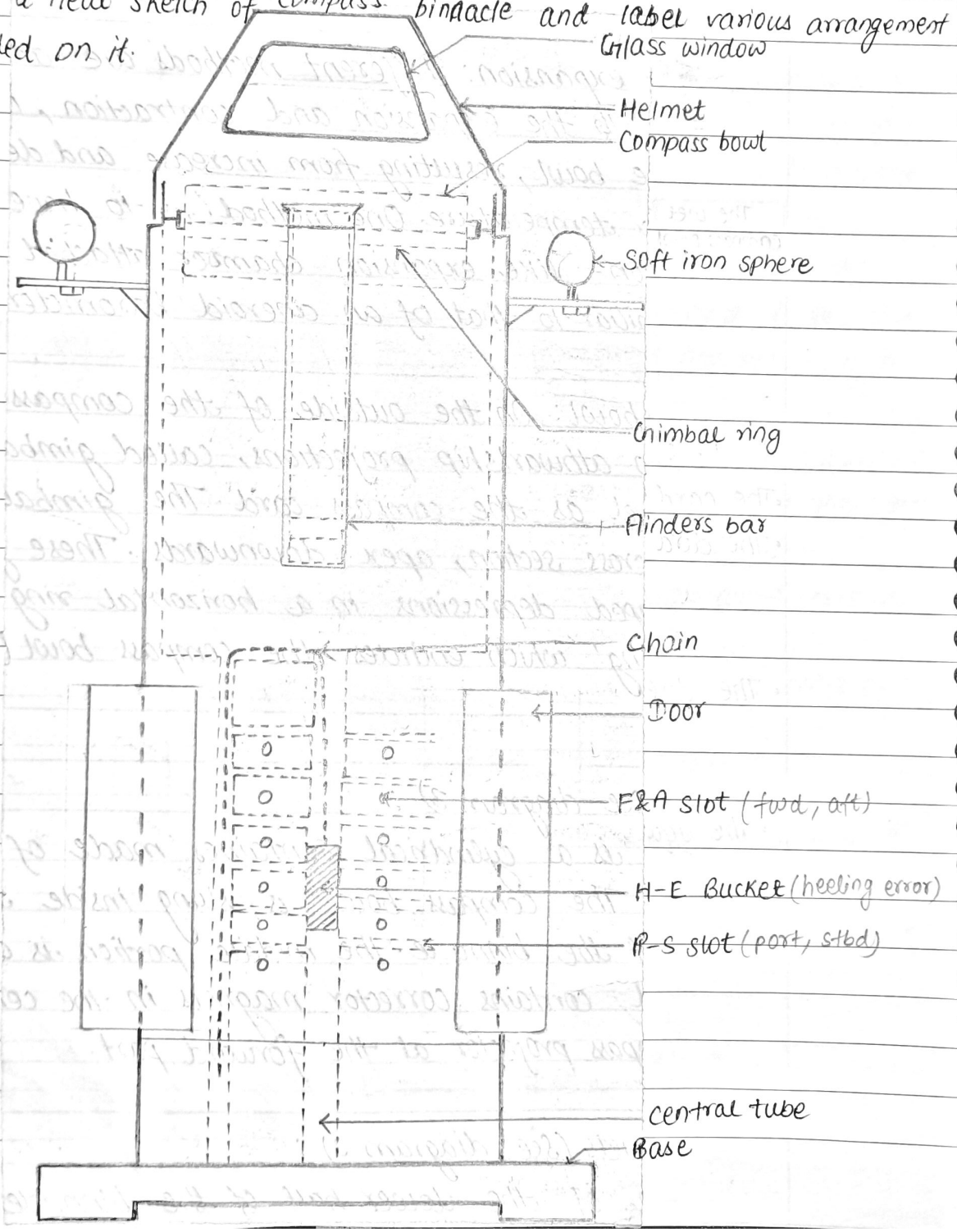
- The bowl : Though the wet card is only 15 cm in diameter, the diameter of the bowl is about 23 cm in order to reduce disturbances caused by turbulence in the liquid during rotation of the card. The top of the bowl is of transparent glass.
- The lubber line : It is the line placed on the inner forward part of compass bowl which indicates the direction of ship's head.
- The binnacle & correctors : Explained in next question.

Ques ④:- Draw a neat sketch of compass binnacle and label various arrangement provided on it.



The binnacle is a cylindrical container made up of non-ferrous metals. No magnetic materials are used in its construction. The compass bowl is slung inside the top portion of binnacle. The middle portion is accessible by door which contains corrector magnets in the centre and compass projector in forward of it.

Ques⑤:- With the help of neat sketch describe various types of soft iron rods which could be present around the magnetic compass.

Ans:- Correctors magnets inside the binnacle is to offset undesirable magnetic effects caused by the ship's steel hull. They are adjusted by qualified compass adjuster during the compass adjustment of ship.

The various types of soft iron rods which are present around the magnetic compass are as follows:-

(a) Heeling correctors: It is a vertical permanent heeling magnets in the central vertical tube beneath the compass

(b) Fore & aft "B" permanent magnets inside the F&A slot

(c) Athwartship "C" permanent magnets inside the P-S slot

(d) Flinders bar: It is a vertical soft iron corrector fitted vertically in the forward or aft part of binnacle depends on which side there is more superstructure. It compensates for ship's steel permanent magnetism.

(e) Quadrantal correctors: These are two soft iron sphere attached to the port and starboard side of the binnacle. to correct the quandrantal deviation.

Ques⑥:- Describe with a simple sketch, the optical system of a magnetic compass binnacle. What is the main feature of this system with respect to the image seen by the helsman?

Ans:- For steering, the optical system of a magnetic compass binnacle also known as compass projector is fitted through which relevant part of the compass card and the lubber line can be seen by helsman one deck below in the bridge, clear enough to steer the ship.

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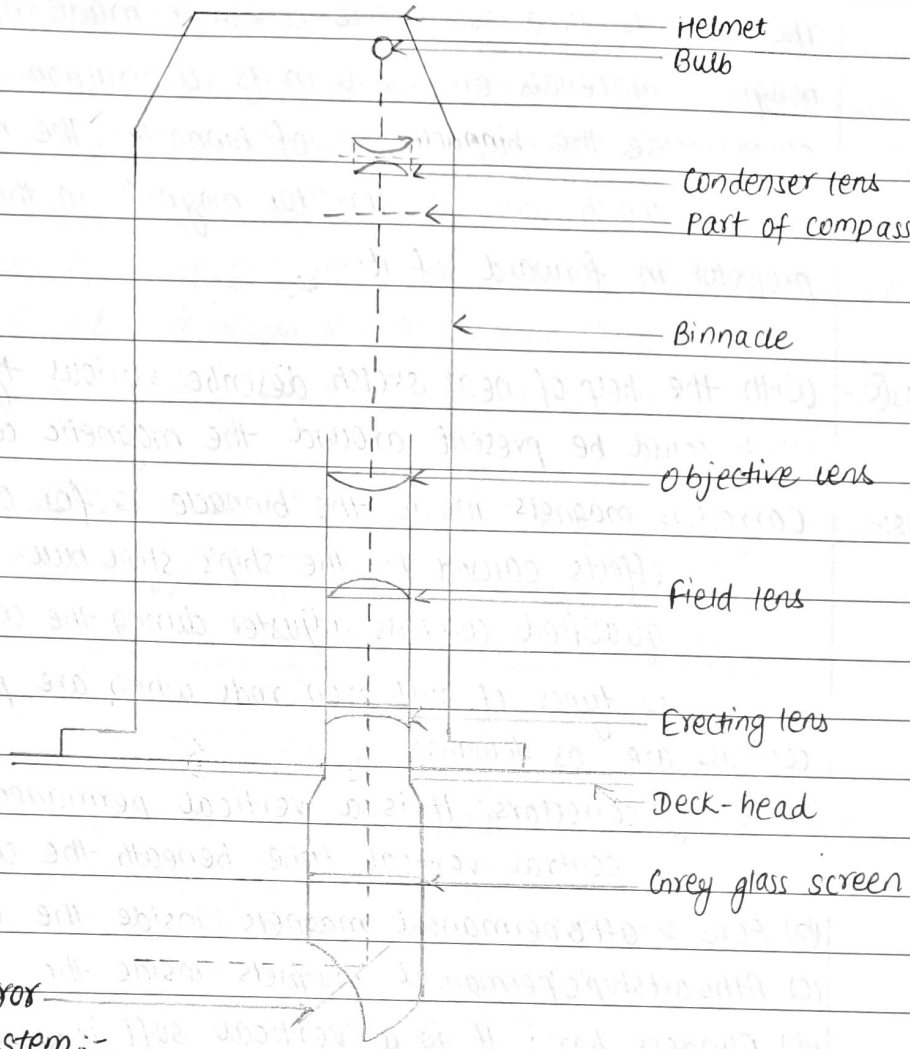

