

**COURSE LIST**  
**2009 – 2013 SERIES**

<b>Course description</b>	<b>RADAR NAVIGATION, RADAR PLOTTING AND USE OF ARPA</b>			
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Course code	TM 3.1.8	Year	III	Number of credits	5+4
	TM 3.2.8	Semester	5+6		

Faculty	Navigation and Naval Transport	The number of hours per semester / activities				
Domain	Naval Engineering and Navigation	Total	C	S	L	P
Specialization	Navigation and Maritime and River Transport	112	56	-	56	-

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Course type <b>DF</b> -fundamental, <b>DD</b> -engineer, domain specific, <b>DS</b> -specialized, <b>DC</b> -complementary	DS
Course optionality: <b>DI</b> -required, <b>DO</b> -optional, <b>DF</b> - facultative	DI

Previous courses	<b>Obligations</b> (conditioned)	Estimated and Coastal Navigation. Fundamentals of radar
	<b>Recommended</b>	Electronics Navigation

Objectives	<p><b>Main objectives:</b> This course provides training in the basic theory and use of radar for deck students and officers in charge of a navigational watch. It is based on the guidance on training in radar observation and plotting and in the operational use of ARPA in Section 0-1/12 of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended in 1995 (STCW 1995). This course aims to meet the minimum training standards in Table A-III1 of STCW 1995.</p> <p>This guidance supersedes the recommendations annexed to Resolutions A.482(XII) and A.483 (XII) adopted by IMO in 1981. This course aims to meet the mandatory minimum requirements for knowledge, understanding and proficiency in Table A-III1 of STCW 1995. The aspects covered include the theory necessary to understand how radar information is obtained and displayed, the limitations and accuracy of that information, the formation and recognition of unwanted responses, the correct use of operational controls to obtain an optimal display and checks on performance of the set.</p> <p>The various modes of display available and the choice of a suitable mode for a particular application are covered, together with the effect that changes in the course or speed of "own" or target ship have on the appearance of the display.</p>
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	<p>The course also covers the recognition of critical targets, the measurement of bearings and distances, and the use of these for fixing the ship's position and maintaining a plot of the movement of other ships as an aid to collision avoidance. Exercises in the application of the International Regulations for Preventing Collisions at Sea (COLREG) make use of the resulting plots.</p> <p><b>Objective :</b> A trainee successfully completing this course and meeting the required performance standards will recognize when radar should be in use, will select a suitable mode and range setting for the circumstances, will be able to set the controls for optimal performance, will be aware of the limitations of the equipment in detecting targets and in terms of accuracy. When within range of the coast, the trainee will be able to compare the radar display with the chart, select suitable conspicuous land targets and use these targets to fix his position, and will be aware of the need to maintain a continuing plot of ship targets which may pose a potential threat of collision.</p> <p>The trainee continuously monitors all targets appearing on the radar screen and plots the ones which could lead to close quarter situation. During a maneuver, the candidate must verify the margins of safety for the ship with respect to the environment (coast, shoals, other dangers to navigation).</p> <p>Additionally, when plotting the candidate must continue to plot each target until it is finally past and clear, determine the relative movement of each target, determine the true course and true speed of each critical target, determine the closest point of approach and the time of the closest point of approach of each target.</p> <p>The trainee plans the desired maneuver, anticipating the moment of the maneuver when the course and speed leading the ship to its destination will be resumed by observing the required CPA and anticipating the new relative movement of each target before each maneuver, ensuring that after each maneuver the targets maintain the predicted relative movement. He will be able to derive from the plot the necessary information about other ships' courses, speeds and nearest approaches to enable action to be taken in ample time, in accordance with COLREG to prevent a close-quarters situation arising.</p> <p>The course structure is in conformity with the IMO STCW 95 (All/1, All/2, A-I/12, B-I/12) requirements, and Model IMO Courses (1.07, 1.08), including the themes structuring and applications parts</p>
Content (descriptors)	<p><b>1 Describe the Basic Theory and Operation of a Marine Radar System</b></p> <p>1.1 Describe the fundamental principles of radar</p> <p>1.2 Principles of measuring distances and bearings</p> <p>1.3 The operation and location of system components</p> <p>1.4 Explain the proper safety distance</p> <p>1.5 Explain the importance of not putting spare parts (spare radar?) for the radar equipment near the magnetic compass or in a shorter distance than specified</p> <p>1.6 State the radiations hazards and precautions</p> <p>1.7 State the safety precautions necessary in the vicinity of open equipment and the radiations hazard near antennae and open waveguides.</p> <p>1.8 Explain the characteristics of radar sets and factors affecting performance and accuracy with reference to detection of targets (3hours)</p> <p>1.9 State the relationship between maximum range and pulse recurrence frequency</p> <p>1.10 Explain the effects on bearing and range accuracy of beam width, heading marker error, centring error, yawing, parallax, variable range marker, gyro error.</p> <p>1.11 Explain the effects on bearing and range discrimination of beam width, spot size, plan position indicator tube size, pulse length, gain</p> <p>1.12 Identify the factors external to the radar set affecting radar detection</p> <p>1.13 Identify the factors that may cause misinterpretation of the radar image.</p> <p>1.14 Explain the cause and effect of interference</p> <p>1.15 Explain the cause and effect of side echoes</p>

