

**ANNEX B OF CMO NO. 20, SERIES OF 2015  
BACHELOR OF SCIENCE IN MARINE TRANSPORTATION  
COURSE SPECIFICATIONS**

|  |   |  |
|--|---|--|
| <b>Course Code</b>                       | : | Nav 1  |
| <b>Course Descriptive Title</b>          | : | Navigational Instruments with Compasses  |
| <b>Course Credits</b>                    | : | 4 units  |
| <b>Lecture Contact Hours per Week</b>    | : | 3 hours  |
| <b>Laboratory Contact Hours per Week</b> | : | 4 hours  |
| <b>Prerequisite/s</b>                    | : | None   |
| <b>Reference/s</b>                       | : | <ol style="list-style-type: none"> <li>1. Table A-II/1 of the 1978 STCW Code as amended<br/>Function: Navigation at the Operational Level</li> <li>2. Table A-II/2 of the 1978 STCW Code as amended<br/>Function: Navigation at the Management Level</li> <li>3. IMO Model Course 7.01 and 7.03</li> <li>4. Annex A of CMO No. 20, Series of 2015 (Curriculum Mapping for BSMT)</li> </ol> |

| COMPETENCE  | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY                             | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|---|---|---|-----------------|
| Plan and conduct a passage and determine position | <i>Electronic systems of position fixing and navigation</i><br><br>Ability to | <ol style="list-style-type: none"> <li>1. Basic principles of hyperbolic terrestrial navigation systems (MC 7.03) <ul style="list-style-type: none"> <li>- describes, with reference to position fixing, the nature of a hyperbola</li> <li>- draws a hyperbolic pattern associated with two foci, with the baseline divided into an exact number of equal divisions</li> </ul> </li> </ol> | 2               |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY                    | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|------------|--|---|-----------------|
|            | determine the ship's position by use of electronic navigational aids | <ul style="list-style-type: none"> <li>- explains the principles of the hyperbolae being position lines</li> <li>- describes the causes of ambiguity and reduced accuracy in the baseline extension area</li> <li>- combines two hyperbolic patterns to illustrate the method of ascertaining position</li> </ul>   |                 |
|            |  | <p>2. Loran-C system (MC 7.03)</p> <ul style="list-style-type: none"> <li>- describes the basic Loran-C and eLoran system</li> <li>- draws a block diagram of a Loran-C receiver, showing how time differences are measured</li> <li>- describes how ambiguity in a position line is resolved</li> <li>- explains why third-cycle matching is used</li> <li>- explains how the use of sky waves affects the measured time difference</li> <li>- describes typical radii of coverage areas</li> <li>- identifies the Loran chart and the additional information printed thereon</li> <li>- switches on equipment; selects chain and relates the time differences obtained to the correct station pair</li> <li>- recognises warnings which indicate that the system may be faulty</li> </ul> | 3               |
|            |  | <p>3. ELoran (MC 7.03)</p> <ul style="list-style-type: none"> <li>- describes the basic operating principles of eLoran</li> <li>- describes the principal difference between eLoran and traditional Loran-C system.</li> <li>- explains the use of eLoran when satellite services are disrupted.</li> <li>- states that each user's eLoran receiver will be operable in all regions where an eLoran service is provided .</li> <li>- describes the control, operating and monitoring systems of</li> </ul>  | 2               |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|------------|---|---|-----------------|
|            |   | eLoran. .<br>- states that eLoran transmissions are synchronized to an identifiable, publicly- certified, source of Coordinated Universal Time (UTC) by a method wholly independent of GNSS<br>- explains the view mode and signal tracking of eLoran.<br>- describes the advantages and limitations of eLoran  |                 |
|            |   | 4. Global navigation satellite systems (MC 7.03)<br>- describes the principles of operation of global navigation satellite systems<br>- states that the system will provide continuous world-wide position-fixing capabilities<br>- describes the intended level of accuracy of the system  | 10              |
|            |   | 5. GPS (MC 7.03)<br>- describes the basic principles of the Global Positioning System (GPS)<br>- describes the system configuration<br>- states the frequencies that are used<br>- describes the C/A & P codes<br>- describes how the basic line measurement is obtained<br>- describes the Dilution of Precision (DOP)<br>- describes the various DOPs that are used<br>- describes the various errors of GPS<br>- describes the reasons for selective availability and the effect it may have on the accuracy of a fix<br>- describes differential GPS<br>- describes the accuracy obtainable with GPS and how the accuracy can be downgraded | 10              |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|------------|---|---|-----------------|