The optical system :-

- Light from the electric bulb passes through the condenser lens.
- The bulb is fitted at the centre of upper condenser lens which sends down the light as a parallel beam through the lower condenser lens
- The beam then passes through the transparent compass card and down the tube
- The relevant part of the compass card and lubber line is then magnified by objective lens & a field lens but the image available is inverted. (lubber line seen aft)
- Hence, the beam is passed through erecting lens and grey glass screen & the image is now correct as seen from below (lubber line seen fwd) but the number on the card is inverted.
- To correct this, image is viewed through mirror. & can be adjusted according to the helsman requirement like angle, brilliance etc.

The main feature of this system with respect to the image seen by helsman is that it appears as seen from above the compass card. It can also be adjusted according to the height of the helsman.

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Ques (7):- What are the care and maintenance to be done for a magnetic compass?

Ans:-
(a) Doors giving access to the corrector magnets should always be kept closed
(b) The soft iron spheres (quadrantal correctors) and their brackets should be painted to prevent rust.
(c) If the binnacle is of wood, it should be varnished and not painted, as painting may cause doors to jam.
(d) Brass parts of the binnacle should be regularly polished.
(e) All magnetic materials and electrical wires should be kept as far as possible away from the compass.
(f) The helmet of binnacle should always be in place except when bearings are actually being taken. Cover it again after use.
(g) If bubbles may develop in the wet compass bowl, it has to be removed at the earliest possible time.

Ques (8):- Describe the procedure for removing air bubble from Magnetic compass.

Ans:- A bubble can form in the magnetic compass bowl due to leakage of some of the liquid. This is rare occurence and can be cured by following manufacturer's instruction.
Below are the procedure for most compasses:
(a) Tilt the bowl until the filler hole comes uppermost. This hole is provided on the side of the bowl.
(b) Unscrew the study screw provided.
(c) Top up with distilled water and pure ethyl alcohol. If not available, only distilled water can do.
(d) Screw the study screw back in place
(e) Gently let the bowl return to upright.

Ques (9):- What is Dip? How compass card is kept horizontal in varying latitudes?

Ans:-
- The vertical angle contained beetween the horizontal and the direction of the Earth's magnetic field at any given place is called the Angle of Dip.
- It results due to tendency of a magnet to align itself from magnetic field lines.

- The dip is considered positive when the north end of a freely suspended magnetized needle dips below the horizontal & is considered negative when south end of needle dips below the horizontal.
- Dip is greatest near the poles and least near the Magnetic equator

(b) The weight of card and magnets is supported partly by buoyancy and partly by an iridium point fitting into sapphire cap. The point of support is above the centre of gravity of the card, so that the card remains horizontal in all latitudes.

Ques (10):- Explain why the value of deviation of a magnetic compass changes with the change in ship's heading.

Ans:-
- The ship during the construction stage or repair will acquire permanent magnetism (due to the energy imparted when cutting or welding) while sitting stationary in the Earth's magnetic field. When (launched, it loses some of the magnetism due to vibration and pounding and it reaches to a stable magnetic condition. That remaining magnetism is known as Permanent Magnetism of the ship.
- Permanent magnetism generally remains more or less same for entire life unless the ship undergoes any major repair or steel renewal. Its forces does not changes with the change in heading. Its forces does changes but very slowly, over the time due to ageing etc. which is known as sub-permanent magnetism.
- In addition to this, a ship acquires induced magnetism when placed in the Earth's magnetic field. The force of the induced magnetism depends on Ship's heading, intensity of earth's magnetic field and the physical properties of the ship's steel.
- At any point, magnetism of the ship is the sum of permanent, sub-permanent and induced magnetism.

Hence, the amount of deviation caused by these magnetism differs at different heading causes different deviation at different heading.

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*Ques (11):- Why the vessel is required to swung once a year to verify magnetic compass deviation card?

Ans:-
- Over a period of time & after certain events, the addition or removal of equipments or carraige of magnetic cargo such as iron ore, the vessel's magnetic field can change
- After one or two year, deviation may be recorded as high as 30 to 40 deg
- In this case, magnetic compass have to be examined and adjusted by an approved compass adjuster.
- Since value of deviation changes with change in ship's heading, vessel required to swung, adjusted and a new deviation card should be issued.

Ques (12):- Write short notes on Variation & Deviation, True North & Magnetic North

Ans:-

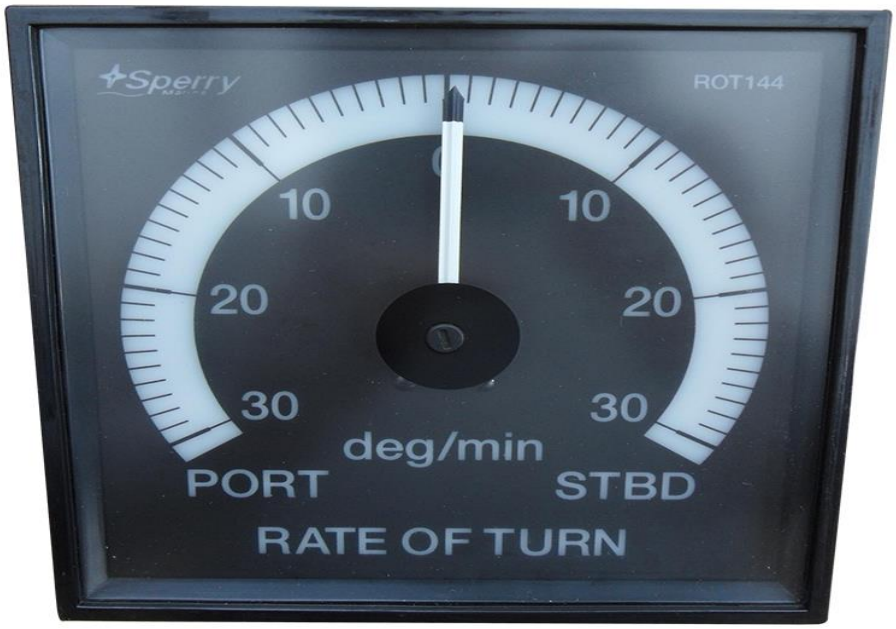
Variation:
- The angular difference beetween the true north and the magnetic north is known as variation.
- The ~~value~~ of variation varies at different location, given in compass rose of paper chart which are. It is same for all the ship.
- Variation is suffixed by "East" or "west"

Deviation:
- Because of the ship's magnetic effect, the compass needle deflected from magnetic north to compass north.
- The angular difference beetween the magnetic north and the compass north is known as deviation.
- The deviation changes with the change in ship's heading. It varies from ship to ship.
- It can be minimised by precisely positioning corrector magnets close to the magnetic compass.
- It needs to be adjusted & a new deviation card issued at maximum two year interval.

True North: True north is the direction that points directly towards the geographic north pole.

Magnetic North: Magnetic north is the direction in which compass needles points to, as it align itself with Earth's magnetic field.

Course Recorder & ROT



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COURSE RECORDER

Ques ①:- Explain purpose and working of a course recorder.

Ans:-

- The main purpose of the course recorder is to automatically record the course of the ship that is being steered.
- It is also used as a evidence purpose in case of any accident.
- The time maintained on the course recorder is the UTC.
- It takes data feed from the gyro compass repeater which is connected to it to control the spirally grooved drum, which moves the course & quadrant stylus.
- The clock is connected to the paper feed roller which control the speed at which paper is pulled under the stylus so the time graduation on the recording paper move at correct speed.
- Recorder should be switched off while in port
- Prior departure, during control testing, the course recorder should be set to correct GMT & to be synchronized with correct gyro heading.
- Every watch, OOW should check whether the correct course is being recorded & pens are full of ink.
- OOW should ensure that the course recorder should not run out of paper.