- 1.16 Explain the cause and effect of indirect echoes
- 1.17 Explain the cause and effect of multiple echoes
- 1.18 Explain the cause and effect of second trace echoes
- 1.19 State the effect on radar performance of power lines and bridges crossing rivers and estuaries
- 1.20 Explain the effect of the ship in seaway
- 1.21 Performance standards - Resolution
- 1.22 List the performance standards contained in Resolution A.477 (XII)
- 1.23 State required accuracy (range and bearing measurement)
- 1.24 State required discrimination (range and bearing)
- 2 Set Up and Operate radar in Accordance with Manufacturer's Instructions**
- 2.1 Prepare and maintain optimal radar display (5ore):
- 2.2 Perform key controls
- 2.3 Perform transmission control (standby/transit, pulse length, PRF)
- 2.4 Use receptor controls to achieve optimum image (tuning, gain, gain logarithmic/liniar)
- 2.5 Use display controls (brilliance, illumination, focus, shift, range rings, VRM, EBL, cursor, heading marker,clearscan, anti-cluter)
- 2.6 Demonstrate the use of each control in the setting up procedure.
- 2.7 Show that small or poor echoes may evade detection
- 2.8 Presentation of the saturation effects of noise at the receiver
- 2.9 Present the scale frequent change importance use of radar
- 2.10 Identify the different display modes (real movement, relative motion, stabilized motion, north up, course up, head up)
- 2.11 Explain the advantages and limitations of various modes of display
- 2.12 Explaining the necessity of maintaining a magnetic compass input for the relative motion and an input from a magnetic compass and the electronic journal for real movement display .
- 2.13 Identify the effects of transmission of a magnetic compass error in a display of an actual or relative movement
- 2.14 Identify the effects of journal transmission errors in a log display of a real movement, or a manual input error rate value
- 2.15 Perform special controls (presentation, speed, re-set, true path correction, magnetic compass tutor)
- 2.16 Presenting the effects of an inappropriate introduction of speed value and correction value of the really road on true motion display
- 2.17 Measure ranges and bearing
- 2.18 States methods and accuracy of measuring ranges (VRM)
- 2.19 Measure bearings with empnasis on accuracy
- 2.20 Explain the methods and accuracies of measuring bearings (EBL)
- 2.21 Measure bearings with empnasis on accuracy
- 2.22 Checks and corrects error in range and bearing
- 3 Perform manual Radar Plotting**
- 3.1 Construct a motion triangle:
- 3.2 Explain the relative motion triangle of the various vectors and angles
- 3.3 Construct a relative motion triangle on a paper plot
- 3.4 Construct a relative motion triangle on a reflection plotter
- 3.5 Determinate the way, speed and the appearance of other vessels
- 3.6 Determinate the way, speed and the appearance of other vessels in a relative presentation (stabilized or not)
- 3.7 Determinate the way, speed and the appearance of other vessels in a real presentation
- 3.8 Making measurements of distances at frequent and regular intervals
- 3.10 Determinate the factors affecting the accuracy of calculating the target courses, speeds and issues
- 3.11 Determinate the current drift using a designated location observations