|            |   | <ul style="list-style-type: none"> <li>- explains WGS 84</li> <li>- explains why a fix obtained from the GPS receiver cannot be plotted direct onto a navigational chart</li> <li>- explains datum shifts</li> <li>- describes the advantages and limitations of GPS</li> </ul>   |                 |
|            |   | <p>6. Augmented satellite systems (MC 7.03)</p> <ul style="list-style-type: none"> <li>- describes the basic principle of Differential GPS</li> <li>- describes how DGPS stations can transmit the corrections</li> <li>- describes the Regional Satellite Navigation Systems such as China's BeiDou (COMPASS) Navigation Satellite System, India's Indian Regional Navigational Satellite System (IRNSS), Japan's Quasi-Zenith Satellite System (QZSS) and France's Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS).</li> <li>- describes the limitation of the DGPS receiver</li> </ul> | 1               |
|            |   | <p>7. GLONASS (MC 7.03)</p> <ul style="list-style-type: none"> <li>- describes the principle on which the GLONASS works</li> <li>- explains the different satellite constellation configurations under GLONASS and GPS respectively</li> <li>- describe the advantage of the receiver capable of operating both GLONASS and GPS "combined GPS/GLONASS receiver equipment"</li> <li>- describes the limitation of the GLONASS system receiver</li> </ul>   | 1               |
|            |   | <p>8. GALILEO (MC 7.03)</p>   | 1               |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY   | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|------------|---|---|-----------------|
|            |   | <ul style="list-style-type: none"> <li>- explains the principle of Galileo as the European satellite navigation system.</li> <li>- describes that Galileo comprises 30 medium earth orbit (MEO) satellites in 3 circular orbits.</li> <li>- states the satellite geometry and dual atomic clocks in the Galileo system.</li> <li>- states that atomic clock signal information is used to calculate the position of the receiver by triangulating the difference in received signals from multiple satellites.</li> <li>- describes the limitations of the Galileo system receiver</li> </ul> |                 |
|            | <p><i>Echo-sounders</i></p> <p>Ability to operate the equipment and apply the information correctly</p> | <p>1. Echo-sounders (MC 7.03)</p> <ul style="list-style-type: none"> <li>- describes the basic principles of marine echo-sounding equipment</li> <li>- identifies the main components on a simple block diagram of an echo-sounder, and states the function of each</li> <li>- describes the accepted value of the velocity of sound in seawater and the limits within which the true value may lie</li> <li>- describes the physical factors which affect the velocity sound in seawater</li> <li>- operates a typical echo-sounder and demonstrates an ability to</li> </ul>                | 9               |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY  | TOPICS/PERFORMANCE   | APPROX<br>HOURS |
|------------|--|--|-----------------|
|            |  | <p>carry out basic user maintenance, e.g. clean platen, change paper, change and adjust stylus</p> <ul style="list-style-type: none"> <li>- differentiates between range and phase, and demonstrates an awareness of the dangers of using the wrong phase</li> <li>- distinguishes between inaccuracies caused by instrument and scale error and those caused by false echoes</li> <li>- explains the causes of inaccuracies to instrument or scale error and states their likely magnitude and measures that may be taken to eliminate them</li> <li>- recognises the various types of "false" echo that may be observed, describes their formation and states the possible action to remove them from the trace</li> <li>- describes the potential errors due to trim, heel and transducer separation</li> </ul> |                 |
|            | <p><i>Compass – magnetic and gyro</i></p> <p>Knowledge of the principles of magnetic and gyro-compasses</p> <p>Ability to determine errors</p> | <p>1. The magnetism of the earth and the ship's deviation (MC 7.03)</p> <ul style="list-style-type: none"> <li>- explains the theory of magnetism as applied to ferromagnetic materials</li> <li>- describes a simple magnet, its poles and the law of attraction and repulsion</li> <li>- describes the magnetic field around a magnet</li> <li>- describes qualitatively flux density and field strength</li> <li>- describes magnetic induction and differentiates between 'hard' and 'soft' iron</li> </ul>  | 6               |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY   | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|------------|---|---|-----------------|