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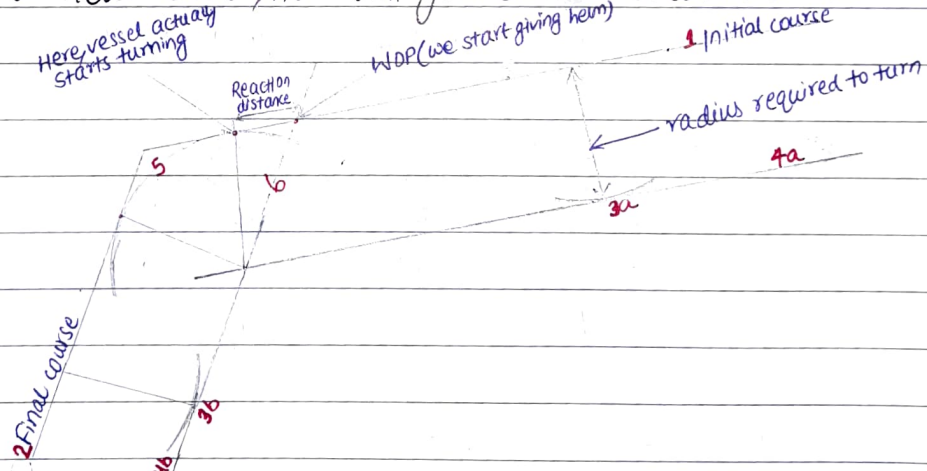
RATE OF TURN INDICATOR

Ques ①:- Explain the use of Rate of Turn Indicator.

Ans:-

- ROTI is a equipment which indicates the (instantaneous) rate at which the ship is turning in degrees per minute.
- It is used to turn a vessel at a steady rate of turn, which is very important in pilotage water.
- It is integrated with steering repeater/auto-pilot & from the input it works out the rate of turn.
- The dial is usually marked 0 to 60° per minute on either side. As per IMO, perfo-rmance standard, the dial should be marked not less than 0 to 30° per minute on either side.
- As we all know, when ship turns, she actually travels some distance round the arc of a circle and cannot execute a sharp turn at a point. Thus, navigator turn the ship along that arc at a constant rate of turn until steady on a new course & hence helsman need to know the rate of turn which are indicated in this equipment.
- IMO recommends, any large alteration of course to be planned with constant radial turn & wheel over point marked.

Ques ②: Show with a neat sketch, how will you execute a constant radial turn?



- As the vessel approaches the W/O point, put the wheel over to the side of the turn and mark the speed.
- As the vessel starts to turn, the speed will drop & as the speed drop adjust the rudder angle and ROT as calculated.
- As she comes out of the turn, speed will increase & hence ROT will again need to be adjusted till she comes on her final course.

GPS & DGPS


FURUNO GPS/WAAS NAVIGATOR
SIM 30–APR–07 06 : 02 : 43
47°37.104' N
122°26.060' W
SPD: 1.0kt
CSE: 321°
MENU
ENT
DISP
GOTO
MARK MOB
GP–32
DIM PWR
FURUNO

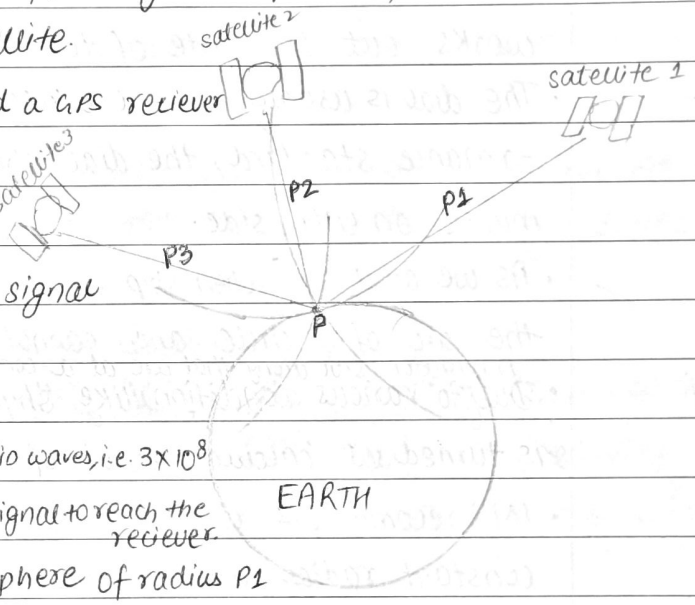
GPS

Ques ①: Describe the principle & working of GPS.

Ans:-

Not so Imp.

- GPS works on the principle of "Ranging"
- The GPS reciever calculates its position by comparing its own self generated timing signals with timing signals sent by orbiting GPS satellites.
- By formula, distance = velocity x time ; the time taken by satellite signal to reach the reciever is multiplied by the speed of radio waves which gives the range of the satellite.
- Consider satellite 1, 2 & 3 and a GPS reciever on earth. Lets say, satellite 1 transmit signal at time 't' and the GPS reciever picks up the signal at time t_1



Then, Range (R) = $V \times (t - t_1)$

V = velocity of radio waves, i.e. 3×10^8

$t - t_1$ = time taken by signal to reach the reciever.

Thus, we are on surface of sphere of radius P1

- Similarly we can get P2 & P3 using satellite 2 & 3. Since, we know location of all 3 satellite in space, we get three range (radius) that intersect at P, which is the position of the GPS reciever.

Ques ②: ~~*~~ (a) How does GPS reciever determines ship's position & speed. (4 times)
(b) What do you understand by pseudo range & true range.

Ans:- (2.a)

- The satellite transmits the signal in 2 frequencies
  L1 signal - 1575.42 MHz - consist of both C/A code and P-code
  L2 signal - 1227.6 MHz - consist of only the P-code.
  Each satellite transmitts Pseudo random noise (PRN) signals on these two different frequencies.
- The PRN code (P-code or C/A code) identifies the satellite to be used.
- The satellite transmits a Navigation message containing GPS date & time, data to determine position of the satellite in the orbit and alamanac data to give information regarding other satellites.
- The PRN code & navigation message are superimposed by Phase modulation onto a carrier frequency (L1 and L2) that is picked up & decoded by reciever.

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- The recieved locks on to one satellite and from this satellite, it obtains the alamanac of all the other satellite and choose the most suitable one for position fixing.
- Then, the time taken by satellite signal to reach the reciever is multiplied by the speed of radio waves which gives the range of the satellite. Thus, the position can be obtained after measuring distance beetween GPS reciever and the selected GPS satellite.

Ans for 2(b)

- Since it is not possible to precisely synchronize satellite clock and reciever clock, so the range calculated will have some error. These are known as Pseudo (false) range. Hence, the additional satellited is used to obtain True range. It is obtained by solving 4 equation.
- There are four unknown of the user i.e. x, y, z and Δt (lat, long, altitude & error in time)
- The position of the satellite S_1 (x_1, y_1, z_1) is known to the user by 30 sec navigational message, which gives the following equation:

$$PR_1 - (C \times \Delta t) = \sqrt{(x_1 - x)^2 + (y_1 - y)^2 + (z_1 - z)^2}$$

- Similiar equations are obtained from other three satellites (S_2, S_3 & S_4), they are:

$$PR_2 - (C \times \Delta t) = \sqrt{(x_2 - x)^2 + (y_2 - y)^2 + (z_2 - z)^2}$$

$$PR_3 - (C \times \Delta t) = \sqrt{(x_3 - x)^2 + (y_3 - y)^2 + (z_3 - z)^2}$$

$$PR_4 - (C \times \Delta t) = \sqrt{(x_4 - x)^2 + (y_4 - y)^2 + (z_4 - z)^2}$$

where, PR is pseudo range obtained from each satellite.
$C - \Delta t$ is error in range calculated

- Hence by solving the above four equation, a 3D fix (lat, long & altitude) can be obtained. For navigating a ship, a 2D fix (lat, long) is only required which is obtained by solving only 3 equations using only 3 satellites.
- On board GPS reciever has a processor that solves these equations.