- 3.12 Explain the "track made over the ground by own ship"
- 3.13 Determinate CPA and TCPA
- 3.14 Determinate CPA-ului and TCPA in a relative movement (image stabilized or not)
- 3.15 Determinate CPA-ului and TCPA in a real movement
- 3.16 Explain the factors affecting the accuracy of determining the CPA and TCPA obtained by plotting.
- 3.17 Explain the effects of target course or speed changes
- 3.18 Explain the effects of target course or speed changes of other ships
- 3.19 Compare radar observations with those of visual
- 3.20 Explaining the delay between the change of the ship way and radar detection of that change
- 3.21 Explain the advantage of having an stabilized image depending on compass, where a relative movement
- 3.22 Explaining the effects of changes in own ship's speed or road speed and target course have on specific target vessels. Present the danger of making small changes to the target course and / or speed information regarding determined accuracy
- 3.23 Report radar information:
- 3.24 Make a report containing the following information: the bearing, distance, CPA, TCPA, the target course layout, speed
- 4 Use radar to ensure safe Navigation**
- 4.1 Determinate the position of a vessel using radar
- 4.2 Explain the characteristics of an object that is easily observed by radar
- 4.3 Explain the characteristics of an object that is very difficult observed by radar
- 4.4 Determinate the vessel's position, using the distances measured by radar
- 4.5 Explain the errors and how they can be minimized
- 4.6 Compare the ship's position by radar determined by other equipment to observe other accuracy point
- 4.7 Compare the relief shown in radar image with what is seen on the navigation map
- 4.8 Identify radar parts for radar navigation and for safe navigation performance:
- 4.9 Highlights acting passive (reflectors) (recognition and use)
- 4.10 Active highlights which act passive (Racona's, echo-enhancer, transponders, ramarks) (recognition and use)
- 4.11 SARTs (recognition and use)
- 4.12 Sources of information on active and passive parts
- 4.13 Use the navigation parallel index lines
- 4.14 Set and use parallels index lines using electronic means
- 4.15 Construct and use parallel index lines in a reflection plotter signs, where it is
- 4.16 Perform corrective actions where the radar signal leaves the parallel index line
- 4.17 Use of several parallel index lines
- 4.18 Build and use parallel index lines for two scales of distance (construction and use)
- 4.19 Present the importance of "wheel over" point
- 4.20 Demonstrate the importance of "wheel over" point
- 4.21 Explain the importance of safety zone
- 4.22 Demonstrate the use of safety zone
- 4.23 Interpretation of the target ship motion using past positions of his signal
- 4.24 Perform corrective actions in case of contrary of the current effects :
- 4.24.1 If the specific target is straight
- 4.24.2 if the ship is maneuvering
- 5 Use Radar to Avoid Collisions or Close Encounters**
- 5.1 Apply the COLREG precautions to avoid collisions or nearby situations

- 5.2 Use the radar as a means of keeping vigil, and expose a continued importance of plotting
- 5.3 Understand the factors that must be taken into account in determining a safe speed, with emphasis on factors influencing the radar.
- 5.4 Presentation of the factors that allow a good quality plot so as to avoid situations of collision
- 5.5 Making changes of way or high enough speed so as to avoid situations of collision
- 5.6 Introducing the moments when radar is used on good weather, both for day and night when there are signs that the visibility will deteriorate and in heavy traffic
- 6 Describe an ARPA System. Operational Use of ARPA**
- 6.1 Correct description of display characteristics lane system
- 6.2 Description of the different characteristics of the display
  - 6.2.1 vectors
  - 6.2.2 graphics
  - 6.2.3 Digital display
  - 6.2.4 potential points of collision
  - 6.2.5 potential danger areas
- 6.3 Description of targets acquire procedure
- 6.4 Proper presentation of IMO standards for ARPA performances
- 6.5 Proper presentation of IMO standards for ARPA performances in terms of accuracy
- 6.6 Requirements submission for acquisition and radar target tracking
- 6.7 Lists of required operational alarms
- 6.8 Present the information that must be presented in alphanumeric form
- 6.9 Effects of ARPA equipment sensor errors in accordance with presentation the performance set by IMO standards
- 6.10 Present the standard performances for gyro input signals and position fixing equipment
- 6.11 The criteria for targets acquisition are set correctly
- 6.12 Submission criteria for target acquisition
- 6.13 Presentation of the criteria for automatic selection of the targets as outlined in the manufacturer's instruction manual book
- 6.14 The list of criteria that are used for manual acquisition of target radar
- 6.15 Introducing the maximum number of targets that can be purchased
- 6.16 Presentation of targets that can not be pursued if no longer considered a threat
- 6.17 Describe the use of appropriate limiting plotting function of radar targets in some areas
- 6.18 Show that targets appearing at a shorter distance than when it was set to "guard zone" will not be automatically plotted
- 6.19 Capability description of a radar target tracking function and its limitations
- 6.20 Plotting and target tracking process description with ARPA
- 6.21 Describe how the targets can be lost and alarms are activated
- 6.22 State the most common circumstances in which targets are reversed each other (target swoop).
- 6.23 State the effects of this reversal between the target "target swoop" affect the displayed information
- 6.24 Explaining the delay in processing activity
- 6.25 Explain the delay in displaying the data processed by ARPA after radar target acquisition
- 6.26 Explain the delay in displaying new information when the own ship maneuvers
- 6.27 State that the full accuracy of derived information may not be attained for up to three minutes after acquisition or target maneuver.
- 6.28 Describe the benefits and limitations of operational warnings.
- 6.29 Describe the plotting and target tracking process with ARPA

