Navigation and Flight Planning

Objective	
To ensure the applicant learns the elements of navigation and flight planning and can plan a VFR cross country properly.	
Purpose	
The entire point of learning to fly is going somewhere! Airplanes are great ways to go to far away places quickly. However, unlike driving a car, navigating in an airplane is considerably more complex. This lesson introduces pilots to the terms and concepts used in air navigation, as well as the basics of planning VFR cross countries, using pilotage, dead reckoning, radio navigation, and more.	

Schedule	**Equipment**
● **Ground Lesson**: 60 minutes ● **Student Q&A**: 20 minutes	● Airplane POH ● VFR Sectional Charts / Plotter / E6B ● Nav Log / Scratch Paper ● Whiteboard / Markers (optional)
Student Actions	**Instructor Actions**
● Ask any questions, receive study material for the next lesson. ● Watch linked video. ● Review listed references.	● Deliver the ground lesson (below). ● Answer student questions.

Completion Standards

- Student can explain the following concepts:
  - Heading, Course, Track, True vs. Magnetic Headings
  - Magnetic Variation, Compass Deviation, Wind Correction Angle
  - How to use a Plotter and E6B
  - How to select suitable VFR Navigation Checkpoints, VFR Cruising Altitudes, and Fuel Stops
  - Pilotage, Dead Reckoning, and Navigation Logs
  - How to compute fuel, performance, and endurance figures
  - How to quickly compute diversions using “rule of thumb” calculations, and lost procedures
  - How to obtain a weather briefing, how to file and use a VFR flight plan
  - How to make a go/no-go decision

References

- FLY8MA.com Flight Training - “Ep. 114: X/C Navigation Log | VFR Cross Country Nav Log Calculations”
  - YouTube - https://www.youtube.com/watch?v=94vSzPU7TDw
- FAA-H-8083-25B (Pilot’s Handbook of Aeronautical Knowledge) - Chapter 16, Page 2-8 [Aeronautical Charts], Chapter 16, Page 8-10 [Effect of Wind], Chapter 16, Page 11-12 [Basic Calculations], Chapter 16, Page 12-17 [Pilotage/Dead Reckoning], Chapter 16, Page 17-22 [Flight Planning/Charting the Course/VFR Flight Plans], Chapter 16, Page 34-35 [Lost Procedures/Flight Diversion]
- FAA-S-ACS-6B (Private Pilot ACS) - Area VI Task A, Area VI Task C, Area VI Task D
- FAA-S-ACS-7A (Commercial Pilot ACS) - Area VI Task A, Area VI Task C, Area VI Task D
- FAA-S-8081-6D (CFI PTS) - Area II Task G

Ground Lesson Outline

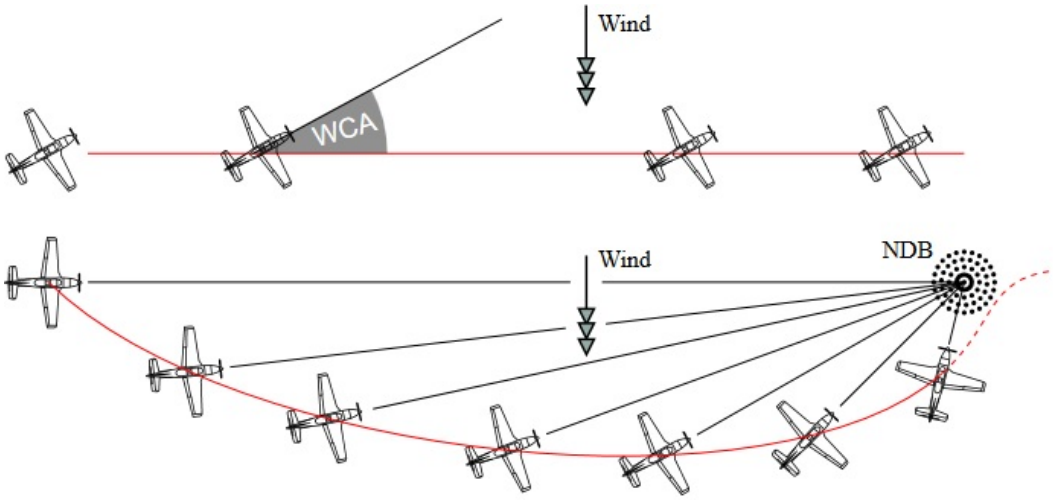
- Navigation Terms
  - Heading, Course, Ground Track, True Airspeed, Ground Speed, etc.
  - Magnetic Variation, Compass Deviation, Wind Correction Angles
- Aeronautical Charts
  - Latitude/Longitude Lines, Isogonic Lines, Scale
  - Spot Elevations, Contour Lines, Maximum Elevation Figures, Obstructions
  - Airports, Depictions of Landmarks/Ground Features, Depictions of Airspace
  - Importance of using the proper and current aeronautical charts
- Plotting a Course
  - Using a Plotter and E6B, Winds Aloft / Weather Data
  - True Course +/- WCA -> True Heading +/- Variation -> Magnetic Heading +/- Deviation -> Compass
  - Performance Charts - Endurance, Performance, Fuel Consumption Calculations and Fuel Stops
    - Selecting an Altitude, VFR Cruising Altitudes - § 91.159
    - Power vs Fuel Consumption, VFR Fuel Requirements - § 91.151
  - Selecting Landmarks and Alternates, Planning for Emergencies
- Fundamentals of Pilotage and Dead Reckoning
  - Landmarks - Lakes, Airports, Distinctive Roads, etc.
  - Checkpoints and Nav Logs - Importance of a Nav Log
    - Estimation of Time (behind schedule or ahead of schedule)
- Fundamentals of Radio Navigation
  - VORs, DME, and GPS
- Diversion to an Alternate
  - “Rule of Thumb” / Rough Calculations -> Time, Distance, Fuel
- Lost Procedures - VOR Triangulation, Use of GPS, Climb, Confess, etc.
- Go/No-Go Decisions
  - Weather Briefing, ADM (Good Judgement)
- VFR Flight Plans
  - Purpose, How to File

