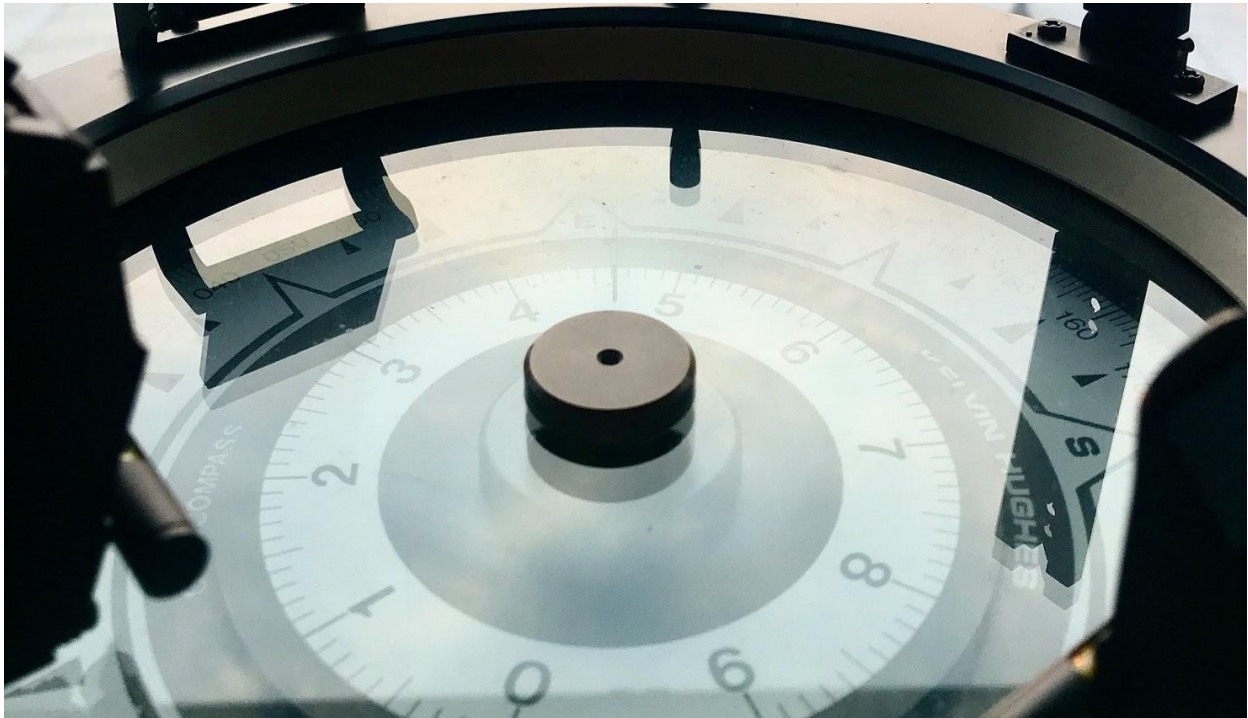


FUNCTION: NAVIGATION (Management Level)

PAPER: NAVIGATIONAL AIDS INCLUDING COMPASS

GYRO NUMERICALS



Chief Mate-FG (Phase-II)

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GYRO – NUMERICAL (NOV 2025 TO FEB 2015)

- 1) A gyrocompass damped in tilt has a damping error of 1.2° in latitude $46^\circ 18' \text{N}$. What will be its damping error in 42°S latitude? (NOV 2024 AM, JAN 2021, MAY 2015)
- 2) Damping error in lat. 40°S was observed to be 1.2°W . Calculate the damping error in latitude 25°N . (FEB 2025 AM, MAY 2019)
- 3) A gyrocompass damped in tilt has a damping error of 2.8°W in latitude of 58°S . What will be the Damping error of the same gyro in 30°N latitude? (OCT 2022, FEB 2015)
-
- 4) Steaming error is 2° on the equator. Allowing for the same speed & course what will the steaming error in latitude $36^\circ 52'$? (NOV 2019, AUG 2017)
- 5) A vessel is steaming at 20 knots on a northerly course in latitude 60° . Find the steaming error of Gyro. (MAY 2016)
-
- 6) For a gyro damped in tilt find the total gyro error while steering $060^\circ (\text{G})$ in latitude 40°S at a speed of 15 knots. Given that $P_d : P_c = 1/40$. (MAY 2023, NOV 2018, SIMILAR: JAN 2016)
- 7) A vessel with a gyro compass damped in tilt (damping ratio $1/40$), sails on a course of 200°T with a speed of 15 knots in latitude $30^\circ 27' \text{N}$. Calculate the course to steer to account for the expected error if the compass is uncorrected. (AUG 2024 AM)
- 8) In latitude 32°N , the Damping Error is 1.2°E . Calculate the total error of the same gyro compass when making good a course of $315^\circ (\text{T})$ at a speed of 18 knots in latitude 48°S . (FEB 2023, NOV 2015, SIMILAR: MAY 2025 AM, NOV 2021)
- 9) A vessel fitted with gyro damped in tilt steers $240^\circ (\text{G})$ at a speed of 15 knots in 30°S latitude. What will be the total gyro error? Given that damping ratio = $1/40$ (AUG 2019)
-
- 10) A ship at anchor is heading $005^\circ (\text{G})$ in $76^\circ 33' \text{N}$ latitude. What is her true heading in each of the following cases?
a) Gyro is Damped in Azimuth
b) Gyro is Damped in Tilt (NOV 2025 PM, MAY 2024 PAPER 1)
- 11) A vessel steers $168^\circ (\text{T})$ at 15.5 knots in $55^\circ 45' \text{N}$ latitude. Find Gyro course in each of the following cases:
a) Gyro is 'Damped in Azimuth'.
b) Gyro is 'Damped in Tilt'. (AUG 2025 PM, MAY 2018)
- 12) Assuming that the peripheral speed of the Earth is 540 knots in 54°N latitude, find the error of the gyro compass when making good a course of $175^\circ (\text{T})$ at 21 knots in the Indian Ocean (latitude $29^\circ 42' \text{S}$), If the gyro compass was:
a) Damped in Azimuth
b) Damped In Tilt (FEB 2017, AUG 2015)
-
- 13) The axis of a gyro-compass damped-in-tilt, uncorrected for speed-course error and damping error, points due north in latitude 61°N , when making good a course of 345° and a speed of 20 Kts. On reaching latitude of 70°N , course is required to be altered to $205^\circ (\text{T})$ and speed is to be reduced to 15 Kts. Calculate the total error of the gyro compass and the gyro-course to steer in new latitude. (Assume that the gyro-compass does not have any other errors). (MAY 2025 PM, AUG 2023, JAN 2022)

14) A ship is making good $270^{\circ}(T)$ while her gyro compass shows $265^{\circ}(G)$, in $54^{\circ}41' N$ latitude. She is required to make good $170^{\circ}(T)$ at 19 knots. What gyro course would you set on her auto-pilot? (There is NO current and gyro compass has NO OTHER ERRORS) **(AUG 2025 AM, MAY 2022, AUG 2018)**

15) A vessel is fitted with "Damped in Azimuth" gyro compass steers $182^{\circ}(G)$ at 27 knots in $55^{\circ} 37'S$ latitude and makes good $174^{\circ}(T)$. What will this gyro compass read when the ship makes good $344^{\circ}(T)$ at 9.5 knots in $73^{\circ}N$ Lat? **(NOV 2024 PM, AUG 2021)**

16) Your ship is anchored at position $54^{\circ} N 060^{\circ} E$ and Gyro error is found to be 2° Low. Find out the course to steer for making good a course of $158^{\circ}(T)$, if ships speed is 16 kts & in Lat $40^{\circ} N$ **(NOV 2017)**

17) A vessel fitted with a gyro damped in tilt steams a straight Rhumb line course from position "P" ($46^{\circ} 30'N$ $170^{\circ} 10'E$) and arrive at position "Q" ($50^{\circ} 10' N$, $179^{\circ} 45'W$) after steaming for 12 hours. State: What is the required Gyro course to be steered by the vessel from P to reach Q? **(NOV 2023 PM, MARCH 2022, SIMILAR: AUG 2016)**

18) Ship sails at 1400 hrs from position $43^{\circ}N$, $058^{\circ} 30'W$ to pick up pilot at 1900 hrs in position $44^{\circ}N$, $060^{\circ}W$. The current has been setting $180^{\circ}(T)$ at 1.5 Kt, throughout. The ship is fitted with sperry gyro, which is uncorrected for damping and N-S speed error. If the damping ratio is $1/40$, calculate the gyro course and the ship's speed, which need to maintained, to reach pilot station in time. **(NOV 2022, FEB 2019)**

