Required Reading:
- Dutton's Nautical Navigation, 15th edition (chapters 2, 3 and 8)
Enabling Objectives

- Know terms associated with the terrestrial coordinate system; Equator, Prime Meridian, Great Circle, Small Circle, Parallel, Meridian, Latitude, Longitude, and Rhumb Line
- Understand the concept of Projections and the main projections used in Navigation
- Know the advantages and disadvantages of the Mercator and Gnomonic Projections
- Understand the difference between Great Circle Routes and Rhumb Lines
- Understand the use of a Nautical Chart and the main concepts associated to nautical charts
- Know chart distribution agencies
- Understand the function and use of Chart One
- Know how to read directions and latitude and longitude on the nautical chart
- Know the lengths of a degree of Latitude and Longitude
- Understand the use of basic plotting tools
Terrestrial Coordinate System
Latitude

- **Equator** is the reference for latitude.

- Measures **angular distance North or South from the Equator** (0° - 090°)

- Described in degrees, minutes and seconds followed by the suffix N/S.

\[ \varphi = XX^\circ XX' XX'' N/S \]

*Degrees expressed always in 2 digits!*
Terrestrial Coordinate System
Longitude

- **Prime Meridian** is the reference for longitude.

- Measure the **angular distance East or West** from the Prime Meridian (0° - 180°).

- Described in degrees, minutes and seconds followed by the suffix E/W.

\[ \lambda = XXX^\circ XX' XX'' \ E/W \]

*Degrees expressed always in 3 digits!*
A combination of latitude and longitude is a position on the Earth’s Grid.

Example:
Riverside Observatory coordinates:
- Lat. = 33° 57’ 12” N
- Long. = 117° 23’ 46” W

Remember:
1 ° = 60’ (minutes)
1’ = 60” (seconds)
Great Circle and Small Circle

**Great Circle** is any circle formed on the surface of Earth by the intersection of a plane passing **through the center of the Earth**, thereby dividing Earth into two equal parts.

**Small Circle** is any circle formed on the surface of Earth by the intersection of a plane **not passing through the center of the Earth**.
Great Circles

- **Meridian** – **Great Circle** that is passes through the poles;

- **Equator** – **Great Circle** that is half-way from the poles;
Projections
Mercator Projection

- Most nautical charts are based on the Mercator Projection.

- Rhumb lines, Meridians and Parallels are represented by straight lines.

- Meridians and parallels are perpendicular to each other, simplifying plotting positions.
- **Advantages:**
  - Lat. and long. appear as a rectangular graticule (easy to plot positions, courses, etc.);
  - Easy to determine lat./long. of a position plotted;
  - Easy to measure distance (lat. scale – 1’ = 1NM); and
  - Easy to locate the four cardinal points.

- **Disadvantages:**
  - Great-circle distances and directions are not readily determinable; and
  - High distortion in extreme latitudes.
  - No representation of the poles.
Projections
Mercator Projection
Nautical Charts

- Chart is a graphic representation of a maritime area and adjacent coastal regions.
- Charts show:
  - depths of water and heights of land
  - natural features of the seabed
  - details of the coastline
  - navigational hazards
  - location of natural and man-made aids to navigation
  - information on tides and currents
  - local details of the Earth’s magnetic field (variation)
  - man-made structures such as bridge and harbours
Nautical Charts

Distribution Agencies

- National Ocean Service (NOS)
  - Division of National Oceanic & Atmospheric Agency (NOAA)
  - Coastal US waters, most rivers and Great Lakes for commercial and civilian use

- Army Corps of Engineers
  - Mississippi River (and its tributaries) and some inland lakes

- National Geospatial Intelligence Agency (NGA) - formerly NIMA
  - Department of Defense and International use
Main information:
- Region identification
- Main title
- Projection and Scale
- Publisher
- Datum
- Depth and elevation notes
- Cautionary notes
- Tidal information
Nautical Charts
Datum

- Reference point in which measurements are made.
  - Horizontal Datum: Reference used for distance
  - Vertical Datum: Reference used for height (sounding)

Datum used can be easily found in the Nautical Chart. (datum note)

Ex.: ED, NAD 83
- Datum shift: difference between actual and plotted position when using different datum (chart and GPS).

Always check chart and GPS datum!!!
Nautical Charts

Chart Scale

- Ratio of a distance unit on the chart to the actual distance on the surface of the Earth.

Ex.: Scale 1:20,000 (one unit of distance on the chart represents 20,000 units on the Earth).

Chart Scale is always described in the Title Block.
- Comparing Scales – 1:5,000,000 x 1:5,000

Seems bigger, but is smaller. Remember fractions!

- Use the larger scale when near dangers (harbor entrance).
- Use the smaller scale when clear from danger (underway at sea).
- If in doubt, always use the larger scale!