|            | of the magnetic and gyro-compasses, using celestial and terrestrial means, and to allow for such errors | <ul style="list-style-type: none"> <li>- explains the meaning of the terms: <ul style="list-style-type: none"> <li>- intensity of magnetization</li> <li>- permeability</li> <li>- magnetic susceptibility(no mathematical formula required)</li> </ul> </li> <li>- describes the magnetic field of the earth</li> <li>- defines 'magnetic poles' and 'magnetic equator'</li> <li>- defines 'angle of dip'</li> <li>- explains how the earth's total field can be split into horizontal and vertical components</li> <li>- defines 'magnetic variation' and explains why it is a slowly changing quantity</li> <li>- states that a compass needle which is constrained to the horizontal can respond only to the horizontal components of the earth's field and the field due to the ship's magnetism</li> <li>- describes the effect of introducing a disturbing magnetic force into the vicinity of a compass needle</li> <li>- states that the direction and strength of a magnetic field may be represented by a vector</li> <li>- uses a vector diagram to find the field at a point resulting from two given fields</li> <li>- states that a compass needle will align itself with the resultant</li> </ul> |                 |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|------------|---|---|-----------------|
|            |   | field   |                 |
|            |   | <p>2. The magnetic compass (MC 7.03)</p> <ul style="list-style-type: none"> <li>- describes the construction of a liquid card magnetic</li> <li>- sketches a section through the compass to show the float chamber, the pivot support and the arrangement of magnets</li> <li>- explains how the card is kept practically horizontal in all latitudes</li> <li>- describes the composition of the liquid and explains how allowance is made for changes in volume of the liquid</li> <li>- describes how to remove an air bubble from the compass bowl</li> <li>- describes how to check that the card is turning freely on its pivot</li> <li>- explains how the compass bowl is supported in the binnacle</li> <li>- describes the marking of the lubber line and its purpose</li> <li>- describes a binnacle and the arrangement of correcting devices provided</li> <li>- defines 'deviation' and states how it is named</li> <li>- illustrates with sketches the deviations on various headings produced by permanent magnetism with a pole or poles lying in the plane of the compass card</li> <li>- explains the need for care in the placing of portable items of magnetic material, including spare corrector magnets, or electrical equipment in the vicinity of compasses</li> <li>- explains the need for regular checking of the compass error</li> <li>- explains why compass error should be checked after a major alteration of course</li> <li>- explains why regular comparisons of standard compass, steering compass and gyro-compasses should be made</li> <li>- explains that the approximate error of the standard compass</li> </ul> | 6               |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY | TOPICS/PERFORMANCE   | APPROX<br>HOURS |
|------------|---|--|-----------------|
|            |   | <p>can be obtained by comparison with the gyro-compass if no other means is available</p>  |                 |
|            |   | <p>3. The gyro-compass (MC 7.03)</p> <ul style="list-style-type: none"> <li>- describes a free gyroscope and its gimbal mountings</li> <li>- states that in the absence of disturbing forces the spin axis of a free gyroscope maintains its direction in space</li> <li>- explains what is meant by gyroscopic inertia and precession</li> <li>- describes the precession resulting from a torque about axes perpendicular to the spin axis</li> <li>- explains that friction at gimbal pivots produces torques which give rise to precession</li> <li>- states that the rate of precession is proportional to the applied torque</li> <li>- states that 'tilt' as movement of the spin axis in the vertical plane</li> <li>- states that 'drift' as the apparent movement of the gyroscope in azimuth resulting from the earth's rotation</li> <li>- describes non-mathematically the apparent movement of a free gyroscope on the earth's surface, given its position and initial attitude</li> <li>- uses the apparent motion of a celestial body in the direction of the gyro axis to aid the description above</li> <li>- explains how a free gyroscope can be made north-seeking by the use of gravity control and describes the resulting oscillations of the axis</li> <li>- describes the use of damping in azimuth and damping in tilt to cause settling of the axis and thus produce a gyro-compass</li> <li>- explains that control and damping can be achieved by replacing the ballistic elements with electrical signals, provided by tilt sensors, to produce torques about the vertical and</li> </ul> | 6               |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|------------|---|---|-----------------|