19) A ship with gyro compass uncorrected for Damping & Steaming errors steers $205^{\circ}(T \& G)$ from position A in lat $58^{\circ}S$ to B in lat $62^{\circ}S$. Determine the speed of the ship & course to steer from position B to A with gyro compass uncorrected. (Pc: Pd = 40:1) **(FEB 2024 PAPER 2, FEB 2024 PAPER 1, SIMILAR QUES: NOV 2023 AM, FEB 2018)**

20) A vessel sails along the meridian from $44^{\circ}S$ to $75^{\circ}S$ in 86.06 hours using her 'Damped in Tilt' Gyro Compass (eccentricity being $1/36$) & FIVE days later returned back to her original location in 77.97 hours using her 'Damped in Azimuth' Gyro compass. Find the Gyro course steered on EACH Leg. **(AUG 2024 PM, FEB 2020, SIMILAR QUES: MAY 2017)**

21) In latitude $30^{\circ}N$, while steering 045° at certain speed, transit bearing of a pair of light houses was observed as $135^{\circ}(T \& G)$. What shall be the gyro transit bearing of another pair of lighthouse true bearing 60° , in latitude $30^{\circ} S$ while steering a course of 315° and same speed. Given that damping ratio = $1/40$. **(JULY 2022)**

22) The auxiliary corrector of a gyro compass damped in tilt was inadvertently left at 'Zero Speed' & 'Zero Latitude'. The vessel was steering 030° by gyro at 18 knots in $48^{\circ}N$ Latitude and also made a good course of $030^{\circ}(T)$. Find the gyro course steered by the vessel if she is making good a course of $060^{\circ}(T)$ at a speed of 15 knots in $59^{\circ}S$ latitude with the auxiliary correctors still left to 'Zero' speed and latitude setting. (Assume there is no current throughout and also the gyro compass is not having any other errors). **(NOV 2020)**

23) A free gyroscope in Lat $50^{\circ}N$ is initially set with its spin axis horizontal and pointing $30^{\circ}E$. Find the interval of time elapsed before the gyro is pointing in the meridian, and before the gyro axis is again horizontal. **(NOV 2025 AM, SEPT 2021)**

24) At 00h 00m 00s GMT in latitude, $45.0^{\circ}S$ and longitude 000.0° , spin axis of a free gyroscope is pointing $120^{\circ}(T)$. At what time it will point $270^{\circ}(T)$ on the same day? **(SEPT 2022)**

25) Performance test of a stationery gyro compass gave the following readings:

First extreme swing to one side – 060° at 13h 50m 03s.

Next extreme swing to one side – 350° at 14h 36m 32s.

Next extreme swing to one side – 011° at 15h 15m 22s.

The gyro compass finally settled at a reading of 006° . Calculate the damping factor, percentage damping and the theoretical settling position. State if the test was satisfactory. **(MAY 2024 PAPER 2)**

26) During a performance test the following peaks were observed, / $A=083^\circ$, $B=039^\circ$ and $C=054^\circ$, Calculate the settling position and the percentage of damping. **(FEB 2016)**

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GYRO NUMERICALS

NOV 2024 AM, 1)
JAN 2021,
MAY 2015

A gyro compass damped in tilt has a damping error of 1.2° in latitude $46^\circ 18' N$. What will be its damping error in $42^\circ S$ latitude

$$\sin D.E = \frac{PD}{PC} \times \tan \text{lat}$$

For same gyro compass in different latitude

Let DE_1 is error in lat_1

DE_2 is error in lat_2

$$\text{Then, } \frac{\sin DE_1}{\sin DE_2} = \frac{PD/PC \times \tan \text{lat}_1}{PD/PC \times \tan \text{lat}_2}$$

$$\frac{PD}{PC} \text{ remains constant}$$

$$\frac{\sin DE_1}{\sin DE_2} = \frac{\tan \text{lat}_1}{\tan \text{lat}_2}$$

$$\frac{\sin 1.2^\circ}{\sin DE_2} = \frac{\tan 46^\circ 18'}{\tan 42^\circ}$$

$$0.019 = \sin DE_2 \times \tan 46^\circ 18'$$

$$\sin DE_2 = 0.018$$

$$DE_2 = 1.03^\circ W \text{ (bcz S' latitude)}$$

Damping error is westerly in SH.

FEB 2025
MAY 2019 2)

Damping error in lat $40^\circ S$ was observed to be $1.2^\circ W$. calculate the damping error in Latitude $25^\circ N$.

Soln:-

$$\sin D.E = \frac{PD}{PC} \times \tan \text{lat}$$

For same gyro compass in different Latitude

Let DE_1 is error in lat_1

DE_2 is error in lat_2

$$\text{Then, } \frac{\sin DE_1}{\sin DE_2} = \frac{PD/PC \times \tan \text{lat}_1}{PD/PC \times \tan \text{lat}_2}$$

$$\frac{PD}{PC} \text{ remains constant}$$

$$\frac{\sin DE_1}{\sin DE_2} = \frac{\tan Lat_1}{\tan Lat_2}$$

$$\frac{\sin 1.2}{\sin DE_2} = \frac{\tan 40}{\tan 25}$$

$$\sin DE_2 \cdot \tan 40^\circ = 0.009$$

$$\sin DE_2 = \frac{0.009}{\tan 40^\circ}$$

$$\sin DE_2 = 0.012$$

$$DE_2 = 0.667^\circ E \text{ (bcz N}^\circ \text{ Latitude)}$$

Damping error in easterly in NH.

- 3) A gyro compass damped in tilt has a damping error of $2.8^\circ W$ in latitude of $58^\circ S$. What will be the Damping error of the same gyro in $30^\circ N$ lat?

Soln:-

$$\sin D.E = \frac{PD}{PC} \times \tan lat$$

For same gyro compass in different latitude

Let DE_1 is error in Lat_1

DE_2 is error in Lat_2

$$\text{Then, } \frac{\sin DE_1}{\sin DE_2} = \frac{PD/PC \times \tan Lat_1}{PD/PC \times \tan Lat_2}$$

$$\frac{\sin DE_1}{\sin DE_2} = \frac{\tan Lat_1}{\tan Lat_2}$$

$$\frac{\sin 2.8}{\sin DE_2} = \frac{\tan 58}{\tan 30^\circ}$$

$$\sin DE_2 \cdot \tan 58^\circ = 0.028$$

$$\sin DE_2 = \frac{0.028}{\tan 58^\circ}$$

$$\sin DE_2 = 0.018$$

$$DE_2 = 1.010^\circ E (bcz N^\circ \text{ Latitude})$$

What gyro course to steer to make $150^\circ (T)$

$$150^\circ - 1.010$$

$$= 148.990 (G)$$

Error Low, Gyro Low

NOV 2019
AUG 2017

- 4) Steaming error is 2° on the equator. Allowing for the same speed & course what will the steaming error in Latitude $36^\circ 52'$?

Soln:-

$$\tan S.E = \frac{V \cos \theta}{900' \cos \text{lat} + V \sin \theta}$$

At most latitude, $V \sin \theta < 900 \cos \text{lat}$

$$\text{Therefore, } \tan S.E = \frac{V \cos \theta}{900(\cos \text{lat})}$$

Speed & course remains constant

$$\frac{\tan S.E_1}{\tan S.E_2} = \frac{\frac{V \cdot \cos \theta}{900 \cos \text{lat}_1}}{\frac{V \cdot \cos \theta}{900 \cos \text{lat}_2}}$$

$$\frac{\tan S.E_1}{\tan S.E_2} = \frac{1/\cos \text{lat}_1}{1/\cos \text{lat}_2}$$

$$\frac{\tan S.E_1}{\tan S.E_2} = \frac{\cos \text{lat}_2}{\cos \text{lat}_1}$$

$$\frac{\tan 2^\circ}{\tan S.E_2} = \frac{\cos 36^\circ 52'}{\cos 0^\circ}$$

$$\tan S.E_2 \cdot \cos 36^\circ 52' = \tan 2^\circ \times \cos 0^\circ$$

$$\tan S.E_2 \cdot 0.800 = 0.035$$

$$\tan S.E_2 = 0.035 / 0.800$$

$$\tan S.E_2 = 0.044$$

$$S.E_2 = 2.5^\circ$$

Since, speed & course remains same.