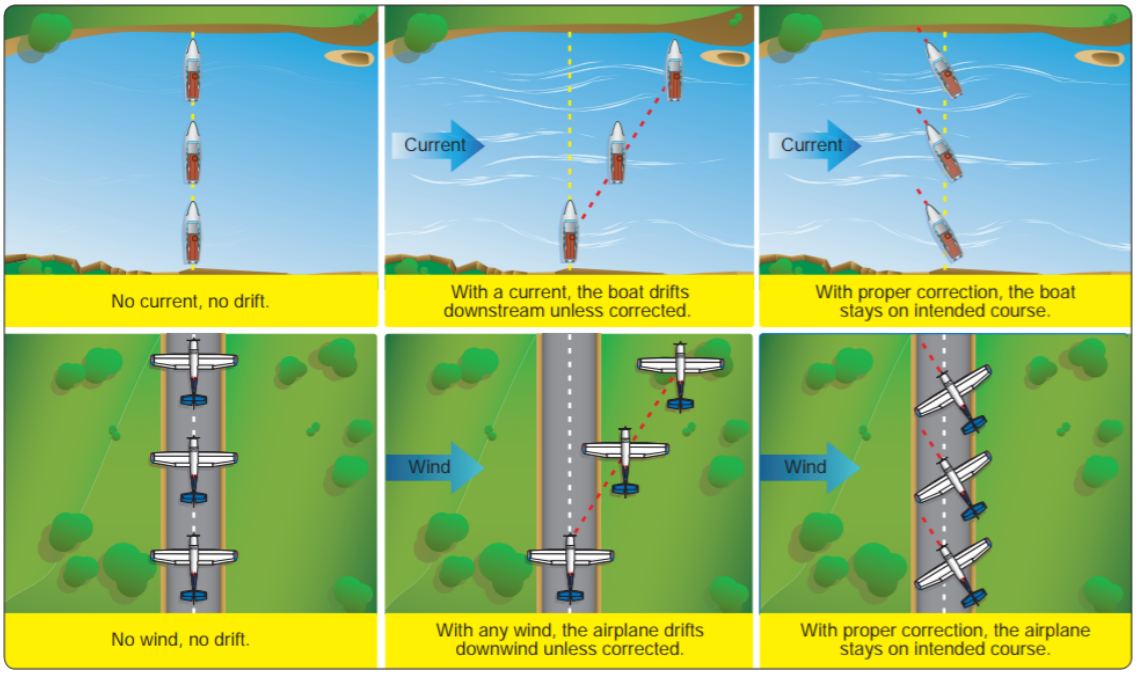
Common Errors

- Misunderstanding the relationship between True and Magnetic Course and Heading
- Inability to use a plotter or E6B to create a VFR Nav Log
- Selection of inappropriate or inadequate visual checkpoints
- Failure to identify location using pilotage