- 6.30 Describe how the targets can be lost and alarms are activated
- 6.31 Present the most common circumstances in which targets are reversed each other (target swoop).
- 6.32 Present the effects that affect the information displayed reversal between targets
- 7 Operate an ARPA System**
- 7.1 Set up and maintain correctly the ARPA display
- 7.2 Use display in true and relative modes
- 7.3 Adjust the radar controls for the optimum display of echoes.
- 7.4 Use log and gyro inputs
- 7.5 Manual execution of radar targets acquisition and hazardous target tracking
- 7.6 Setting automatic radar target acquisition and exclusion zones
- 7.7 Use a time base for vectors or graphic schemes appropriate to produce required information
- 7.8 Identify the differences between the shown information when the display is stabilized in the "sea stabilized mode" and when in ground stabilized mode
- 7.9 Selecting the stabilization depending on the circumstances
- 7.10 Set up and use echo-referencing when the mode is true
- 7.11 Use ARPA to obtain information about the radar target
- 7.12 Use display in true and relative modes and demonstrate the use of true and relative vectors in each mode.y
- 7.13 Demonstrate the benefits of switching between true and relative vectors
- 7.14 Use PPC and PAD graphics
- 7.15 Determinate the risk of collision by extrapolating the vectors and using the PAD
- 7.16 Use „target history” function
- 7.17 Use the "trial manoeuvre" (which approximates using features of their own ship maneuver)
- 7.18 References to the radar manual for information about the characteristics of the used vessel's model
- 7.19 Set and recognize different types of alarms
- 7.20 Explain the benefits and limitations of different type of alarms
- 7.21 Setting the rejection to avoid false interference
- 7.22 Set the rejection to avoid false interference
- 7.23 Incorrect identification of the vector type (a common error)
- 7.24 Getting information from the vector that displays information in numerical form
- 7.25 Explain that for a lost target which is subsequently reacquired, may temporarily show a course and speed suggesting an alteration when none has occurred.
- 7.26 Explain that the PAD and PPC graphics displayed apply only to own ship and targets and do not indicate mutual threats between targets.
- 7.27 State that the track line between the target and the PAD is not an indicator of target speed.
- 7.28 Assess history displays, changing radar mode and vector presentation.
- 7.29 State that a change of direction in the relative history display does not necessarily imply that the target has altered course.
- 7.30 Explain that the misinterpretation of the information obtained from ARPA can lead to dangerous situations
- 7.31 State that errors in bearing can be generated in the radar installation
- 7.32 State the errors in range can be generated in a radar
- 7.32.1 own ship motion
- 7.32.2 asymmetric wave of radar antenna
- 7.32.3 azimuth quantization
- 7.32.4 backlash
- 7.33 Explanation of errors occurring in the next causes:
- 7.33.1 Roll motion of the ship:

- 7.33.2 range quantization
- 7.34 Explain that own ship alteration of course may temporarily produce unreliable indications because of the ARPA smoothing filter
- 7.35 Describe the effects of heading and speed errors on derived information.
- 7.36 State that the smoothness of the displayed true history track gives some indication of satisfactory tracking by ARPA.
- 7.37 Set up and maintain correctly a ARPA display (0.5 ore)
- 7.38 Use "Self Diagnostic"
- 7.39 Make programs to verify the accuracy by comparison with known solutions
- 7.40 Make demonstration of the performance level, including trial maneuvers with manually plotting
- 7.41 Making the right decisions when the ARPA system does not work
- 7.42 Identify and explain the risks of excessive confidence in the ARPA system
- 7.43 Use ARPA and explain the need for compliance with basic principles to be on watch
- 7.44 Making accurate feedback alarms (such as collision alarm, or for a new target ship)
- 7.45 Avoid CPA and BCR
- 7.46 Explain that the signal sensors do not react until the lack of a signal, and not for a faulty signal
- 8 Making complex exercises, in real-time radar plotting**
- 8.1 Plot the target course, the speed, CPA, TCPA and relative or actual plotting appearance
- 8.2 Use of ARPA and the information received from this activity to ensure safe navigation and collision prevention
- 8.3 Apply COLREG for areas of open water but in low visibility conditions
- 8.4 Determine the target course, speed, CPA, TCPA and the aspect for each dangerous vessel
- 8.5 Make a correct target course change to meet the minimum requirements for CPA for the overtaking situations of a ship or crossing the road, or meeting.
- 8.6 Determine the return time
- 8.7 Making avoidance maneuvers, including reducing speeds where appropriate, to avoid very nearby situations
- 8.8 Execute the maneuvers for the situations where the vessels change the course and / or speed
- 8.9 The maneuvers are carried out consistently to avoid a collision
- 8.10 Plans and executes a maneuver through waters with navigational obstructions in heavy traffic
- 9 Use ARPA in heavy traffic**
- 9.1 Plans and executes a passage through waters with navigational obstructions in heavy traffic
- 9.2 Analyze all of the information in order to make the above point
- 9.3 Uses parallel index line to pass a given distance off a fixed point.
- 9.4 Uses parallel index lines for track-keeping with a change of course.
- 9.5 Uses parallel index line and dead range for approaching an anchorage position.
- 9.6 Uses parallel index lines as in 4 și 5 with and without tidal set.
- 9.7 Identifies radar-conspicuous objects.
- 9.8 Check ship's position with other means available.
- 9.9 Plots ship's track during coastal passage, making allowance for current tide or wind.
- 9.10 Executes a passage and avoid the collisions in a traffic separation scheme.
- 9.11 States requirements of COLREG, rule 10 regarding traffic separation schemes.
- 9.12 Executes a passage in a traffic separation scheme involving:
- 9.12.1 Entering and leaving lanes
- 9.12.2 Crossing lanes
- 9.12.3 Crossing one lane to cross the other