By use of GPS signal, speed of the vessel can also be determined by following two methods:

(a) The doppler shift in recieved GPS signal can be used to calculate the relative speed of reciever w.r.t the satellite.

(b) The average speed can also be calculated by measuring the difference beetween two succesive position.

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Ques ③ Explain how the frequency used by GPS satellites can also be used to determine the speed of the vessel.

Ans :-

- The carrier frequency is used to determine the speed of the user by measurement of Doppler Shift i.e. change in frequency recieved when the distance beetween the satellite and the user is changing due to the relative motion beetween the two.
- The position and velocity of the satellite & the position of the user are known to the user's reciever.
- The reciever calculates the satellite speed vector in the direction towards the user.
- The relative approach speed beetween the satellite and the user's speed (based on the Doppler shift measurement) is not equal to the satellite speed vector towards or away from the satellite.
- Similarly, by other two satellites, the reciever can calculate the other two satellite speed vector which will be towards or away from their respective satellites.
- These 3 satellite speed vectors are resolved within the reciever and the speed of the user is calculated.

Ques *** ④: Describe the contents of Navigation message in GPS. (5 times)

Ans :-

- Each satellite transmits a navigation message of 30 seconds in the form of 50 bits/sec data frame.
- This data is different for each satellite & is previously supplied to it by Master Control Station.
- Navigation message is divided into 5 sub-frames each of 300 bits, transmitted at 50 bits/sec takes 6 seconds to transmit.
- Each subframe start with 'Telemetry' word containing the satellite status, followed by HOW (Hand over word) which enables the reciever to acquire the code.

Remaining parts of subframe contains:

(a) 1st sub-frame contains data related to satellite clock correction

(b) 2nd & 3rd sub-frame contains satellite empheris defining the position of the satellite.

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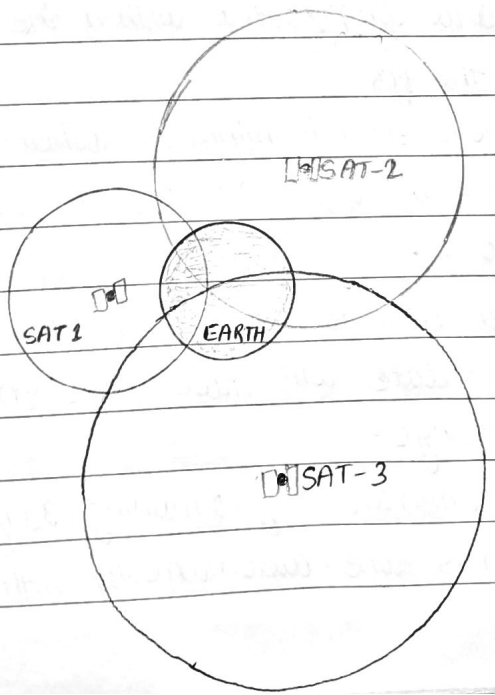
(c) 4th sub-frame passes the alpha-numeric data to the user and will only be used when upload station want to pass specific message.

(d) 5th sub-frame give almanac of all other satellites, thus allowing the user to choose the most suitable one for position fixing.

Ques⑤: Why shipboard reciever need to track minimum of three satellite for position?

Ans:-

- A GPS reciever must lock-on to four satellites to get a 3D fix (lat, long, altitude) in which three satellites are used to get position & altitude and the fourth satellite is used to synchronize the reciever clock & the satellite atomic clock.
- For navigation, we require a 2D fix (lat, long) & for that a minimum of three satellite is which two satellites are used to calculate the position and the third satellite is used to synchronize the reciever clock & the satellite atomic clock.
- If a reciever picks up a signal from a satellite and reciever know that it is 20000 km away, that means reciever must be somewhere on a sphere of radius 20,000 km, having that satellite as a center.
- With two signals from two different satewite, the reciever must be somwhere where two spheres meet.
- Three signals puts the reciever at one point & confirms the reciever position. So the reciever need minimum of three satellite to calculate its position.



Ques⑥: What are the various alarms of the GPS.

Ans:- The various alarms of the GPS are as follows:

(a) Arrival alarm: It informs the navigator that vessel is approaching a destination waypoint.

(b) Anchor watch alarm: It warns the OOW that vessel moves beyond set limit from anchored position.

(c) Cross track error (XTE) alarm: It warns the OOW that vessel is off the intended course.

(d) Speed alarm: It informs the navigator that vessel's speed is higher than the set range.

(e) Trip alarm: It informs the navigator that distance run is greater than trip alarm setting.

(f) WAAS/DGPS alarm: It warns the OOW that WAAS/DGPS signal is lost.

Ques: What is clock-bias error? Ans:- There are two clock-bias error (i) User clock error (ii) Satellite clock error. (3 times)

Ques⑦: What are the various errors of the GPS? (OR) What factors affects the accuracy of a GPS position?

Ans:- Errors of GPS:

(i) Atmospheric error: • Due to different atmospheric condition in earth's different layer, the speed of GPS signal is affected which causes difference in time taken and hence fix will not be accurate.

• Each satellite transmits its signal in two frequency (L1 & L2) and hence a dual frequency reciever recieves both the frequency & error is calculated and compensated within the reciever which improve the accuracy of the fix.

• The atmospheric error is minimum when satellite is directly overhead and is maximum when satellite is near the horizon.

(ii) User clock error: •

• If the reciever clock is not precisely synchronized with satellite clock, the range calculate will have some error. This is known as pseudo (false) range.

• This error is eliminated by obtaining range from minimum three satellite which is done automatically within the reciever.

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(iii) Satellite clock error

- This error is caused due to difference in satellite clock's w.r.t GPS time.
- Error in satellite's clock is monitored by ground based station which passes the information to Master Control Station, who then upload the clock data to the satellite as part of the Navigation Message (1st sub frame)

(iv) GDOP error

- The angular seperation beetween satellites determine the accuracy of fix. Wider the angular seperation beetween satellites, the better is the accuracy of fix.
- Knowing the positions of the satellites from alamanac data of navigation message (5th sub-frame), the reciever automatically select the suitable satellite based on their geometry and elevation.
- GDOP values are displayed on the reciever unit.

(v) Multipath error.

- This error is caused when signals are recieved indirectly from some obstructions like building, walls, becons etc.
- When both direct and indirect signals recieves at slightly different time, both the signal mixed cause distortion of signal, thus leading to error.
- Positioning of antenna at right place will eliminate this error.

(vi) Orbital error.

- The satellites are monitored by the ground station and their paths are predicted. However, some satellite may deviate from their predicted path cause small error in position.

Ques (8):- Write the functions of various segments of GPS? What is clock bias error? (3 times) OR, w.r.t GPS, explain space segment and ground segment (OR) Describe the feature and function of the ground control segment.

Ans:- The GPS consist of 3 segments - Space segment, Ground segment, User segment

Space segment:

- It consist of 24 operational satellites evenly placed in 6 different (plane) orbits. These planes are inclined at an angle of 55°.
- These satellites are launched at a height of 20,200 km above the earth's surface. It takes 12 hours to complete one orbit.

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- The positions of satellites are such that we can recieve signals from a minimum of 4 satellites at any point on the earth.
- Each satellite contains four atomic clocks which keep precisely accurate time to within three nano-second.
- Each satellite have a propulsion system so that it can be moved in orbit to correct the positioning error.

Ground control segment

- It consist of five land based monitoring stations located at Hawaii, Ascension island(south atlantic), Kwajalein(North Pacific), Diego Garcia (Indian ocean) & Colardo Spring (U.S.A)
- It also has a Master control station located at Colorado springs in U.S.A.
- The monitor stations are equipped with atomic clocks and GPS recievers which collects GPS data from all satellites, which are, in view from their location.
- The collected data is sent to Master control station where abnormalities are revised. The updated data are fed to the upload stations which transmit the data to each satellite.
- Master control station are also responsible for satellite maintenance, detecting and responding to PPS&SIS failures, determine error of atomic clocks etc.

User segment

- It consist of a receiving antenna, reciever with built in computer and display unit.
- The reciever locks on to one satellite and from this satellite it obtains the alamanac data of all the other satellite and choose the most suitable one for position fixing.
- The fix obtained is displayed on the display unit along with other information such as course and speed made good etc.
- To enhance the posn accuracy, there are dual frequency reciever that can recieve both the frequencies (L1 & L2)

* Clock-bias error - It is a very small error in calculated position due to difference in atomic clock of satellite which result in travel time measurement error which cause a difference of about 1.5m in the final calculated position.