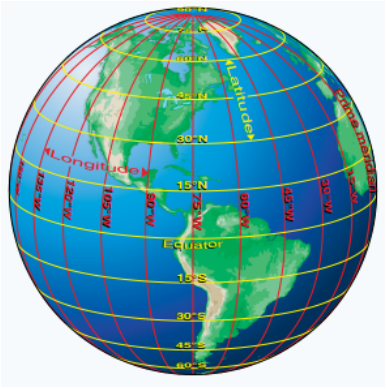
Ground Lesson Supplement

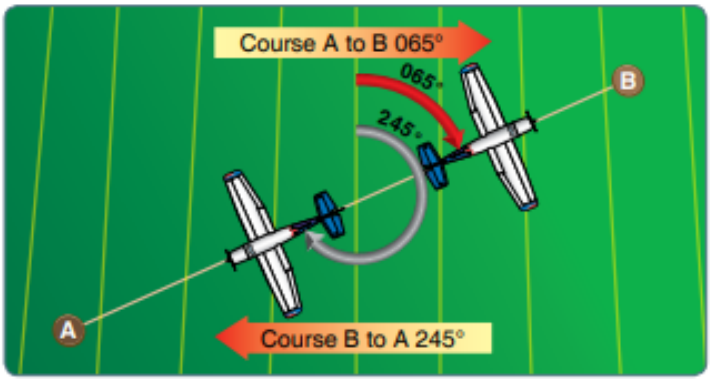
- **Heading vs Track** - Airplanes fly within the air, which is nearly always moving. Simply pointing at a ground landmark and flying 'towards' it will result in the airplane flying a longer, curved path. As an airplane flies through the air, in order to track a straight line, called a *course* line, they must fly at an angle relative to the line which counteracts the effects of the wind. This is called a **wind correction angle**, or WCA.



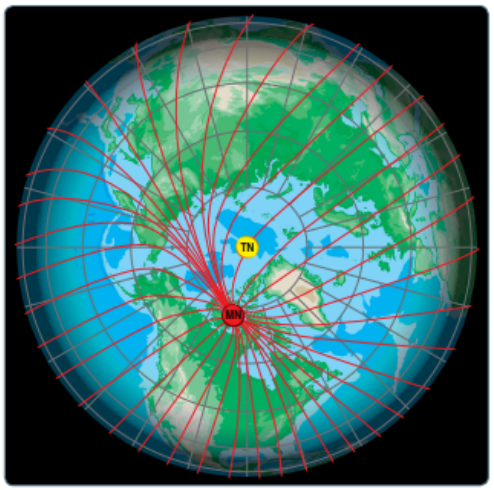


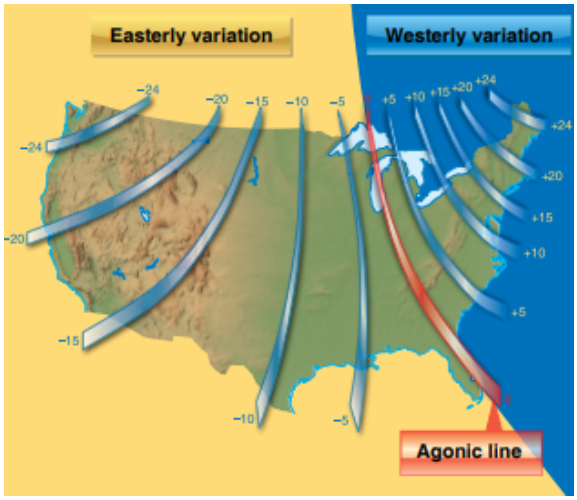
- **Latitude and Longitude** - Course lines are measured relative to lines of longitude.