The sign for steaming error remains same

Answer: 2.5° (same sign)

- MAY 2016 5) A vessel is steaming at 20 knots on a northerly course in latitude 60° . Find the steaming error of gyro.

Soln:-

$$\tan S.E = \frac{V \cos \theta}{900' \cos \text{lat} + V \sin \theta}$$

$$\tan S.E = \frac{20 \cdot \cos 0^\circ}{900 \cos 60^\circ + 20 \cdot \sin 0^\circ}$$

$$\tan S.E = 20/450$$

$$\tan S.E = 0.044$$

$$S.E = 2.545^\circ W \quad (\text{CO: N}^{\text{th}} \rightarrow \text{steaming error is W})$$

MAY 2023
NOV 2018
SIMILAR Ques:
JAN 2016

6) For a gyro damped in tilt find the total gyro error while steering $060^\circ(G)$ in latitude $40^\circ S$ at a speed of 15 knots. Given that $P_d:P_c = 1/40$

Soln:-

$$\text{Total error} = \text{Damping error} \pm \text{steaming error}$$

$\Rightarrow$ Damping error

$$\sin D.E = \frac{P_d}{P_c} \times \tan \text{lat}$$

$$\sin D.E = \frac{1}{40} \times \tan 40^\circ$$

$$\sin D.E = 0.021$$

$$D.E = 1.202^\circ W \quad (\text{bcz S}^{\text{th}} \text{ latitude})$$

Damping error is westerly in SH

$\Rightarrow$ steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{lat} + V \sin \theta}$$

$V = \text{ship's speed}$
 $\theta = \text{course}$

$$\tan S.E = \frac{15 \cdot \cos 60^\circ}{900 \cdot \cos 40^\circ + 15 \cdot \sin 60^\circ}$$

$$\tan S.E = \frac{7.5}{689.440 + 12.990}$$

$$\tan S.E = \frac{7.5}{702.430}$$

$$\tan S.E = 0.011$$

$$S.E = 0.612^\circ W \quad (\text{CO: NE}^{\text{th}} \text{ i.e. N}^{\text{th}} \text{ component} \rightarrow \text{S.E is W})$$

$\Rightarrow$ Total error

$$\text{Total error} = \text{Damping error} + \text{steaming error}$$

$$= 1.202^\circ W + 0.612^\circ W$$

$$= 1.814^\circ W$$

Ans.

7) A vessel with a gyro compass damped in tilt (damping ratio 1/40), sails on a course of 200°T with a speed of 15 knots in latitude 30°27'N. Calculate the course to steer to account for the expected error if the compass is uncorrected.

Soln:- Note:- When gyro is damped in tilt, then there will be both damping error & steaming error.

Total error = Damping error + steaming error

⇒ Damping error

$$\sin D.E = \frac{P_d}{P_c} \times \tan Lat$$

(consider $P_d/P_c = 1/40$, if not given)

$$\sin D.E = \frac{1}{40} \times \tan 30^\circ 27'$$

$$\sin D.E = 0.015$$

$$D.E = 0.842 E \text{ (bez N's Lat)}$$

⇒ Steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos Lat + V \sin \theta}$$

$$\tan S.E = \frac{15 \cos 200^\circ}{900 \cos 30^\circ 27' + 15 \sin 200^\circ}$$

$$\tan S.E = \frac{-14.095}{770.734}$$

$$\tan S.E = -0.018$$

$$S.E = 1.048 E \text{ (Course: } 200^\circ \text{ i.e. SW, it has S's component} \rightarrow \text{S.E is E)}$$

⇒ Total error

Total error = Damping error + Steaming error

$$= 1.048 + 0.842$$

$$= 1.89^\circ E \text{ (Low)}$$

Hence, course to steer = $200^\circ - 1.89$ (Error low, Gyro low)

$$= 198.11^\circ$$

Ans

FEB 2023
NOV 2015 8)
SIMILAR QUES:
NOV 2021
MAY 2025 AM

In latitude 32°N , the Damping error is 1.2°E . Calculate the total gyro error of same gyro compass when making good course $315^\circ(\text{T})$ at a 18 knots in Latitude 48°S

Soln:-

Total error = Damping error + Steaming error
 $\Rightarrow$ Damping error

$$\sin D.E = \frac{PD}{PC} \times \tan \text{lat}$$

For same gyro compass in different latitude

$$\frac{\sin DE_1}{\sin DE_2} = \frac{PD/PC \times \tan \text{lat}_1}{PD/PC \times \tan \text{lat}_2}$$

$$\frac{\sin DE_1}{\sin DE_2} = \frac{\tan \text{lat}_1}{\tan \text{lat}_2}$$

$$\frac{\sin 1.2}{\sin DE_2} = \frac{\tan 32^\circ}{\tan 48^\circ}$$

$$\sin DE_2 \cdot \tan 32^\circ = \sin 1.2 \cdot \tan 48^\circ$$

$$\sin DE_2 \cdot \tan 32^\circ = 0.023$$

$$\sin DE_2 = 0.037$$

$$DE_2 = 2.133 \text{ W (S}^\text{th} \text{ Latitude)}$$

$\Rightarrow$ Steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{lat} + V \sin \theta}$$

$$\tan S.E = \frac{18 \cdot \cos 315^\circ}{900 \cdot \cos 48^\circ + 18 \cdot \sin 315^\circ}$$

$$\tan S.E = \frac{12.728}{602.218 + (-12.728)}$$

$$\tan S.E = 0.022$$

$$S.E = 1.237 \text{ W (CO: NW i.e. it has N}^\text{th} \text{ component} \rightarrow \text{S.E is W)}$$

$\Rightarrow$ Total error

$$\text{Total error} = \text{Damping error} - \text{steaming error}$$

$$= 2.133 + 1.237$$

$$= 3.370 \text{ W} = \text{Ans}$$

AUG 2019 9) A vessel fitted with gyro damped in tilt steers $240^\circ(G)$ at a speed of 15 knots in $30^\circ S$ latitude. What will be the total gyro error. Given that damping ratio = $1/40$

Soln:- Total error = Damping error + steaming error
 $\Rightarrow$ Damping error

$$\sin D.E = \frac{P_d}{P_c} \times \tan \text{lat}$$

$$\sin D.E = \frac{1}{40} \times \tan 30^\circ$$

$$\sin D.E = 0.014$$

$$D.E = 0.827 W \text{ (S' lat)}$$

$\Rightarrow$ Steaming error

$$\tan S.E = \frac{v \cos \theta}{900 \cdot \cos \text{lat} + v \sin \theta}$$

$$\tan S.E = \frac{15 \cdot \cos 240^\circ}{900 \cdot \cos 30^\circ + 15 \cdot \sin 240^\circ}$$

$$\tan S.E = \frac{-7.5}{779.423 + (-12.990)}$$

$$\tan S.E = \frac{-7.5}{766.433}$$

$$\tan S.E = 0.009$$

$$S.E = 0.561 E \text{ (co: sw i.e. it has S' component $\rightarrow$ S.E is E)}$$

$\Rightarrow$ Total error

$$\text{Total error} = D.E - S.E$$

$$= 0.827 - 0.561$$

$$= 0.266 W \text{ (High)} \quad \underline{\underline{\text{Ans}}}$$

NOV 2025 PM 10) A ship at anchor is heading $005^\circ(G)$ in $76^\circ 33'N$ latitude. What is her true heading in each of the following cases?

MAY 2024 PAPER 1

a) Gyro is damped in Azimuth

Solⁿ:- Note: When Gyro is damped in Azimuth, then there is no damping error, Only steaming error is present

Vessel is at anchor, so there will not be the steaming error.

Total error = 0 or NIL

Hence, her true heading = $005^\circ(T)$
Ans

b) Gyro is damped in tilt

Solⁿ:- Note: When Gyro is damped in tilt, then there will be both damping error and steaming error

Vessel is at anchor, so there will not be the steaming error.

⇒ Damping error

$$\sin D.E = \frac{P_d}{P_c} \times \tan \text{lat}$$

(consider $\frac{P_d}{P_c} = \frac{1}{40}$, if not given)

$$\sin D.E = \frac{1}{40} \times \tan 76^\circ 33'$$

$$\sin D.E = 0.105$$

$$D.E = 6.0^\circ E(N' \text{ lat})$$

⇒ Steaming error

0 or NIL as vessel is at anchor

⇒ Total error

Total error = Damping error + Steaming error

$$= 6.0 + 0$$

$$= 6.0^\circ E$$

Hence, true heading = $005^\circ - 6^\circ$

$$= 359^\circ(T)$$

Ans

11) A vessel steers $168^\circ(T)$ at 15.5 knots in $55^\circ 45'N$ latitude. Find Gyro course in each of the following cases.