Ques (9): With reference to GPS, write short notes on

(a) P & C/A code (3 times) (OR) System configuration and frequency used

- Each satellite transmits two code:

P code (Precession code) that is only available to US military and its allies

C/A code (Coarse Acquisition code) is available to all civilian users.

- L1 carrier signal - 1575.42 MHz - consist of both P & C/A code

L2 carrier signal - 1227.6 MHz - consist of only the P-code

- The PRN code (P code or C/A code) identifies the satellite to be used.
- These codes also measure the time taken by satellite signal to reach the receiver.

P-Code: • It is different for every satellite.

• It is available only for US military & its allies.

• The P-code are sent on both L1 & L2 frequency

• It is more complicated than C/A code, so it is more difficult to acquire by receivers. That's why military receivers starts by acquiring C/A code first and then move on to P-code. (NOT SO imp)

C/A code: • It is available to all civilian users

• The C/A codes are sent only on the L1 frequency

• It provides less accurate position than the P-code.

(b) Carrier frequency

- The satellite transmits the signals in 2 frequency.

L1 carrier signal - 1575.42 MHz - consist of both P & C/A code.

L2 carrier signal - 1227.6 MHz - consist of only the P-code.

- Each satellite transmit pseudo random noise (PRN) signal on these two different carrier frequency.
- The reason for transmitting the signal in 2 frequency is to reduce the atmospheric error.
- Since, different frequencies are affected in a different way by same atmospheric interferance, the error is calculated using two frequency and compensated within the receiver which improve the accuracy of the fix.

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Ques⑩: What is dilution of precesion? Briefly explain the various type DOP's of the GPS system. (OR) w.r.t GPS, write short notes on GDOP & HDOP

Ans:-
- Dilution of precesion (DOP), or, Geometric dilution of precision (GDOP) is a term used in satellite navigation and geomatics engineering. It is a value of (probable) geometrical effect on GPS accuracy.
- The angular seperation beetween satellites determines the accuracy of fix. Wider the angular seperation beetween satellites, the better is the accuracy of fix.
- If the satellites are clustered together at the time of measurement, the sphere formed from different satellite is much close to as a single sphere. So the precision will be diluted & DOP value will be high. The higher the DOP, lesser the accuracy of fix.
- If the satellite are widely spaced, the sphere formed from different satellite are seperated by good distance, so the dilution of precesion will be low. The lower the DOP, greater the accuracy of fix.
- Modern recievers automatically select the suitable satellite for position fixing.

There are various type of DOP's of the GPS system. They are:

(a) Horizontal DOP (HDOP): is the error in the horizontal plane or 2D fix (Lat, long)

(b) Vertical DOP (VDOP): is the error in the vertical plane (altitude)

(c) Position DOP (PDOP): is the error in a 3D fix (lat, long, altitude)

(d) Time DOP (TDOP): is the error in positioning due to clock error.

Ques⑪: With respect to GPS, write short notes on Precise Positioning Service (PPS) & Standard Positioning service (SPS)

Ans:- Precise positioning service (PPS):
- It is positioning and timing service which have authorized access and is used by military.
- It modulates on both L1 and L2 frequencies
- The L1 frequency transmitted by all satellites contains a C/A code ranging signal with navigational data message which are available

P & C-A code is person
L1 & L2 frequency is vehicle
person use vehicle to reach the reciever from satellite.

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for civil use ; & P-code ranging signal with navigational data message which are reserved for U.S. military use.

- The L2 frequency consist of only P-code and is reserved for military use.
- The positional accuracy is must higher for security point of view.

Standard Positioning service (SPS):

- It is positioning and timing service provided for civil use.
- It modulates on L1 frequency only.
- The L1 frequency transmitted by all satellites contains a C/A code ranging signal with navigational data message which are available for civil use.
- The positional accuracy is not higher in compare of PPS.
- All the civil users worldwise use SPS.

DGPS

Ques (12)(a) Explain the functioning of DGPS and its limitations. (OR)
How does DGPS enhance position fixing of GPS data.

Ans:- A DGPS is used to enhance the accuracy of a normal GPS.

- The DGPS refrence station is situated at a fixed location and from this position the GPS reciever obtain data from all the satellite within its range.
- As the refrence stations knows their precise geographical location, so they compare it with position recieved from GPS & computes the correction.
- These corrections are then broadcast to GPS user's to improve their positional accuracy.
- These corrections are transmitted in two ways:

(a) Computing & transmitting a position correction in terms of latitude, longitude and altitude

(b) Computing & transmitting a pseudo range correction of each satellite which is then applied to user's pseudo range measurement before the position is calculated which results in higher accuracy of position fix.

- On-board recievers are programmed to auto-track DGPS stations, recieve the corrections from them & apply it to their own fix.

Limitations: In very restricted water, multipath error in DGPS can be significant. Hence, it is important to use other means of position fixing such as radar.

- DGPS can give accuracy of upto about 1-10m.

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12(b) What are the two methods by which the DGPS system computes the correction to be applied to the position obtained by GPS.

Ans:- (i) In first method,

- It computes and transmitts a position correction in terms of latitude, longitude and altitude.
- It requires less data than second method but the accuracy decreases as the distance from reference station increases.
- In this method, Refpence station as well as user should select the same satellite which is practicaly not possible because user can't select satellite manually.

(ii) In second method,

- The reference station recieves signals from all visible satellites and measures the pseudo range to each of them.
- Since the satellite signals contains information on precise satellite location and the reference station knows its precise position, the true range of each satellite is calculated.
- By comparing the measured pseudo range and the true range, the correction are obtained for each satellite which are then transmitted and applied to pseudo range measured by user.

Ques (13): (a) What do you understand by chart datum? Which default datum is used in GPS.

(b) Can a fix obtained from GPS reciever be plotted directly onto a navigational chart.

Ans:- • A geodetic datum is the tool used to define the shape and size of the earth, as well as reference point for various coordinates.

• Because of different local datums, the same positions can have many different coordinates, so it is important to know which datum a particular chart is refered to.

• There are many datums in use around the world like World Geodetic System, North American datums, European datums etc.

• Within the World Geodetic System (WGS), there are several datums in use like WGS 84, 72, 70 and 60. The WGS 84 is currently the default datum which is used in GPS. It is most widely used datums around the world.

• While working on charts, it is important to ensure that which datum that particular chart is referred to.

__/__/____

(b) • To plot the GPS fix directly onto a navigational chart, it is important to ensure that the GPS and the navigational chart are of same datum.

• In case, the datums used are not same, the user will have to apply datum shift correction to minimize errors.

Smart Mariner Edition
for smart sailors

ECDIS

25/03/2022

ECDIS

Ques①: Write short notes on ECDIS.

Ans:-

- ECDIS is electronic chart display and information system used for navigation purpose in navel vessel and as well as merchant ships.
- It is a legal chart.
- The first performance standard was issue in 1995
- ECDIS was accepted by SOLAS as a replacement for paper chart in 2002
- Recognizing the advantage of ECDIS for navigation, in 2009, IMO adopted further amendments to regulation V/19 to make mandatory the carriage of ECDIS.
- The amendments entered into force on 1 January 2011, making ECDIS mandatory.
- ECDIS is for safe navigation and should not to be used for collision avoidance
- Besides enhancing navigational safety, ECDIS eases navigator's workload with its automatic capabilities such as route planning, route monitoring, automatic ETA calculation and ENC updating.
- ECDIS is also interfaced with other navigational equipment such as GPS, Gyro, AIS, RADAR, ARPA etc.

Ques②: What are the advantages and disadvantages of ECDIS over paper chart?

Ans:-

Advantages:

(a) All information is processed and displayed in real time
(b) It eases the process of passage planning.
(c) Various alarms and indication are there to indicate and highlight dangers
(d) Chart correction has became easier in ECDIS as compared to paper charts.
(e) Other navigational equipment such as AIS, ARA etc. can be overlayed & integrated
(f) With the facility of zoom in and zoom out, features can be examined as per necessity.
(g) One can obtain more accurate ETA
(h) All in all, it enhances the safety of navigation

Disadvantage:

(a) Over-reliance
(b) Too much information may cause clutter and can be distracting.