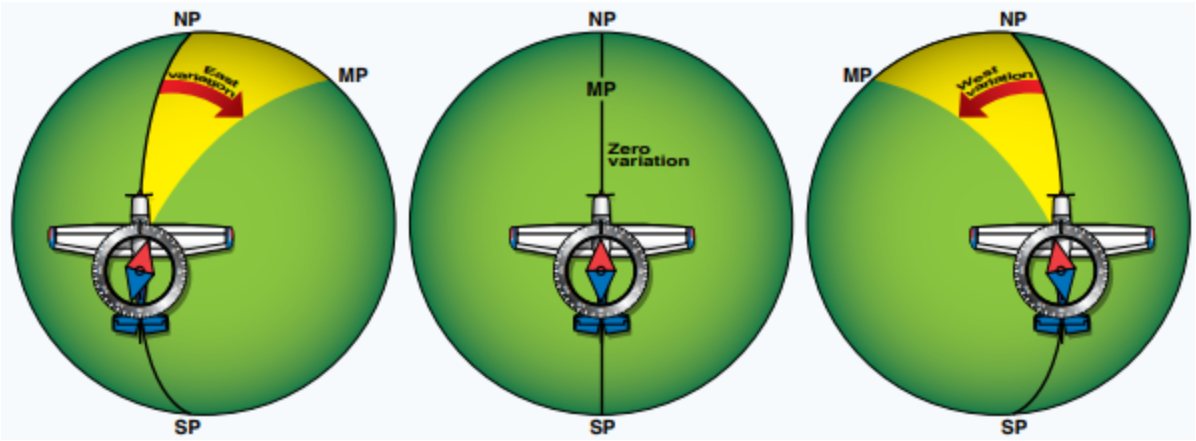




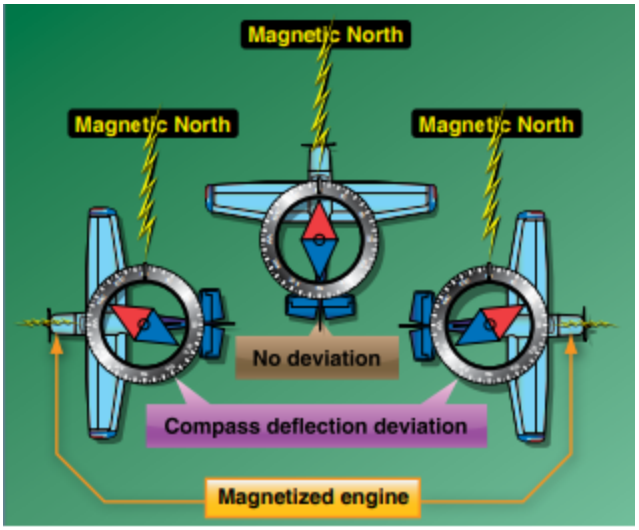
- **Magnetic Variation** - Magnetic North is not coincident with True North, creating *magnetic variation*. *Isogonic lines* are lines of equal magnetic variation.



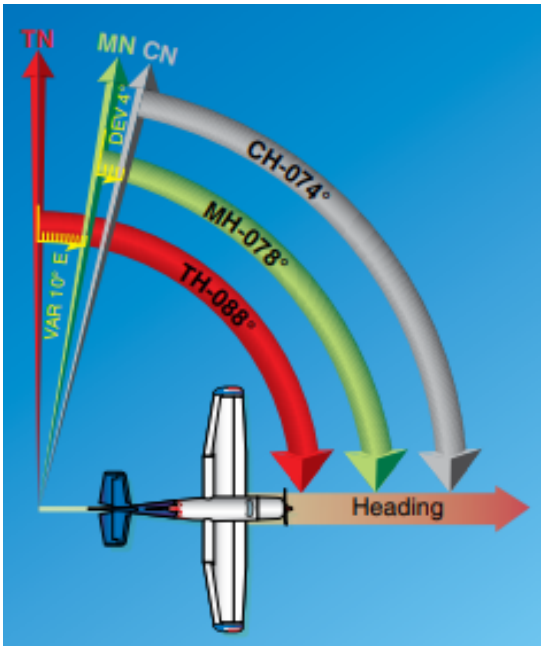




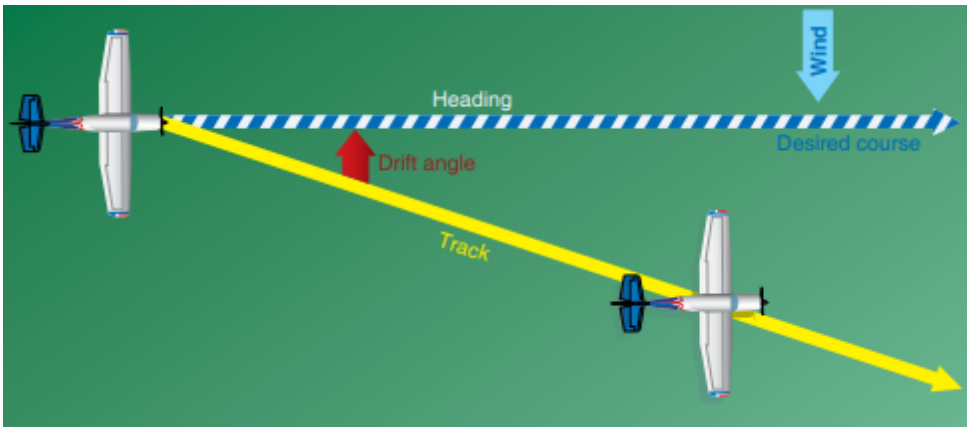
- **Compass Deviation** - Caused by large magnetic disturbances present in the airplane cockpit, depend on the heading. Corrected by using a *compass deviation card* (affixed to the compass)