AUG 2025 PM

MAY 2018

a) Gyro is 'Damped in Azimuth'.

Soln:- Note: When gyro is damped in Azimuth, then there is no damping error.

Only steaming error is present

⇒ Steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{lat} + V \sin \theta}$$

$$\tan S.E = \frac{15.5 \cos 168^\circ}{900 \cos 55^\circ 45' + 15.5 \cos 168^\circ}$$

$$\tan S.E = \frac{-15.161}{491.363}$$

$$\tan S.E = -0.031$$

$$S.E = 1.767 E \quad (\text{co:SE i.e. it has S component, Hence, steaming error is E})$$

$$\text{Gyro course to steer} = 168^\circ - 1.767$$

$$= 166.2^\circ (G) = \text{Ans}$$

b) Gyro is 'Damped in Tilt'

Soln:- Note: When gyro is 'Damped in Tilt', then there will be both damping error & steaming error.

⇒ Damping error

$$\sin D.E = \frac{P_d}{P_c} \times \tan \text{lat}$$

(consider, $P_d/P_c = 1/40$, if not given)

$$\sin D.E = \frac{1}{40} \times \tan 55^\circ 45'$$

$$\sin D.E = 0.037$$

$$D.E = 2.104 E \quad (N^{\text{th}} \text{ lat})$$

⇒ Steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{lat} + V \sin \theta}$$

$$\tan S.E = \frac{15.5 \cos 168^\circ}{900 \cos 55^\circ 45' + 15.5 \cos 168^\circ}$$

$$S.E = 1.767 E$$

⇒ Total error = Damping error + steaming error

$$\Rightarrow 2.104 + 1.767 = 3.871 E$$

$$\text{Gyro course to steer} = 168^\circ - 3.871$$

$$= 164.129 (G) = \text{Ans}$$

FEB 2017, 12)

AUG 2015

Assuming that the peripheral speed of the earth is 540 knots in 54°N latitude, find the error of the gyro compass when making good a course of $175^\circ(\text{T})$ at 21 knots in the Indian Ocean (latitude $29^\circ 42'\text{S}$). If the gyro compass was a) Damped in Azimuth b) Damped in tilt

Soln:-

Given peripheral speed of earth in $\text{Lat } 54^\circ = 540 \text{ Kts}$

Let " " " " at equator = $x \text{ Kts}$.

$$\frac{\cos \text{Lat}_1}{\cos \text{Lat}_2} = \frac{\text{speed}_1}{\text{speed}_2}$$

$$\frac{\cos 54^\circ}{\cos 0^\circ} = \frac{540}{x}$$

$$\cos 54^\circ \cdot x = 540$$

$$x = \frac{540}{\cos 54^\circ}$$

$$x = 918.7 \text{ Kts}$$

a) Damped in Azimuth

Note: When Gyro is damped in Azimuth, then there is no damping error.
Only steaming error is present.

$\Rightarrow$ Damping error

0° or NIL

$\Rightarrow$ Steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{Lat} + V \sin \theta}$$

$$\tan S.E = \frac{21 \cdot \cos 175^\circ}{918.7 \cos 29^\circ 42' + 21 \cdot \sin 175^\circ}$$

$$\tan S.E = \frac{-20.920}{798.012 + 1.830}$$

$$\tan S.E = \frac{-20.920}{799.842}$$

$$\tan S.E = -0.026$$

$$S.E = 1.498 \text{ E (10W)} \quad (\text{CO: SE i.e. H has SY component})$$

Hence steaming error is E

$$\text{Total error} = D.E + S.E$$

$$0 + 1.498$$

$$= 1.498 \text{ E}$$

b) Damped in Tilt

Note: When Gyro is 'Damped in tilt', then there will be both damping error & steaming error

⇒ Damping error

$$\sin D.E = \frac{P_d}{P_c} \times \tan \text{lat}$$

(consider, $P_d/P_c = 1/40$, if not given)

$$\sin D.E = \frac{1}{40} \times \tan 29^\circ 42'$$

$$\sin D.E = 0.014$$

$$D.E = 0.817' W (S' lat)$$

⇒ Steaming error

$$S.E = 1.498' E (LOW)$$

⇒ Total error

$$\text{Total error} = D.E \sim S.E$$

$$= 1.498 - 0.817$$

$$= 0.681' E = \text{Ans}$$

13) The axis of a gyro compass damped in tilt, uncorrected for speed-course error and damping error, points due North in Latitude $61^\circ N$, when making good a course of 345° and a speed of 20 kts. On reaching Latitude of $70^\circ N$, course is required to be altered to $205^\circ (T)$ and speed is to be reduced to 15 kts. Calculate the total error of the gyro compass and the gyro compass to steer in new latitude (Assume that the gyro compass does not have any other error)

Soln:- Give in Ques: Gyro compass points due North

Note: When Gyro compass points due North, Damping error & Steaming error is numerically same with different name.

That means, Gyro spin axis points North & Total error is 0 or Nil

Case I: Lat: $61^\circ N$ CO: 345° $V = 20$ kts.

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{lat} + V \sin \theta}$$

$$\tan S.E = \frac{20 \cdot \cos 345^\circ}{900 \cdot \cos 61^\circ + 20 \sin 345^\circ}$$

$$\tan S.E = \frac{19.319}{431.152}$$

$$\tan S.E = 0.045$$

S.E = 2.565 W or High (bcz co: NE i.e. it has N^{ly} component)

Damping error will be same with different name.

D.E = 2.565 E (we also know, D.E is E^{ly} in NH)

$$\sin D.E = \frac{P_d}{P_c} \times \tan \text{lat}$$

$$\sin 2.565 = \frac{P_d}{P_c} \times \tan 61^\circ$$

$$\frac{P_d}{P_c} = 0.025$$

Case II: Lat: 70°N CO: 205°(T) V = 15 Kts.

⇒ Damping error

$$\sin D.E = \frac{P_d}{P_c} \times \tan \text{lat}$$

$$\sin D.E = 0.025 \times \tan 70^\circ$$

$$\sin D.E = 0.069$$

D.E = 3.939 E (D.E is E^{ly} in NH)

⇒ Steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{lat} + V \sin \theta}$$

$$\tan S.E = \frac{15 \cdot \cos 205^\circ}{900 \cdot \cos 70^\circ + 15 \cdot \sin 205^\circ}$$

$$\tan S.E = \frac{-13.595}{301.479}$$

$$\tan S.E = -0.045$$

S.E = 2.582 E or low (bcz co: SE i.e. it has S^{ly} component)

⇒ Total error

$$\text{Total error} = D.E \sim S.E$$

$$= 3.939 + 2.582$$

$$= 6.521^\circ \text{ E or low} = \text{Ans}$$

⇒ Gyro course to steer

$$205^\circ - 6.521 \quad (\text{Error low, Gyro low})$$

$$= 198.479 \text{ or } 198.5^\circ = \text{Ans}$$

AUG 2025 AM 14)
MAY 2022
AUG 2018

A ship is making good $270^\circ(T)$ while her gyro compass shows $265^\circ(G)$, in $54^\circ 41'N$ latitude. She is required to make good $170^\circ(T)$ at 19 knots. What gyro course would you set on her Auto-Pilot (There is no current and gyro compass has no other errors)

Soln:- True heading: $270^\circ(T)$ Gyro heading: $265^\circ(G)$
Gyro error = $5^\circ E$ or low

Note: In exactly E/W course, S.E is 0 or NIL

$$\begin{aligned}\text{Total error} &= 5^\circ E \text{ or low} \\ D.E + S.E &= 5^\circ E \text{ or low} \\ D.E + 0 &= 5^\circ E \text{ or low} \\ D.E &= 5^\circ E \text{ or low}\end{aligned}$$

$\Rightarrow$ Damping error
Damping error remains same as latitude & hemisphere remain same.
 $\Rightarrow$ Steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{lat} + V \sin \theta}$$

$V = 19 \text{ Kts}$ course $(\theta) = 170^\circ(T)$ Lat: $54^\circ 41'N$

$$\tan S.E = \frac{19 \cdot \cos 170^\circ}{900 \cdot \cos 54^\circ 41' + 19 \cdot \sin 170^\circ}$$

$$\tan S.E = \frac{18.711}{523.585}$$

$$\tan S.E = 0.036$$

$$S.E = 2.047^\circ E \text{ or low (co: SE, it has S'y component, so error is E)}$$

$\Rightarrow$ Total error

$$\begin{aligned}\text{Total error} &= D.E + S.E \\ &= 5^\circ + 2.047^\circ \\ &= 7.047^\circ E \text{ or low}\end{aligned}$$

$$\begin{aligned}\text{Gyro course to set on the Auto-Pilot} &= 170^\circ - 7.047^\circ \\ &= 162.95^\circ(G) \quad \text{Ans}\end{aligned}$$

NOV 2024 PM 15)

AUG 2021

A vessel is fitted with "Damped in Azimuth" gyro compass steers $182^\circ(G)$ at 27 knots in $55^\circ 37'$ latitude and makes good $174^\circ(T)$. What will this gyro compass read when the ship makes good $344^\circ(T)$ at 9.5 knots in $73^\circ N$ lat?