(c) Complacency due to automatic plotting of position
(d) Wrong setting & wrong input may lead to accident
(e) Alarm fatigue: If alarm start going off too frequently, navigator could end up acknowledging the alarm even without checking it
(f) Different vessel have different type of equipment. Even if essential features are same but still it take some time until one get comfortable.
(g) Lack of ENCs for certain trading area which require addition paper chart carriage.

Ques ③:- Explain the difference between raster & vector charts (3 times)

Ans:-
(a) Raster chart is a direct scan copy of a paper chart whereas Vector chart is a computer generated charts.
(b) In raster chart, entire chart is saved in one layer whereas In vector chart, information is saved in many layers.
(c) In raster charts, all the information appears cluttered whereas In vector chart, cluttering can be avoided.
(d) In raster charts, information can be added only whereas In vector chart, information can be added as well as can be removed.
(e) In raster chart, interrogation of information is not possible whereas In vector charts, by clicking on feature like lighthouse, buoy etc., all the details of that feature is displayed
(f) In raster chart, zoom in can cause distortion whereas In vector charts, there is no distortion while changing scale/zooming in.
(g) RNC data will not trigger automatic alarm whereas In vector charts, various settings and alarms are provided.
(h) Memory requirement is higher in case of raster chart
(i) In raster chart, worldwide coverage is possible whereas In vector charts, world-wide coverage will take time
(j) Raster chart is simple, cheaper to produce & easily available whereas vector charts are costly and time consuming to produce
(k) For permanent correction in raster chart, the chart has to be replaced, whereas In vector chart, ENC database is corrected.

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Ques ④:- Explain the methods of updating Electronic Navigation Chart (ENC)?

Ans:-

- Updates to the ENCs reach the ship in various ways, those are
  - → On data distribution media (DVD)
  - → As an email attachment (SATCOM)
  - → As an internet download
- There are three methods followed on-board to update ENCs:
  - → **Sequential**:
    - As it name suggests, this method is done in sequence
    - It should be done every week
    - If we miss one week, the ECDIS will not load the update of next week
  - → **Cumulative**:
    - In this method, we do not need to do previous update compulsarily. When we put the current CD, it will automatically take all the previous updates till date.
    - It should be done once in 3/4 week.
  - → **Online**:
    - In this function, our ECDIS is connected online & it keep getting all the updates continuosly.
    - But due to cyber security reason, it's not preferrable.
- The procedure for loading the updates in ECDIS:

(1) Insert CD in ECDIS CD ROM (OR) insert the pendrive
(2) Select "CHART" → "CHART PORTFOLIO"
(3) Choose load and update charts
(4) Choose "From CD ROM" or "From Pen Drive" from the sub menu
(5) Define the location of the "CD ROM" or "Pen drive" and select the file "PERMIT.TXT" or "AVCS update"
(6) Click on the "LOAD" button. Your ENCs are now corrected upto current week.
(7) DO check it by going in "ENC update report" menu

ENC, SENC, Standard display, Display base

AIS


FURUNO
UNIVERSAL AIS
[OWN STATIC DATA] 1/5
NAME :BOOLI MOOG
CALL SIGN: SVDJ2
MMSI :671599000
IMO No. :0086130 61
MENU
ENT
DISP
DIM
NAV STATUS
FA-150
PWR
0735
07

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AIS

Ques ①: Explain the working principle of AIS & frequencies used (7 times) (OR) How data is transmitted in AIS? (OR) Write short note on AIS (6 times)

Ans:-

- The "Automatic Identification System" is a broadcast transponder system which is fully automatic and works without human intervention.
- It is capable of sending own ship information such as identification (name, call sign etc), position, course, speed and more to other ship and to shore.
- Each AIS system consist of a VHF transmitter, two VHF STDMA recievers, one VHF DSC reciever (CH70) and a standard marine electronic communication link which provides various input data from other equipments. An internal or external GNSS reciever (GPS, GLONASS etc) provides precise position information and accurate time signals.
- AIS operates on two dedicated VHF frequencies or channels
  AIS 1 - 161.975 MHz - channel 87B (simplex for ship to ship)
  AIS 2 - 162.025 MHz - channel 88B (Duplex for ship to shore)
- AIS uses Self-organizing time division multiple access (STDMA) technology to meet high broadcast rate. It normaly work in autonomous and continuos mode.
- In STDMA, one minute of time is divided into 2250 slots. Each slot is of 26.67 milliseconds and contains 256 bits of data. Between the A1 and A2 AIS frequencies, there are 4500 time slots. The rate of transmission is 9600 bits/second.
- It uses the highly accurate GPS time signal to synchronize multiple data transmission from many user on a single narrow band VHF channel.
- Each ship transmits and recieves data to/from any ship or AIS station in its VHF range. The area within the VHF range is known as CELL of the ship & ship lies in the centre of this cell.
- When any ship enters into a cell, the free slot is then occupied by that ship. This is automatic and on random basis. There is no master station involved. The highly accurate time signals from GPS prevent over lapping.
- If the amount of AIS data begins to overload the system, the size of the cell is automatically reduced by ignoring weaker station that is far way.
- System coverage is by "line of sight" & thus depends on antenna height. If obstruction like land are not too high, it may sea beyond the land. Typical range at sea is 20NM.

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Explain the use of AIS in collision avoidance & SAR operation.

Ques ①:- Explain the purpose & benifit of AIS. (3 times) (OR),
What are the objective of AIS? What are the added advantages of AIS over ARPA w.r.t collision avoidance.

Ans:- AIS is an automated autonomous system for the exchange of navigational information between suitably equipped ships and shore stations using distinct messages operating at duplex marine VHF channel 161.975 MHz(87B) & 162.025 MHz(88B)

The primary aim of AIS is
- To enhance safety of life at sea.
- To enhance safety & efficiency of navigation
- To protect the maritime environment.

Some other purpose of AIS are:
- Used for collision avoidance but not as a sole anti-collision aid.
- Used by coastal states to obtain information about a ship & cargo in a mandatory reporting system
- Used by VTS as a traffic managment tool.
- Used as virtual AIS also known as pseudo AIS to represent navigational mark(buoy etc.) where there is no physical mark. It is also used when distress vessel has no AIS.
- Used as Aids to Navigation - mounted on physical buoys etc

Benifits of AIS:
- AIS is an aid to navigation & if used correctly, it can help in preventing or avoiding a collision or near miss.
- AIS helps to improve situational awareness for the navigators, by providing positive identification of vessels.
- AIS provides fast, automatic and accurate information regarding risk of collision by calculating CPA and TCPA which can be compared with ARPA
- AIS reduced the work load associated with verbal reporting system required by the VTS.
- AIS can be interfaced with VDR, RADAR and ECDIS
- AIS can pick up targets regarding heavy weather, poor visibility, rain etc
- AIS can pick up targets beyond small targets and bends
- AIS can be installed on lighthouses, buoys, beacons for positive identification of these marks.
- Pseudo AIS can be used to generate virtual AIS to indicate danger. It is also used to generate target in case of SAR operation.
- AIS also contributes to maritime security as authorities can monitor the movement of vessels.

AIS does not face target swap, ranges bearing discrimination as found in ARPA.

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What are the precautions to be taken when using AIS for collision avoidance and why?

Ques③:- What are the limitations of AIS in safe navigation due to which AIS cannot be used for collision avoidance as a sole anti-collision aid?

Ans:- AIS cannot be used as a sole anti-collision aid. It is used in conjuction with other anti-collision aids such as RADAR, ARPA etc.

It is a valuable navigational aid but its accuracy depends on operator fed data and associated input devices.

Few major limitations in use of AIS for collision avoidance are:

(a) Small crafts, fishing vessels, warships and some VTS stations may not be fitted with AIS

(b) Some ship may have their AIS switched off under certain circumtances like in piracy prone areas.

(c) User input like heading, speed, ROT etc. may have some error, missing or not updated.

(d) DR position being transmitted by other vessel in case of temporary or complete failure of Electronic position fixing system.

(e) AIS will automatically transmit "NOT AVAILABLE" data value in case of sensor failure.