|            |   | <p>horizontal axes</p> <ul style="list-style-type: none"> <li>- describes a familiar gyro-compass with particular reference to: <ul style="list-style-type: none"> <li>- the method of support</li> </ul> </li> <li>- control and damping arrangements</li> <li>- the method of maintaining the heading indication in line with the axis of the gyro</li> <li>- the transmission of heading to repeaters</li> <li>- demonstrates the starting of the gyro-compass and explains how to minimize settling time by slewing and levelling it to the correct heading</li> <li>- explains the necessary time for the compass to settle after switching on prior to sailing</li> <li>- lists the settings to be made or adjusted while the compass is in use</li> <li>- explains how the repeater system is switched on and aligned with the master gyro-compass</li> <li>- describes how gyro heading input is supplied to a radar installation</li> <li>- describes the alarms fitted to a gyro-compass</li> </ul> |                 |
|            |   | <p>4. Compass and bearing corrections (MC 7.03)</p> <ul style="list-style-type: none"> <li>- defines true, magnetic and compass north</li> <li>- finds deviation and variation from tables and charts</li> <li>- calculates true course from compass course</li> <li>- calculates compass course from true course</li> </ul>  | 3               |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|------------|---|---|-----------------|
|            |   | <ul style="list-style-type: none"> <li>- measures compass error, using a transit bearing</li> <li>- applies compass error to the ship's head and compass bearings to convert to true</li> <li>- takes a compass bearing of a charted object and lays the true bearing off on the chart</li> </ul>   |                 |
|            |   | <p>5. Errors of the compass and azimuths (MC 7.03)</p> <ul style="list-style-type: none"> <li>- obtains the error of the magnetic compass or gyro compass by comparing the compass bearing of the body with the true azimuth of the body obtained at the time of observation</li> <br/> <li>- obtains the azimuth of the body from tables, or by formula or calculation using GMT of observation, information from the Nautical Almanac, LHA of the body and the observer's DR position</li> <li>- obtains from tables or by calculation, using the observer's DR position and information from the Nautical Almanac, the true bearing of a heavenly body on rising or setting, i.e. solves an amplitude problem</li> <br/> <li>- obtains the magnetic variation for the observer's position, using isogon lines or other information on the chart</li> <br/> <li>- applies variations to the error of the magnetic compass to find the deviations for the direction of the ship's head</li> <br/> <li>- calculates compass error and gyro error, from transit or charted range bearings and bearings to distant fixed objects</li> </ul> | 13              |

| COMPETENCE                             | KNOWLEDGE, UNDERSTANDING AND PROFICIENCY  | TOPICS/PERFORMANCE   | APPROX HOURS |
|--|---|--|--------------|
|  |   | 6. Fluxgate compass (MC 7.03) <ul style="list-style-type: none"> <li>- Defines single axis and dual axis</li> <li>- Explains basic operation</li> <li>- Explains TMC</li> <li>- Describes solid state type</li> </ul>  | 1            |
| Determine and allow for compass errors | <i>The principles of the Magnetic Compasses</i><br><br>Knowledge of the principles of magnetic and gyro-compasses | 1. The Parts of the Magnetic Compass and their Function (MC 7.01) <ul style="list-style-type: none"> <li>- describes the conditions which give rise to each of the coefficients</li> <li>- explains the requirements of SOLAS Chapter V - Regulation 19, in regard to the requirements for the carriage of magnetic compasses</li> <li>- explains that ships must also be fitted with a pelorus, or other means, to take bearings over an arc of 360° of the horizon and a means for correcting heading and bearings to true at all times.</li> <li>- describes the parts of the magnetic compass and explains their function</li> <li>- briefly explains the operating principle of Transmitting Magnetic Compass (TMC)</li> <li>- outlines the performance standards for magnetic compasses</li> </ul> | 3            |