Soln:-

True heading: $174^\circ(T)$

Gyro heading: $182^\circ(G)$

Gyro error: $8^\circ W$ or High

* Damped in Azimuth

Note: When gyro is damped in Azimuth, then there is no damping error. Only steaming error is present.

Case I:

$$\text{Total error} = D.E \sim S.E$$

$$8^\circ W = D \sim S.E$$

$$\text{So, } S.E = 8^\circ W \text{ or high}$$

Case II:

$$V = 9.5 \text{ knots}$$

$$CO: 344^\circ$$

$$\text{Lat: } 73^\circ N$$

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{Lat} + V \sin \theta}$$

$$\tan S.E = \frac{9.5 \times \cos 344^\circ}{900 \times \cos 73^\circ + 9.5 \times \sin 344^\circ}$$

$$\tan S.E = \frac{9.132}{260.516}$$

$$\tan S.E = 0.035$$

$$S.E = 2.008^\circ W \text{ or high (bcz CO: NW, it has N component, so error is W)}$$

$$\text{Total error} = D.E \sim S.E$$

$$S.E = 0 + 2.008^\circ$$

$$= 2.008^\circ W \text{ or high}$$

$$\text{Gyro reading} = 344^\circ + 2.008^\circ$$

$$= 346.008^\circ \sim 346^\circ(G) = \text{Ans}$$

* This question fits when question has "Damped in tilt".

NOV 2017 16)

Your ship is anchored at position 54°N 060°E and gyro error is found to be 2° low. Find out the course to steer for making good a course of $158^{\circ}(\text{CT})$, if ship's speed is 16 kts in Lat 40°N .

Soln:- Case I:

→ vessel is anchored & therefore is no steaming error.

Gyro error : 2°E or low

$$\text{D.E} + \text{S.E} = 2^{\circ}\text{E or low}$$

$$\text{D.E} + 0 = 2^{\circ}\text{E or low}$$

$$\text{D.E} = 2^{\circ}\text{E or low}$$

$$\sin \text{D.E} = \text{Pd/Pc} \times \tan \text{lat}$$

$$\sin 2^{\circ} = \text{Pd/Pc} \times \tan 54^{\circ}$$

$$\text{Damping factor or Pd/Pc} = 0.025$$

Case II:

$$V = 16 \text{ KTS} \quad \text{CO: } 158^{\circ} \quad \text{Lat: } 40^{\circ}\text{N}$$

$$\sin \text{D.E} = \text{Pd/Pc} \times \tan \text{lat}$$

$$\sin \text{D.E} = 0.025 \times \tan 40^{\circ}$$

$$\sin \text{D.E} = 0.021$$

$$\text{D.E} = 1.202^{\circ}\text{E (bcz N}^{\text{th}}\text{ latitude)}$$

$$\tan \text{S.E} = \frac{V \cos \theta}{900 \cos \text{lat} + V \sin \theta}$$

$$\tan \text{S.E} = \frac{16 \times \cos 158^{\circ}}{900 \cos 40^{\circ} + 16 \times \sin 158^{\circ}}$$

$$\tan \text{S.E} = \frac{14.835}{695.434}$$

$$\tan \text{S.E} = 0.021$$

$$\text{S.E} = 1.222^{\circ}\text{E (co: SE, it has S}^{\text{th}}\text{ component, so error is E)}$$

$$\text{Total error} = \text{D.E} \sim \text{S.E}$$

$$= 1.202 + 1.222$$

$$= 2.424^{\circ}\text{E or low}$$

$$\text{Gyro course to steer} = 158^{\circ} - 2.424$$

$$= 155.576^{\circ} \sim 155.6^{\circ}(\text{G})$$

Ans

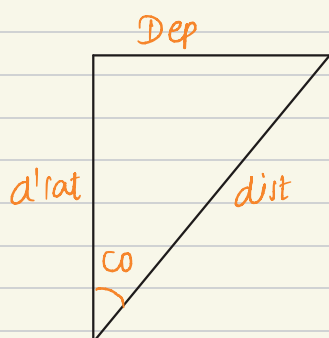
17) A vessel fitted with a gyro damped in tilt steams a straight Rhumb line course from position "P" (46° 30'N 170° 10'E) and arrive at position "Q" (50° 10' N, 179° 45'W) after steaming for 12 hours. State: What is the required Gyro course to be steered by the vessel from P to reach Q?

Posⁿ P : 46° 30' N 170° 10' E
 Posⁿ Q : 50° 10' N 179° 45' W
 d'lat : 03° 40' d'long: 01° 05' 0" W
 m'lat : 48° 20' N

$$\cos m'lat = dep/d'long$$

$$\cos 48^{\circ} 20' = dep/01^{\circ} 05' 0"$$

$$Dep = 00^{\circ} 43.2'$$



$$\tan Co = \frac{Dep}{d'lat} \Rightarrow \tan Co = \frac{00^{\circ} 43.2'}{03^{\circ} 40'} \Rightarrow Co : 11.11^{\circ}$$

$$\sin Co = \frac{Dep}{dist} \Rightarrow \sin 11.11^{\circ} = \frac{00^{\circ} 43.2'}{dist} \Rightarrow Dist : 3^{\circ} 44.2' (x60) = 224.1 NM$$

$$Distance = speed \times time \longrightarrow speed = \frac{Distance}{time} \Rightarrow speed = \frac{224.1}{12} = 18.68 Kts$$

⇒ Damping error

$$\sin D.E = \frac{Pd}{Pc} \times \tan Lat$$

$$\sin D.E = \frac{1}{40} \times \tan 48^{\circ} 20'$$

$$\sin D.E = 0.028$$

$$D.E = 1.610^{\circ} E \text{ (DE is E'ly in NH)}$$

⇒ Steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos lat + V \sin \theta}$$

$$\tan S.E = \frac{18.68 \times \cos 11.11^{\circ}}{900 \cos 48^{\circ} 20' + 18.68 \times \sin 11.11^{\circ}}$$

$$\tan S.E = \frac{18.330}{601.916}$$

$$\tan S.E = 0.030$$

$$S.E = 1.744 W \text{ or High (Co: NE i.e. it has N'ly component, so error is West)}$$

⇒ Total error

$$Total error = D.E \sim S.E$$

$$= 1.744 - 1.610$$

$$= 0.134 W \text{ or High}$$

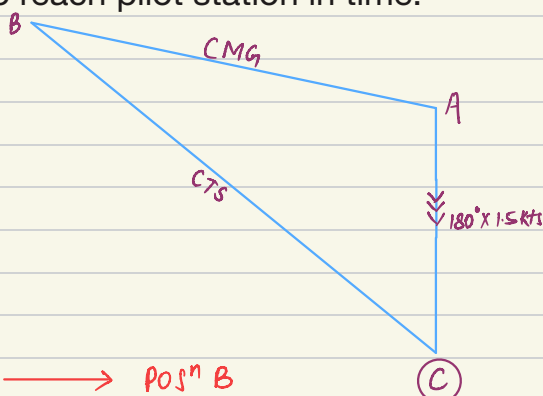
$$Gyro compass to steer = 11.11 + 0.134 \text{ (Error high, Gyro high)}$$

$$= 11.244 (G)$$

Ans

18) Ship sails at 1400 hrs from position 43°N, 058° 30'W to pick up pilot at 1900 hrs in position 44°N, 060°W. The current has been setting 180°(T) at 1.5 Kt, throughout. The ship is fitted with sperry gyro, which is uncorrected for damping and N-S speed error. If the damping ratio is 1/40, calculate the gyro course and the ship's speed, which need to be maintained, to reach pilot station in time.