(f) Incorrectly calibrated sensors will cause wrong information to be transmitted which dangerously confuse the recieving vessel.

Precautions while using AIS in collision avoidance:

- Do not rely on AIS as the sole information system.
- It is an addition source of information which should not replace other anti collision aids.
- Be aware that some ship may do not have AIS fitted or might switched off.

Describe the contents and indicate the broadcast interval for each message type for a class A AIS.

Ques④: List the information transmitted by an AIS device & at what interval.

Ans:- Data transmitted by AIS falls in four categories:

(a) Static data

1. IMO number
2. Name & call sign
3. Length & beam
4. Type of ship
5. Location of position fixing antenna.

* It is programmed when installing the equipment. This data is sent every 6 minutes or on request

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(b) Dynamic Data

1. Ship's position (WGS 84 ref)
2. UTC time
3. COG & SOG
4. Heading
5. Navigational status (manually selected)
6. ROT (if available)

* This data is sent as per ship's navigational status or speed
  - At anchor - every 3 minutes
  - Speed 0 to 14 Kts - every 12 seconds
  - Speed 14 to 23 Kts - every 6 seconds & every 2 seconds - if changing course
  - Speed over 23 Kts - every 2 seconds.

(C) Voyage related data

1. Ship's draft
2. Destination & ETA
3. Type of cargo
4. No. of crew members.

* This has to be entered manually. This data is sent every 6 minutes or on request.

(d) Safety related message

These are normally sent in text format and may be directed to specific stations or all stations. and sent only when required. It should be used only for safety related communication & should not be used for commercial or personal communications.

Ques ⑤: What is the use of the AIS pilot plug.

Ans:- The AIS pilot plugs provides a means to Pilot and other mariner to connect their own laptop or other portable devices to a vessel's AIS.

The AIS pilot plug is supposed to provide:

(a) Static information : IMO number, Name & call sign, ship's type & dimensions

(b) Dynamic information : Own ship & target vessel position, time, COG & SOG, Heading, ROT & navigational status.

(c) Voyage related information : Ship's draft, destination & ETA, type of cargo.

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Ques⑥:- What are the different classes of AIS.

Ans:- There are two main classes of AIS - class A & class B.
& some other types of AIS used for shore stations, AIS on buoys, AIS on search & rescue aircrafts and AIS on SART.

CLASS 'A'	CLASS 'B'
(i) For regulated vessels	(i) For non regulated vessels like small crafts
(ii) Used "SOTDMA" which gives them priority and guarantees a time slot	(ii) Uses carrier sense Time Division Multiple Access (CSTDMA) which senses if a time slot is empty, then quickly grab it
(iii) Overlapping does not occur. Hence, transmission is guaranteed.	(iii) Collision of time slots can occur. Transmissions are not guaranteed.
(iv) Tx Power is 12.5W	(iv) Tx power is 2W
(v) Range is 20-25 NM	(v) Range is 7-8 NM
(vi) Static data - every 6 minute Dynamic data - 2 to 12 sec. Voyage related data - every 6 minute	(vi) Static data - every 6 min Dynamic data: At anchor - every 3 min SOG less than 2Kt - 3 min SOG more than 2Kt - 30 sec Voyage related data - every 6 min.

Does not transmit vessel's IMO number or CALL SIGN

Does not transmit ETA or destination etc

LRIT

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LRIT

Ques① :- Write short notes on LRIT (7 times) (OR) How does LRIT system function?

Ans :- The Long Range identification tracking system provides for global identification and tracking of ships through the INMARSAT satellite system. It is a system that requires vessels to automatically transmit their identity, position and data/time of the position at max^m 6 hour interval.

The LRIT system consist of

ⓐ Shipborne LRIT information transmitting equipment

ⓑ Communication Service Provide (CSP) : It provides the communication infrastructure and services to ensure end-to-end secure transfer of the LRIT message from ship to the Application Service Provider (ASP)

ⓒ Application Service Provider (ASP) : It converts the data to a common data format and sent it to the LRIT data center.

ⓓ LRIT data center : It stores and processes the data. It determines which reports are to be sent to coastal/port states via Internation Data Exchange based on the Data distribution plan.

ⓔ LRIT Data distribution plan (DDP) : It verifies that the Member state requesting for the information should be provided with the same or not It specifies which are the autorized user/recievers of LRIT.

ⓕ LRIT International data exchange (IDE) : It routes data to the authorised recievers

Working of LRIT

LRIT data is automatically transmitted every 6 hours through the following route.

1. Ship to satellite
2. Satellite to CSP
3. CSP to ASP
4. ASP to LRIT data centre
5. LRIT data centre forward the information to authorised recievers via the International Data Exchange after recieving feedback from DDP

- Information transmitted by ship is available to the vesser's flag state at all times.
- For another flag state to access the information, they will send request to IDE.
- DDP is linked to IDE which will have the "routing rules". Each contracting government will provide these "routing rules" to IMO, who have developed the DDP.

What is the function of DDP? ⇒

- DDP verifies that the Member state requesting for the information should be provided with the same ornot.

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- DDP verifies the information request is valid or not
- DDP ensures that LRIT data flow should be according to the wishes of contracting gorernment
- The IDE will then act as a link to the requesting data centre and the providing data centre.

Ques 2(a) What is the purpose of the LRIT system?

(b) List the data transmitted by LRIT & time interval

Ans: (a) Purpose of LRIT :-

- The LRIT system is a designated IMO system designed to collect and provide vessel's position information recieved from IMO member state ships
- The main purpose of LRIT ship position report is to enable a contracting gorernment to obtain ship identity and location information in sufficient time to evaluate any security risk posed by a ship off its coast and to respond, if necessary.
- It allows coastal states to access information about ships navigating off their coasts.
- LRIT has also become an essential component of SAR operation and marine environment protection.
- It provides almost world wide coverage that allows visibility to position reports of vessels that would otherwise be invisible and potentially a threat

(b) Information transmitted :

→ Ship's identity
→ Position (Lat/Long)
→ Date & time (UTC)

Update interval:

→ The default interval is 6 hours which may be changed if required
→ Minimum interval is 15 mins
→ May be switched off by Master under certain conditions

P.T.O

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Ques ③:- List the authorised users/ recievers of LRIT information and state the condition under which LRIT information from ships can be released to the authorised users.

Ans:- (a) Flag state: Full access to all the ship sailing under their flag.

(b) Coastal state: If the vessel is operating within 1000 NM off their coast, but not if the vessel is in territorial waters of another state.

(c) Port state: If the vessel is indicating their intention to enter a port under their jurisdiction (usually upto 96H prior entry), but not if the vessel is in territorial waters of another state.

(d) Ship owner: Access restricted to own ships.

(e) Surveyor: Restricted access to verify LRIT conformance test

(f) Agents and charterer: Selective access if granted by ship owner

(g) Piracy prevention task forces: Access via a special format.

(h) SAR services: Authorized SAR service can request & recieve data for the vessels within their SAR area, free of cost. However, cost for communication & data transfer will be borne by flag state of that vessel for which the data was requested.

(i) International Data Exchange: Full access to all data so that it can be distrib-uted as required.

Ques ④: Explain the function of LRIT National data centre

Ans:-
- The primary purpose of an LRIT data centre are to collect, store and provide information transmitted by the ship to the authorised recievers via International Data Exchange based on the Data distribution plan.
- LRIT data centres are required to archieve their data, so that reports can be recovered in case of any misshappen.
- LRIT data centre may make a charge to other data centre to provide LRIT data
- LRIT data centre may be either National, regional or international.

National DC - establish to provide information to only one contracting government

Regional DC - establish to provide information to number of contracting goverment

International DC - establish to provide information on an international basis to many countries that do not wish to establish their own DCs.

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Ques ⑤: Explain the difference between AIS & LRIT (10 Times)

Ans:-

- AIS is a broadcast system and data is available to all reciever within the range whereas LRIT data is only available to authorized recieves.
- AIS works on very high frequency whereas LRIT works on a satellite system
- AIS range is limited to VHF range whereas LRIT has a world wide coverage
- AIS data is not stored by any organization whereas LRIT data is stored and available on demand.
- AIS have a display UNIT on-board whereas LRIT does not have any display.