|  |   | 2. The Errors of the Magnetic Compass and their Correction (MC 7.01) <ul style="list-style-type: none"> <li>- Explains the importance of keeping a record of observed deviations</li> <li>- Determines deviations and prepares a table or graph of deviations</li> <li>- Defines the approximate coefficients A, B, C, D and E</li> <li>- States the equation for the deviation on a given heading in terms of the coefficients</li> </ul>   | 27           |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|------------|---|---|-----------------|
|            |   | <ul style="list-style-type: none"> <li>- Describes the conditions which give rise to each of the coefficients</li> <li>- Explains the use of the approximate coefficients A, B,C, D and E</li> <li>- Describes why coefficients A and E may exist at a badly sited compass</li> <li>- Explains the non-magnetic causes of an apparent coefficient A</li> <li>- Explains that coefficient B results partly from the ship's permanent magnetism and partly from induced</li> <li>- Explains that induced magnetism may also contribute to coefficient C in a badly sited compass</li> <li>- Describes how the deviation associated with the coefficient permanent B varies with magnetic latitude</li> <li>- Describes how the deviation associated with the coefficient induced B varies with magnetic latitude</li> <li>- Explains why the deviation due to permanent magnetism should be compensated by permanent magnets and that due to induced magnetism by spherical soft iron correctors, where possible</li> <li>- Describes the causes of heeling error and how it varies with heel, course and magnetic latitude Describes the correction of heeling error and why the correction does not remain effective with change of magnetic latitude</li> <li>- Defines the constants <math>\lambda_1</math> and <math>\lambda_2</math></li> <li>- Defines the constant <math>\mu</math></li> <li>- Explains how the soft iron spheres increase the mean directive force towards magnetic north and that the value of <math>\lambda</math> with the spheres in place is called the ship's multiplier</li> <li>- Describes the vertical force instrument and its use in correcting heeling error</li> <li>- Describes methods of obtaining a table of deviations</li> </ul> |                 |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY  | TOPICS/PERFORMANCE   | APPROX<br>HOURS |
|------------|--|--|-----------------|
|            |  | <ul style="list-style-type: none"> <li>– Analyses a table of deviations to obtain approximate coefficients</li> <li>– States that anything which could affect the deviation of the compass should be stowed in its sea-going position before correcting it</li> <li>– Explains the adjustment of the compass by the analysis and/or tentative methods and obtains a table of residual deviations</li> <li>– States the order in which corrections should be made and explains why they are made in that order</li> <li>– Describes how heeling error may produce an unsteady compass on certain headings after a large change of magnetic latitude and how to deal with it</li> <li>– Explains why a large coefficient B may appear after a large change of magnetic latitude and how to correct it</li> <li>– Describes how sub-permanent magnetism gives rise to retentive error</li> <li>– States that deviations may be affected by cargo of a magnetic nature, the use of electro-magnets for cargo handling, or repairs involving hammering or welding of steelwork in the vicinity of the compass</li> <li>– Defines the magnetic moment of a bar magnet as the product of the pole strength and the length of the magnet</li> <li>– States that, for a suspended magnet vibrating in a magnetic field, <math>T^2</math> is proportional to <math>1/H</math>, where T is the period of vibration and H is the field strength</li> <li>– Explains how the relative strengths of two fields may be found</li> </ul> |                 |
|            | <i>The Principles and errors of gyro compasses</i> | <ol style="list-style-type: none"> <li>1. The Principles of gyro compasses (MC 7.01) <ul style="list-style-type: none"> <li>– Reviews the operating principles of the mechanical/ballistic gyro compass</li> </ul> </li> </ol>   | 3               |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY                            | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|------------|--|---|-----------------|