Soln:-



Posⁿ A → Posⁿ B

Posⁿ A : 43° 00' 0" N 058° 30' W

Posⁿ B : 44° 00' 0" N 060° 00' W

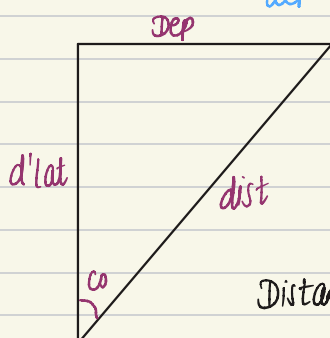
d'lat : 1° 00' 0" d'long : 1° 30' W

m'lat : 43° 30' 0" N

$$\cos m'lat = dep / d'long$$

$$\cos 43° 30' = dep / 1° 30'$$

$$dep = 1.088 = 1° 5.3' W$$



$$\tan Co = \frac{dep}{d'lat} \Rightarrow \tan Co = \frac{1° 5.3'}{1° 00'} \Rightarrow \tan Co = 1° 5.3' \Rightarrow Co = 47° 25.3'$$

$$\sin Co = \frac{dep}{dist} \Rightarrow \sin 47° 25.3' = \frac{1° 5.3'}{dist} \Rightarrow dist = \frac{1° 28.6'}{\sin 47° 25.3'} = 88.6 \text{ NM}$$

$$\text{Distance} = \text{Speed} \times \text{time} \Rightarrow \text{speed} = \frac{\text{Distance}}{\text{time}} \Rightarrow \text{Speed} = \frac{88.6}{5} = 17.72 \text{ Kts}$$

1400 to 1900 hrs

To find Posⁿ C, Apply Run @ 180° x 1.5 Kts for 5 hours

Co: 180° Dist: 1.5 x 5 = 7.5 NM

Since, Co: 180°, d'long is 0 & d'lat = 0° 7.5' S

Posⁿ A : 43° 00' 0" N 058° 30' 0" W

d'lat : 0° 7.5' S d'long : 0° 00' 0"

Posⁿ C : 42° 52.5' N 058° 30' 0" W

Posⁿ C → Posⁿ B

Posⁿ C : 42° 52.5' N 058° 30' 0" W

Posⁿ B : 44° 00' 0" N 060° 00' 0" W

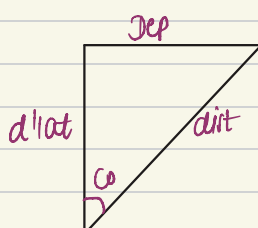
d'lat : 1° 7.5' S d'long : 1° 30' 0" W

m'lat : 43° 26.3' N

$$\cos m'lat = dep / d'long$$

$$\cos 43° 26.3' = dep / 1° 30'$$

$$dep = 1° 5.3' W$$



$$\tan Co = \frac{dep}{d'lat} \Rightarrow \tan Co = \frac{1° 5.3'}{1° 7.5'} \Rightarrow \tan Co = 0.967 \Rightarrow Co = 44.1° W = 315.9°$$

$$\sin Co = \frac{dep}{dist} \Rightarrow \sin 44.1° = \frac{1° 5.3'}{dist} \Rightarrow dist = \frac{1° 33.9'}{\sin 44.1°} = 93.9 \text{ NM}$$

$$\text{Distance} = \text{Speed} \times \text{time} \longrightarrow \text{Speed} = \frac{\text{distance}}{\text{time}} \Rightarrow \text{Speed} = \frac{93.9}{5} \Rightarrow 18.78 \text{ Kts}$$

⇒ Damping error

$$\sin D.E = \frac{P_d}{P_c} \times \tan \text{lat}$$

$$\sin D.E = \frac{1}{40} \times \tan 43^\circ 26.3'$$

$$\sin D.E = 0.024$$

$$D.E = 1.36^\circ \text{ E (DE is E'ly in NH)}$$

⇒ Steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{lat} + V \sin \theta}$$

$$\tan S.E = \frac{18.78 \times \cos 315.9^\circ}{900 \times \cos 43^\circ 26.3' + 18.78 \times \sin 315.9^\circ}$$

$$\tan S.E = \frac{13.486}{640.434}$$

$$\tan S.E = 0.021$$

$$S.E = 1.21^\circ \text{ W (co: } 315.9^\circ \text{ i.e. NW, it has N'ly component, so error is west)}$$

⇒ Total error

$$\text{Total error} = D.E \sim S.E$$

$$= 1.36 - 1.21$$

$$= 0.15^\circ \text{ E or low}$$

$$\text{CTS} = 315.9^\circ$$

$$\begin{aligned} \text{Gyro course to steer} &= 315.9^\circ - 0.15^\circ \\ &= 315.8^\circ \\ &\quad \text{Ans} \end{aligned}$$

19) A ship with gyro compass uncorrected for Damping & Steaming errors steers 205° (T & G) from position A in lat 58°S to B in lat 62°S . Determine the speed of the ship & course to steer from position B to A with gyro compass uncorrected. ($P_c: P_d = 40:1$)

Solⁿ:-

Note: Since True & Gyro are same, that means, D.E and S.E are of same value but of different name

Case I: A to B

⇒ Damping error

$$\sin D.E = \frac{P_d}{P_c} \times \tan \text{lat}$$

$$\sin D.E = \frac{1}{40} \times \tan 60^\circ$$

$$\sin D.E = 0.043$$

$$D.E = 2.482 W \text{ (D.E is Wⁿ in SH)}$$

⇒ Steaming error

$$S.E_1 = 2.482 E \text{ (co: SE i.e. it has Sⁿ component, so error is East)}$$

⇒ To find speed of the ship

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{lat} + V \sin \theta}$$

$$\tan 2.482 = \frac{V \cdot \cos 205^\circ}{900 \cos 60^\circ + V \sin 205^\circ}$$

$$0.043 = \frac{-0.906V}{450 + (-0.423V)}$$

$$0.043 = \frac{-0.906V}{450 - 0.423V}$$

$$19.35 - 0.018V = -0.906V$$

$$19.35 = -0.906V + 0.018V$$

$$19.35 = -0.888V$$

$$V = 21.79 \text{ Kts} \text{ Ans}$$

Case II: B to A

⇒ Damping error

$$D.E = 2.482 W \text{ (D.E remains same, as latitude & Hemisphere are same)}$$

⇒ Steaming error

$$V = 21.79 \text{ Kts} \quad \text{Co: } 205 - 180 = 25^\circ \quad \text{Lat: } \frac{58 + 62}{2} = 60^\circ\text{S}$$

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{lat} + V \sin \theta}$$

$$\tan S.E = \frac{21.79 \cdot \cos 25^\circ}{900 \cdot \cos 60^\circ + 21.79 \cdot \sin 25^\circ}$$

$$\tan S.E = \frac{19.748}{459.209}$$

$$\tan S.E = 0.043$$

$$S.E = 2.462 W \text{ (co: NE i.e. it has Nⁿ component, so error is W)}$$

⇒ Total error

$$\begin{aligned} \text{Total error} &= D.E \sim S.E \\ &= 2.482 + 2.462 \\ &= 4.944 W \text{ or High} \end{aligned}$$

Hence,

$$\begin{aligned} \text{Gyro course to steer} &= 025^\circ + 4.944 \text{ (Error High, Gyro High)} \\ &= 29.944(G) \\ &\text{Ans} \end{aligned}$$

20) A vessel sails along the meridian from 44°S to 75°S in 86.06 hours using her 'Damped in Tilt' Gyro Compass (eccentricity being 1/36) & FIVE days later returned back to her original location in 77.97 hours using her 'Damped in Azimuth' Gyro compass. Find the Gyro course steered on EACH Leg.

Solⁿ:-

NOTE:- Vessel sails along the meridian

That means, $\text{Co} : 180^\circ$

= Case 1 :- 44°S to 75°S (Damped in Tilt)

Note: When gyro is damped in tilt, there is both Damping error & steaming error.