A Large Scale Charts provides a smaller area and more details.
Charts Series

Sailing
(1:600,001 and Smaller)

Harbor
(Larger than 1:50,000)

Coastal / Approach
(1:50,001 to 1:150,000)

General
(1:150,001 to 1:600,000)

Larger scale ➔ smaller area ➔ more details!
Nautical Charts
Components

**Compass Rose:**
- Used to measure directions (true or magnetic) using slider/parallel ruler
- Contains the local variation and annual change (increase or decrease).

**Distance Scale:**
- Used to measure distances using compass or divider
- United States of America Nautical Symbols Abbreviations and Terms.

<table>
<thead>
<tr>
<th>No.</th>
<th>INT.</th>
<th>Description</th>
<th>NOAA</th>
<th>NGA</th>
<th>Other NGA</th>
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<td>Small Craft (Leisure) Facilities</td>
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</table>

Chart No. 1

- "Nautical Chart Symbols, Abbreviations and Terms" is a reference publication depicting basic chart elements and explains nautical chart symbols and abbreviations associated with National Ocean Service and NGA charts.

- A valuable aid for new chart users and a useful tool for all mariners.
### Schematic Layout of U.S. Chart No. 1:

#### Rocks, Wrecks, Obstructions

<table>
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<tr>
<th>No.</th>
<th>INT</th>
<th>Description</th>
<th>NOAA</th>
<th>NOAA</th>
<th>Other NGA</th>
<th>ECDIS</th>
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<td>11</td>
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<td><img src="chart_image2.png" alt="Image" /></td>
<td><img src="chart_image3.png" alt="Image" /></td>
<td><img src="chart_image4.png" alt="Image" /></td>
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</tbody>
</table>

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**Column 1:** Numbering system following the “Chart Specifications of the IHO.” A letter in this column indicates a supplementary national symbol or abbreviation for which there is no international equivalent.

**Column 2:** Representation that follows the “Chart Specifications of the IHO” (NT 1 symbol)

**Column 3:** Description of symbol, term, or abbreviation

**Column 4a:** Representation used on charts produced by the National Oceanic and Atmospheric Administration (NOAA)

**Column 4b:** Representation used on charts produced by the National Geospatial-Intelligence Agency (NGA)

**Column 5:** Representation of symbols that may appear on NGA reproductions of foreign charts

**Column 6:** Representation used to portray ENC data on ECDIS

**Column 7:** Description of ECDIS symbols

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* When columns 4a and 4b are combined then NOAA and NGA both use the same symbol. When either column 4a or 4b is blank then the respective agency uses the INT 1 symbol shown in column 2.

** When columns 6 and 7 have several rows for the same symbol number, then ECDIS portrays this feature differently depending on the ship’s draft and other conditions as defined in ECDIS by the mariner (as is the case for K 11). When columns 6 and 7 combine rows to span across several symbol numbers then ECDIS portrays all of the grouped symbol numbers the same way (see C 5–C 7).

† Signifies that this representation is obsolete, but it may appear on older charts.

* Signifies that a feature attribute value, such as a height, distance or name, may be obtained through an ECDIS cursor pick report. There are many attribute values that may be obtained in this manner, but the cursor pick icon is only used to note values that are specifically referred to in the description of symbols or notices and that ECDIS does not display next to the symbol. Height of trees in C 14 is an example.
**Compass**: Used for plotting and measuring distances or latitude and longitude.

**Divider**: Used for measuring distances or latitude and longitude.
Reading Distance

Don't use the longitude scale!!!

Remember: 1' = 1 NM

Some charts have a distance scale which can be easier than using latitude scale. Just place the compass or divider on the distance scale to measure.
1 – Locate the closest intersection of a major meridian/parallel.

2 – Measure the longitude using minute/second scale and plot on the parallel.

3 – Measure the latitude using minute/second scale and plot on the meridian AND from your previous mark.

4 – Using your longitude mark, plot the longitude from the latitude mark.

Plot: Lat.: 38° 56’ 30” N
Long: 076° 25’ 30” W
Reading Latitude and Longitude

1° = 60'
1' = 60"

Position lat. 25° 39’00”N
/ long 080° 07’00”W

25° 39’00”N
- The length of a degree of latitude (measured along a meridian) is the same everywhere on Earth, and equals 60 NM (nautical miles).

$1^\circ = 60 \text{ NM} \quad \Rightarrow \quad 1' = 1 \text{ NM}$

- The length of a degree of longitude (measured along a parallel) changes depending on the latitude.
Navigation Tools
Slider Ruler

Scales for reading distances
(if it matches the scale of the chart)

For reading direction in DEGREES TRUE!
Reading Directions

- 000° T
- 090° T
- 270° T
- 180° T
Reading Directions

What is the bearing to the radio tower?

1 – Place your ruler connecting your ship to the radio tower (object A to object B).

2 – Slide your ruler to the closest meridian, place the crosshair on the line, and read the bearing.

Make sure to look at the right direction: **113°T**!
Questions ?