|            | Ability to determine and allow for errors of the magnetic and gyro-compasses | <ul style="list-style-type: none"> <li data-bbox="743 321 1709 461">– Explains the operating principle of other types of gyro compasses such as Fibre Optic gyro-compass and ring laser gyro-compass and their advantages over the mechanical / ballistic gyro-compass</li> </ul> <p data-bbox="688 506 1394 539">2. Gyro compass errors and correction (MC 7.01)</p> <ul style="list-style-type: none"> <li data-bbox="743 545 1709 649">– Explains why a gyro-compass that is damped in tilt will settle with its spin axis at a small angle to the meridian, except when at the equator</li> <li data-bbox="743 656 1604 721">– States that the resulting error is known as latitude error or damping error and varies directly as the tangent of the latitude</li> <li data-bbox="743 727 1709 831">– States that latitude error can be removed by a manual setting that mechanically moves the lubber line and the follow-up system to show the correct heading</li> <li data-bbox="743 837 1709 941">– States that course and speed error is caused by the tilting of the spin axis, resulting from the ship's motion over the surface of the earth</li> <li data-bbox="743 948 1688 1026">– States that the rate of tilting, in minutes of arc per hour, is equal to the north-south component of the ship's velocity</li> <li data-bbox="743 1032 1709 1136">– Explains how the tilt causes precession in azimuth to the west on northerly headings and to the east on southerly headings in compasses with liquid ballistic control</li> <li data-bbox="743 1143 1667 1247">– States that the velocity error is removed by manual settings of latitude and speed to offset the lubber line and the follow-up system in liquid-controlled compasses</li> <li data-bbox="743 1253 1667 1318">– Explains how the correction is made in compasses that employ other methods of detecting tilt</li> <li data-bbox="743 1325 1688 1390">– States that ballistic deflection results from changes in the ship's north-south component of velocity</li> </ul> | 7               |

| COMPETENCE | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY | TOPICS/PERFORMANCE   | APPROX<br>HOURS |
|------------|---|--|-----------------|
|            |   | <ul style="list-style-type: none"> <li>– Explains the behavior of a liquid ballast during a change of speed or an alteration of course</li> <li>– Explains that the precession resulting from ballistic deflection may be arranged to move the compass to the correct settling position, after allowance for the change in course and speed error, by choosing a suitable period for the compass</li> <li>– Explains that the pendulum of a tilt detector will be thrown out of the vertical during a change of course or speed, producing an error in its output</li> <li>– Explains that the method used in the above objective is not applicable for compasses without liquid ballistic control since course and speed error is fully corrected for all headings</li> <li>– Explains that errors are limited by damping the pendulum and limiting the applied torque for large deflections of the pendulum</li> <li>– States that the sensitive element of a gyro-compass is made such that its moment of inertia about any axis is the same, thus preventing any tendency to turn when swinging pendulously as a result of rolling or pitching</li> <li>– Describes the effect of rolling on a liquid ballistic for various ship's headings</li> <li>– Explains why the movement of the liquid causes an error except on the cardinal headings</li> <li>– Explains how intercardinal rolling error is reduced to negligible proportions</li> <li>– States that intercardinal rolling error does not occur in compasses having no gravitational control attachments to the gyroscope</li> <li>– States that errors caused by acceleration of the compass during rolling and pitching can be reduced by sitting the master compass low down, near the rotational centre of the ship</li> </ul> |                 |

| COMPETENCE   | KNOWLEDGE,<br>UNDERSTANDING<br>AND<br>PROFICIENCY  | TOPICS/PERFORMANCE  | APPROX<br>HOURS |
|--------------|--|---|-----------------|
|              |  | <ul style="list-style-type: none"> <li>- Outlines the performance standards for gyro-compasses</li> </ul>   |                 |
|              | <p><i>Systems under the Control of the Master Gyro and the Operation and Care of the Main Types of Gyrocompasses</i></p> <p>An understanding of systems under the control of the master gyro and a knowledge of the operation and care of the main types of gyro-compass</p> | <p>1. Systems under the Control of the Master Gyro and the Operation and Care of the Main Types of Gyrocompasses (MC 7.01)</p> <ul style="list-style-type: none"> <li>- Defines the main systems under the control of the master gyro</li> <li>- Defines the main types of gyro-compass in use at sea</li> <li>- Refers to manufacturers' manuals to determine necessary maintenance tasks</li> </ul> | 2               |
| <b>TOTAL</b> |  |   | <b>116</b>      |