AIS	LRIT
• AIS operates in the VHF range by line of sight and therefore has a "local coverage only	• LRIT is a satewite based system and therefore has a global coverage
• It is used for navigation as an anti-collision aid.	• It is used for maritime security and awareness
• The data is public and anyone can see that data	• The data is secured & own by flag state & can be provided to authorized recievers on request
• AIS transmits ship's identification, position, Date & Time, vessel type, COG & SOG & other voyage related data	• LRIT transmits ship's identification, Position (Lat/long) & Date, Time
• AIS updates data at interval of few seconds (2-12 sec)	• LRIT broadcast data at interval of 6 hours which can be reduced upto 15mn
• The information is free of cost to all.	• The information must be purchased except own flag & SAR services.
• There is display onboard for AIS	• There is no display for LRIT
• AIS data is not stored anywhere	• LRIT data is stored & available on demand

VDR &

S-VDR

29/03/2022

VDR

Ques ①: Write short note on VDR.

Ans:-

- A VDR or voyage data recorder is an instrument installed onboard a ship which continuosly record vital information related to the operation of ship.
- The various sensors are placed on prominent locations including bridge from which the required data is continuosly collected
- The data comprises of voices, ship location, various parameters etc which are fed to a storage unit and are saved there for atleast 12 hours
- This recording is recovered and used for investigation in case of any accident
- The data collected by VDR is digitalised, compressed and stored in a protective storage unit which is mounted in a safe place
- The data recorded in last 12 hours are automaticaly overwritten by the latest data. Hence, after an incident, the SAVE button must be pressed
- There is also a record button provided in the bridge unit, so that after pushing the button (in starting time of incident like collision), the recorder will start recording new set of information from that time
- A VDR is capable of withstanding heavy weather, collisions, fire and pressure condition even when ship is several meter inside the water.
- The storage unit of VDR is tamper proof & retrievable fixed or floating unit connected with EPIRB for early location in case of accident

Ques ②:- What is the purpose of VDR? List the data recorded by VDR & S-VDR (8 times)

Ans:-

- The main purpose of the VDR is to digitalize, compress and store data in a secure and retrievable form which can be recovered and used for investigation in case of any accident.
- It continuosly records the data related to status, output of various ship's equipment, command and control of the ship.
- Additionaly, the recorded data can also be used for self analysis, lesson learning tool & training purposes, as not to repeat mistakes in future

Some other benifits of VDR are:

→ Accident investigation

→ Promotion of safe practices

→ Response assessment and study

→ Training aid & support
→ Reduction in insurance cost
→ Heavy weather damage or near miss analysis.

The list of data being recorded by VDR/S-VDR are :

VDR	S-VDR
Date, Time and position (GPS)	Date, Time and position (GPS)
Speed (Log)	Speed (Log)
Heading (Gyro)	Heading (Gyro)
Bridge and VHF Audio.	Bridge and VHF Audio
RADAR Display Image	RADAR display image
AIS data	AIS data
ECDIS	Any other NMEA format data.
Depth (Ecosounder)	
Bridge mandatory alarms	
Rudder order and response	
Engine & Thruster order and response	
Hull opening status, W/T & Fire Doors status	
Acceleration & Hull stresses, Rolling motion	
wind direction and speed	
Configuration data	
Electronic log book (if used)	

Ques ③ Comparision between - VDR & S-VDR.

Ans:- Voyage data recorder, or VDR, is a data recording system designed to collect data from various sensors onboard a vessel so as to enable accident investigator to review the movement and actions taken before an accident and help to identify the cause of any accident. It is similiar to 'Black box' carried on aircraft.

A simplified voyage data recorder (S-VDR) which is a lower cost simplified version of VDR and requires only basic ship's data to be recorded.

The list of data being recorded by VDR/S-VDR are:

Same as above in Q-2

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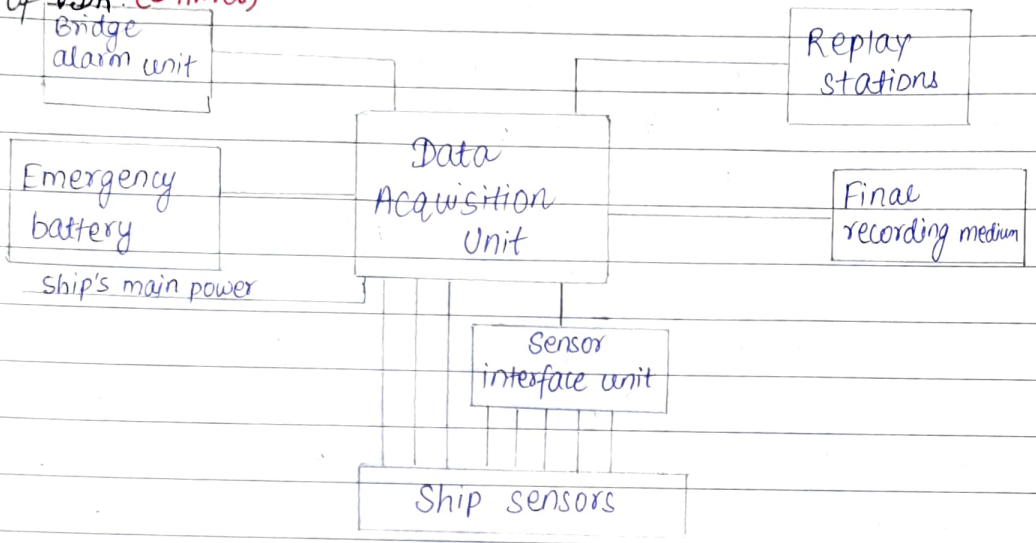
Ques ④:- With the help of simple block diagram, briefly explain the various modules of VDR. (3 times)

Ans:-



The various modules of VDR are as follows:

ⓐ **Data acquisition module**: It acquires data from various sources using interface, processes and stores the data in a specified format

ⓑ **Audio module**: It consist of a audio mixer for recording audio from micro-phone placed in the wheelhouse, bridge wings, ECR and various other locations. VHF audio signals can also be interfaced with this unit.

ⓒ **Final recording module**: It is a crash proof, tamper proof, pressure tight & fire resistant storage medium used to store the VDR data. It is a capsule resistant to shock, fire, immersion, temperature (1100°C) and deep sea pressure of 6000m. It is mounted as a float free unit in a compass deck or bridge wing. It is also fitted with a device to aid a location, so that it can be retrived in case of any accident and can be used for investigation.

ⓓ **Bridge remote alarm module**: It is a small panel connected to the Data Acquisition module which generates an audible and visual alarm in case of any error develop in the equipment

ⓔ **Replay module**: It is an optional module and used to download and replay the saved information in audio visual form.

P.T.O

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Ques⑤:- Explain the data retrieving procedures in case of a collision.

Ans:- The recovery of VDR data is conditional

- In case of a non-catastrophic accident, recovery of the VDR memory is simple. In some VDR, it can be obtained just by removing the hard disc from the VDR unit. It should be obtained soon after the accident to best preserve the relevant evidence for use of both the investigator and ship owner. As the investigator will be not be there soon after the accident, so it is a owner's responsibility to ensure timely preservation of this evidence
- In the case of abandoning of ship, where the time and other responsibility permit, master have to recover the memory and preserve it until passed to the investigator.
- In case of a catastrophic accident, where the memory has not been retrieved prior abandonment, a decision will be taken by Flag state on possibility and cost of recovering the VDR. If it is decided to recover the VDR, the investigator should be responsible for coordinating in its recovery. The possibility of capsule having sustained damage must be considered and specialist expertise will be required to ensure the best chance of recovering and preserving the evidence.

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SEXTANT

06/04/2022

SEXTANT

Ques①:- How will you find the index error of a sextant.

Ans:-

Index error: The sextant has an index error if the index mirror and horizon mirror are not parallel to each other when the index arm and the drum with minute scale are set exactly at zero.

How to determine:

→ During day time, clamp the index bar at zero and view the horizon through the telescope by holding the sextant vertically.

→ If the true horizon and its reflection appears in the same line, index error is zero.

→ If they appear displaced vertically, turn the micrometer drum, till they are in same line

→ The micrometer reading is then the index error, which is

- On the arc if the micrometer reading is more than zero
- Off the arc if the micrometer reading is less than zero.