	<p>9.12.4 Leaving one lane to cross the other.</p> <p>9.13 Executes a passage, as in content 2 above, in heavy traffic</p> <p>9.14 Managing a watch team</p> <p>9.15 Explain the preparation, the mode of organization and roles</p> <p>9.16 Start making plans</p> <p>9.17 Monitoring progress</p> <p>9.18 The existence of a clear and effective communication between all team members</p> <p>9.19 Realizes a safe passage and return of collision situations</p> <p>9.20 Ensure that watch team members use all the sources to obtain information about the activity of passage</p> <p>9.21 Controlle the ship development in a "blind pilotage" drill</p>
Competences	Use of conventional radar and ARPA to ensure safe navigation. Determinate the position of the vessel and conduct the ship on radar information. Use radar information for decision and control.
Test and evaluation	

Final grade (percentage)	- answers to exam / colloquium / practical work	60 %			
	- certified applied activities / lab / practical work / project, etc..	30 %			
	- tasks	10%			
Bibliography	<ol style="list-style-type: none"> <li>1. <b>Bagshaw I. W.</b>, <i>Worked examples in relative radar plotting</i>, Brown, Son &amp; Ferguson, 1989</li> <li>2. <b>Balaban, Gh.</b>, <i>Tratat de navigație maritimă</i>, Editura Sport-Turism, 1981</li> <li>3. <b>Bârsan E.</b>, <i>Navigație Maritimă Modernă</i>, Editura ExPonto, 2005</li> <li>4. <b>Bârsan E.</b>, <i>Navigație Radar și Radar Plotting</i> – Editura ExPonto 2000</li> <li>5. <b>Bole A., Dineley W.</b>, <i>The navigation control manual</i>, Butterworth-Heinemann Ltd., 1992</li> <li>6. <b>Bowdich N.</b>, <i>The American practical navigation</i>, Defense Mapping Agency, USA, 1995</li> <li>7. <b>Simpson Alexander</b>, <i>Navigation Guide</i>, Brown, Son &amp; Ferguson, 1991</li> <li>8. <b>Vîjîiac Nicolae</b>, <i>Performantele radarelor ARPA</i>, CPLMC, 1990</li> </ol>				
List of needed materials	<ul style="list-style-type: none"> <li>- instruments</li> <li>- handling boards</li> <li>- Navigation map</li> <li>- Notebook for lab</li> <li>- Briefing / debriefing room equipped with multimedia equipment</li> <li>- radar simulator Transas NT Expert 4.60</li> <li>- Navigation and maneuvering simulator NT Pro 4.61</li> <li>- Sympodium Smartech Interactive drawing system</li> </ul>				
Balance of spent hours	<b>Chapter nr.</b>	<b>Course Hours</b>	<b>Seminar Hours</b>	<b>Laboratory Hours</b>	<b>Project Hours</b>
Total 112 hours					



Lecturer Position, title, first name, name	Signature
Associate Prof. Eugen BARSAN, Ph.D.	
Head of chair Position, title, first name, name	Signature
Associate Prof. Paulică ARSENIE	
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Sen.lect.Dr.eng. Liviu Stan	

Legend: C-course, S-seminar, L- Laboratory or simulator activities, P- project or practical work