Lat 44°S $\rightarrow$ Lat 75°S $\Rightarrow d'lat = 31^\circ S$

$$\begin{aligned} \text{Dist} &= 31 \times 60 \\ &= 1860 \text{ NM} \end{aligned}$$

Vessel travels 1860 NM in 86.06 hours

Speed = Distance/time

$$\Rightarrow 1860/86.06 = 21.61 \text{ Kts}$$

$\Rightarrow$ Damping error $\sin D.E = \frac{Pd}{Pc} \times \tan lat$

$$\sin D.E = \frac{1}{36} \times \tan 59^\circ 30'$$

$$\sin D.E = 0.047$$

$$D.E = 2.703^\circ W \text{ (DE is W in SH)}$$

$\Rightarrow$ Steaming error $\tan S.E = \frac{V \cos \theta}{900 \cos Lat + V \sin \theta}$

$$\tan S.E = \frac{21.61 \times \cos 180^\circ}{900 \cos 59^\circ 30' + 21.61 \times \sin 180^\circ}$$

$$\tan S.E = 21.61/456.785$$

$$\tan S.E = 0.047$$

$$S.E = 2.709^\circ E \text{ (Co: S, hence error is east)}$$

$\Rightarrow$ Total error $\text{Total error} = D.E - S.E$

$$= 2.709 - 2.703$$

$$= 0.006 E \text{ or low}$$

Gyro course to steer = $180^\circ - 0.006$

$$= 179.994(G) \approx 180^\circ(G) = \text{Ans}$$

= Case 2 : 75°S to 44°S (Damped in Azimuth)

Note: When gyro is damped in Azimuth, there is no damping error, there are only steaming error.

Vessel travels 1860 NM in 77.97 hours

Speed = Distance/time

$$\Rightarrow 1860/77.97 = 23.86 \text{ Kts}$$

$\Rightarrow$ Damping error 0 or NIL

$\Rightarrow$ Steaming error $\tan S.E = \frac{V \cos \theta}{900 \cos Lat + V \sin \theta}$

$$\tan S.E = \frac{23.86 \times \cos 0^\circ}{900 \cos 59^\circ 30' + 23.86 \times \sin 0^\circ}$$

$$\tan S.E = 0.052$$

$$S.E = 2.990^\circ W \text{ (Co: N, hence error is West)}$$

$\Rightarrow$ Total error $\text{Total error} = D.E - S.E$

$$= 0 - 2.990$$

$$= 2.990^\circ W \text{ or high}$$

Gyro course to steer = $000^\circ + 2.990$

$$= 2.990(G) \approx 003^\circ(G) = \text{Ans}$$

SIMILAR QUES: MAY 2017

21) In latitude 30°N , while steering 045° at certain speed, transit bearing of a pair of light houses was observed as 135° (T & G). What shall be the gyro transit bearing of another pair of lighthouse true bearing 60° , in latitude 30°S while steering a course of 315° and same speed. Given that damping ratio = $1/40$.

Solⁿ:- Note: For transit bearing, it should have same True & gyro bearing.
D.E & S.E will be same but of different name.

Case I:- In latitude 30°N

⇒ Damping error

$$\sin D.E = \frac{Pd}{Pc} \times \tan \text{Lat}$$

$$\sin D.E = \frac{1}{40} \times \tan 30^\circ$$

$$\sin D.E = 0.014$$

$$D.E = 0.827^\circ E \text{ (DE is E" in NH)}$$

⇒ Steaming error

$$S.E = 0.827^\circ W \text{ (same but of diff. name)}$$

To find speed

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{Lat} + V \sin \theta}$$

$$\tan 0.827 = \frac{V \cos 045^\circ}{900 \cos 30^\circ + V \sin 45^\circ}$$

$$0.014 = \frac{0.707V}{779.423 + 0.707V}$$

$$10.912 + 0.009V = 0.707V$$

$$10.912 = 0.707V - 0.009V$$

$$0.697V = 10.912$$

$$V = 15.66 \text{ Kts}$$

Case II: In latitude 30°S

⇒ Damping error

$$\sin D.E = \frac{Pd}{Pc} \times \tan \text{Lat}$$

$$\sin D.E = \frac{1}{40} \times \tan 30^\circ$$

$$\sin D.E = 0.014$$

$$D.E = 0.827^\circ W \text{ (DE is W" in SH)}$$

⇒ Steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{Lat} + V \sin \theta}$$

$$\tan S.E = \frac{15.66 \times \cos 315^\circ}{900 \cos 30^\circ + 15.66 \times \sin 315^\circ}$$

$$\tan S.E = \frac{11.073}{768.350}$$

$$\tan S.E = 0.014$$

$$S.E = 0.826^\circ W \text{ (CO: NW i.e. it has Nly component, so error is west)}$$

⇒ Total error

$$\text{Total error} = D.E \sim S.E$$

$$= 0.827 + 0.826$$

$$= 1.653^\circ W \text{ (High)}$$

$$\text{Gyro transit bearing} = 060^\circ + 1.653$$

$$= 061.6^\circ (G)$$

(Error High, Gyro High)

22) The auxiliary corrector of a gyro compass damped in tilt was inadvertently left at 'Zero Speed' & 'Zero Latitude'. The vessel was steering 030° by gyro at 18 knots in 48°N Latitude and also made a good course of 030° (T). Find the gyro course steered by the vessel if she is making good a course of 060° (T) at a speed of 15 knots in 59°S latitude with the auxiliary correctors still left to 'Zero' speed and latitude setting. (Assume there is no current throughout and also the gyro compass is not having any other errors).

Solⁿ:- The auxiliary corrector of a gyro compass damped in tilt was inadvertently left at 'Zero Speed' & 'Zero Latitude'. $\longrightarrow$ This means Gyro damped in tilt is uncorrected

= Case I: In latitude 48°N

$$V = 18 \text{ Kts} \quad \underbrace{\text{CO}(\theta) = 030^\circ \quad \text{CMG} : 030^\circ(\text{T})}_{\text{This means D.E \& S.E are same, but different name.}} \quad \text{Lat} : 48^\circ\text{N}$$

$\Rightarrow$ To find Damping factor

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{Lat} + V \sin \theta}$$

$$\tan S.E = \frac{18 \times \cos 30^\circ}{900 \times \cos 48^\circ + 18 \times \sin 30^\circ}$$

$$\tan S.E = \frac{15.588}{611.218}$$

$$\tan S.E = 0.026$$

$$S.E = 1.461 \text{ W} \quad (\text{CO: NE i.e. it has Nly component, so error is west})$$

$$D.E = 1.461 \text{ E} \quad (\text{same value but of diff. name})$$

$$\sin D.E = \rho_d / \rho_c \times \tan \text{lat}$$

$$\sin 1.461 = \rho_d / \rho_c \times \tan 48^\circ$$

$$\text{Damping factor or } \rho_d / \rho_c = 0.023$$

= Case II: In Latitude 59°S

$$V = 15 \text{ Knots} \quad \text{CO}(\theta) = 060^\circ \quad \text{Lat} : 59^\circ\text{S}$$

$\Rightarrow$ Damping error

$$\sin D.E = \rho_d / \rho_c \times \tan \text{lat}$$

$$\sin D.E = 0.023 \times \tan 59^\circ$$

$$\sin D.E = 0.038$$

$$D.E = 2.194 \text{ W} \quad (D.E \text{ is Wly in SH})$$

$\Rightarrow$ Steaming error

$$\tan S.E = \frac{V \cos \theta}{900 \cos \text{Lat} + V \sin \theta}$$

$$\tan S.E = \frac{15 \times \cos 60^\circ}{900 \times \cos 59^\circ + 15 \times \sin 60^\circ}$$

$$\tan S.E = \frac{7.5}{476.525}$$

$$\tan S.E = 0.016$$

$$S.E = 0.902 \text{ W} \quad (\text{CO: NE i.e. it has Nly component, error is W})$$

$\Rightarrow$ Total error

$$\text{Total error} = D.E + S.E$$

$$= 2.194 + 0.902$$

$$= 3.096 \text{ W or High}$$

$$\text{Gyro course to steer} = 060^\circ + 3.096$$

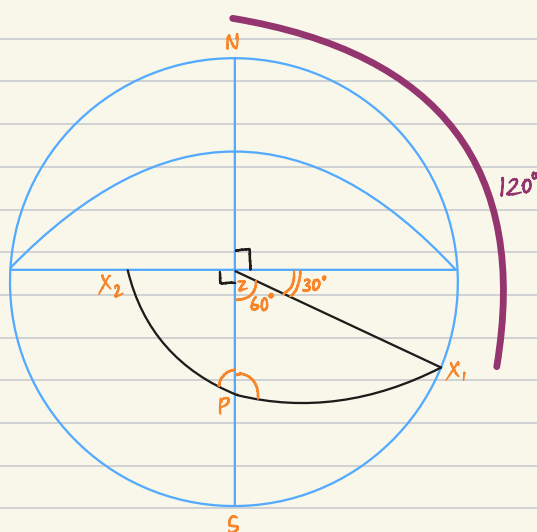
$$= 63.096^\circ \approx 063^\circ(\text{G})$$

Ans

24) At 00h 00m 00s GMT in latitude, 45.0°S and longitude 000.0° , spin axis of a free gyroscope is pointing 120° (T). At what time it will point 270° (T) on the same day?

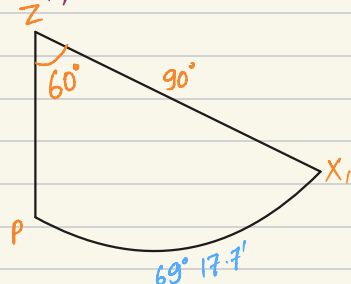
SEPT 2022

Solⁿ:-



$$PZ = 45^\circ, \angle Z = 60^\circ, PX_1 = PX_2$$

In $\triangle PZX_1$,



$$\cos \angle Z = \frac{\cos PX_1 - \cos PZ \cdot \cos ZX_1}{\sin PZ \cdot \sin ZX_1}$$

$$\cos \angle Z \cdot \sin PZ \cdot \sin ZX_1 = \cos PX_1 - \cos PZ \cdot \cos ZX_1$$

$$\cos PX_1 = \cos \angle Z \cdot \sin PZ \cdot \sin ZX_1 + \cos PZ \cdot \cos ZX_1$$

$$\cos PX_1 = \cos 60^\circ \cdot \sin 45^\circ \cdot \sin 90^\circ + \cos 45^\circ \cdot \cos 90^\circ$$

$$\cos PX_1 = 0.354$$

$$PX_1 = 69^\circ 17.7' = PX_2$$

$$\cos \angle P = \frac{\cos ZX_1 - \cos PZ \cdot \cos PX_1}{\sin PZ \cdot \sin PX_1}$$

$$\cos \angle P = \frac{\cos 90^\circ - \cos 45^\circ \cdot \cos 69^\circ 17.7'}{\sin 45^\circ \cdot \sin 69^\circ 17.7'}$$

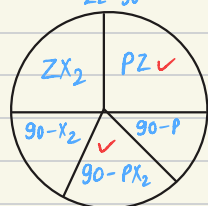
$$\cos \angle P = \frac{0 - 0.250}{0.661}$$

$$\cos \angle P = -0.378$$

$$\angle P = -67^\circ 47.5'$$

$$= 112^\circ 12.6'$$

In $\triangle PZX_2$,



$$\sin(\text{mid part}) = \tan(\text{adj}) \times \tan(\text{adj})$$

$$\sin(90-P) = \tan PZ \cdot \tan(90-PX_2)$$

$$\cos P = \tan 45^\circ \cdot \tan(90-69^\circ 17.7')$$

$$\cos P = \tan 45^\circ \cdot \tan 20^\circ 42.3'$$

$$\cos P = 0.378$$

$$P = 67^\circ 47.5'$$

$$\text{Total } P = 67^\circ 47.5' + 112^\circ 12.6'$$

$$= 180^\circ 00.1'$$

$$= 12\text{H } 00\text{M } 0.9\text{S}$$

= Ans

25) Performance test of a stationery gyro compass gave the following readings:

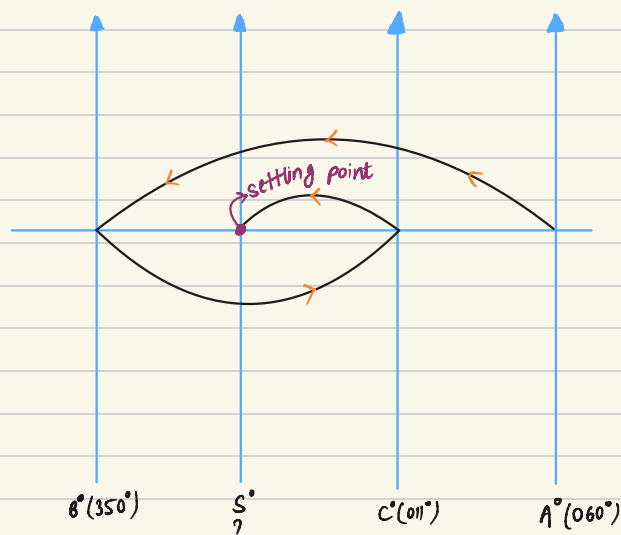
MAY 2024 First extreme swing to one side – 060° at 13h 50m 03s.

PAPER 2 Next extreme swing to one side – 350° at 14h 36m 32s.

Next extreme swing to one side – 011° at 15h 15m 22s.

The gyro compass finally settled at a reading of 006° . Calculate the damping factor, percentage damping and the theoretical settling position. State if the test was satisfactory.

Solⁿ:-



$$\begin{aligned} \rightarrow \text{Damping factor} &= (B \sim C) \div (A \sim B) \\ &= (350^\circ \sim 011^\circ) \div (060^\circ \sim 350^\circ) \\ &= 21^\circ \div 70^\circ \\ &= 0.3^\circ \\ &\quad \text{Ans} \end{aligned}$$

$$\begin{aligned} \rightarrow \text{Damping percentage} &= (1 - 0.3) \times 100 \\ &= 70\% \\ &\quad \text{Ans} \end{aligned}$$

$$\begin{aligned} \rightarrow \text{Theoretical settling position} &= B + \left(\frac{(A \sim B) \cdot (B \sim C)}{(A \sim B) + (B \sim C)} \right) \\ &= 350^\circ + \left(\frac{(060^\circ \sim 350^\circ) \cdot (350^\circ \sim 011^\circ)}{(060^\circ \sim 350^\circ) + (350^\circ \sim 011^\circ)} \right) \\ &= 350^\circ + \left(\frac{70 \times 21}{70 + 21} \right) \\ &= 350^\circ + 16.154^\circ \\ &= 6.15^\circ \end{aligned}$$

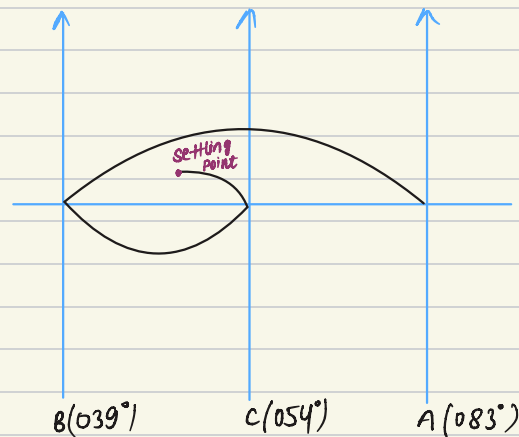
$$\text{Actual settling position} = 6^\circ$$

$$\begin{aligned} \text{Difference} &= 6.15^\circ - 6^\circ \\ &= 0.15^\circ \end{aligned}$$

The difference is less than 0.5° , so test is satisfactory Ans

26) During a performance test the following peaks were observed, / $A=083^\circ$, $B=039^\circ$ and $C=054^\circ$, Calculate the settling position and the percentage of damping.

Soln:-



$$\begin{aligned}\rightarrow \text{Damping factor} &= (B \sim C) \div (A \sim B) \\ &= (039^\circ \sim 054^\circ) \sim (083^\circ - 039^\circ) \\ &= 15 \div 44 \\ &= 0.341 \\ &= \text{Ans}\end{aligned}$$

$$\begin{aligned}\rightarrow \text{Damping percentage} &= (1-f) \times 100 \\ &= (1-0.341) \times 100 \\ &= 0.659 \times 100 \\ &= 65.9\% \\ &= \text{Ans}\end{aligned}$$

$$\begin{aligned}\rightarrow \text{Settling position} &= B + \left(\frac{(A \sim B) \cdot (B \sim C)}{(A \sim B) + (B \sim C)} \right) \\ &= 039^\circ + \left(\frac{44 \times 15}{44 + 15} \right) \\ &= 039^\circ + 11.186^\circ \\ &= 50.186^\circ \\ &= 50.2^\circ \\ &= \text{Ans}\end{aligned}$$