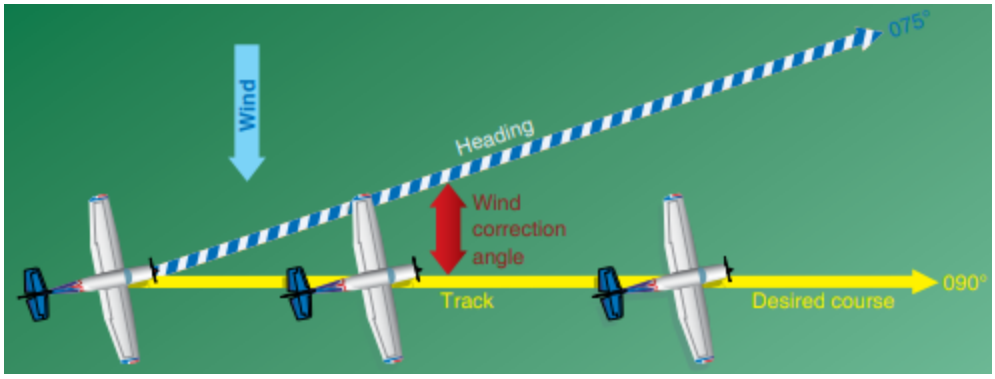


For (Magnetic)	N	30	60	E	120	150
Steer (Compass)	0	28	57	86	117	148
For (Magnetic	S	210	240	W	300	330
Steer (Compass)	180	212	243	274	303	332



- **Wind Correction Angle** - Corrects for wind drift.



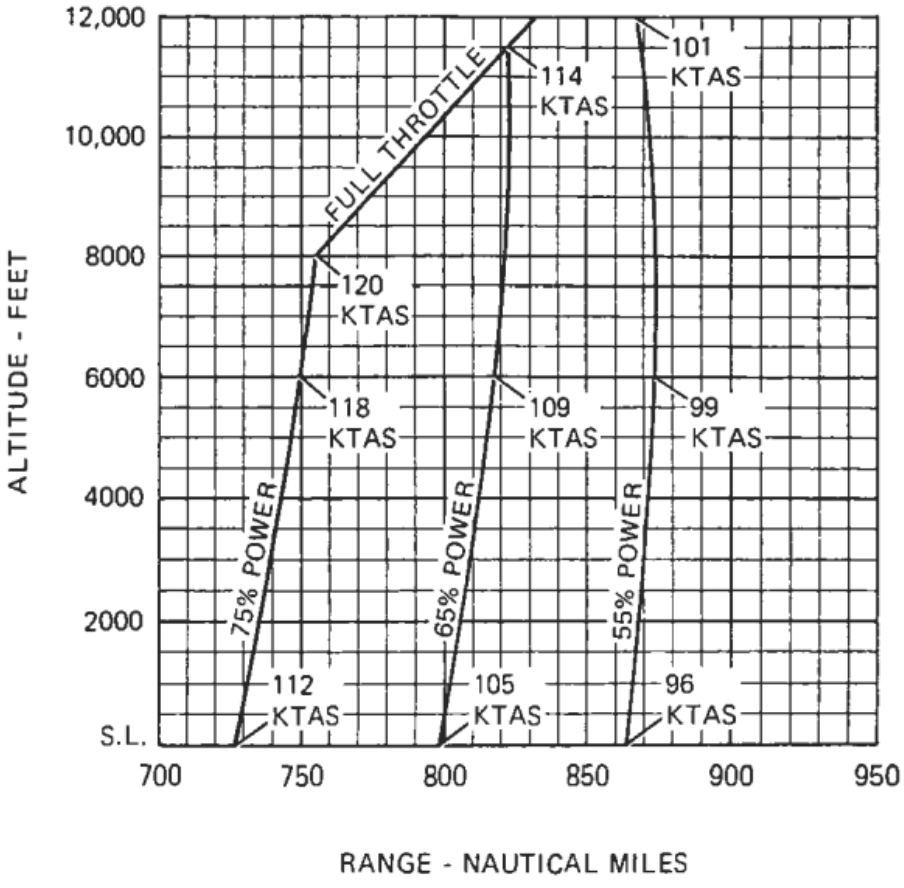


- **Cruise Performance**

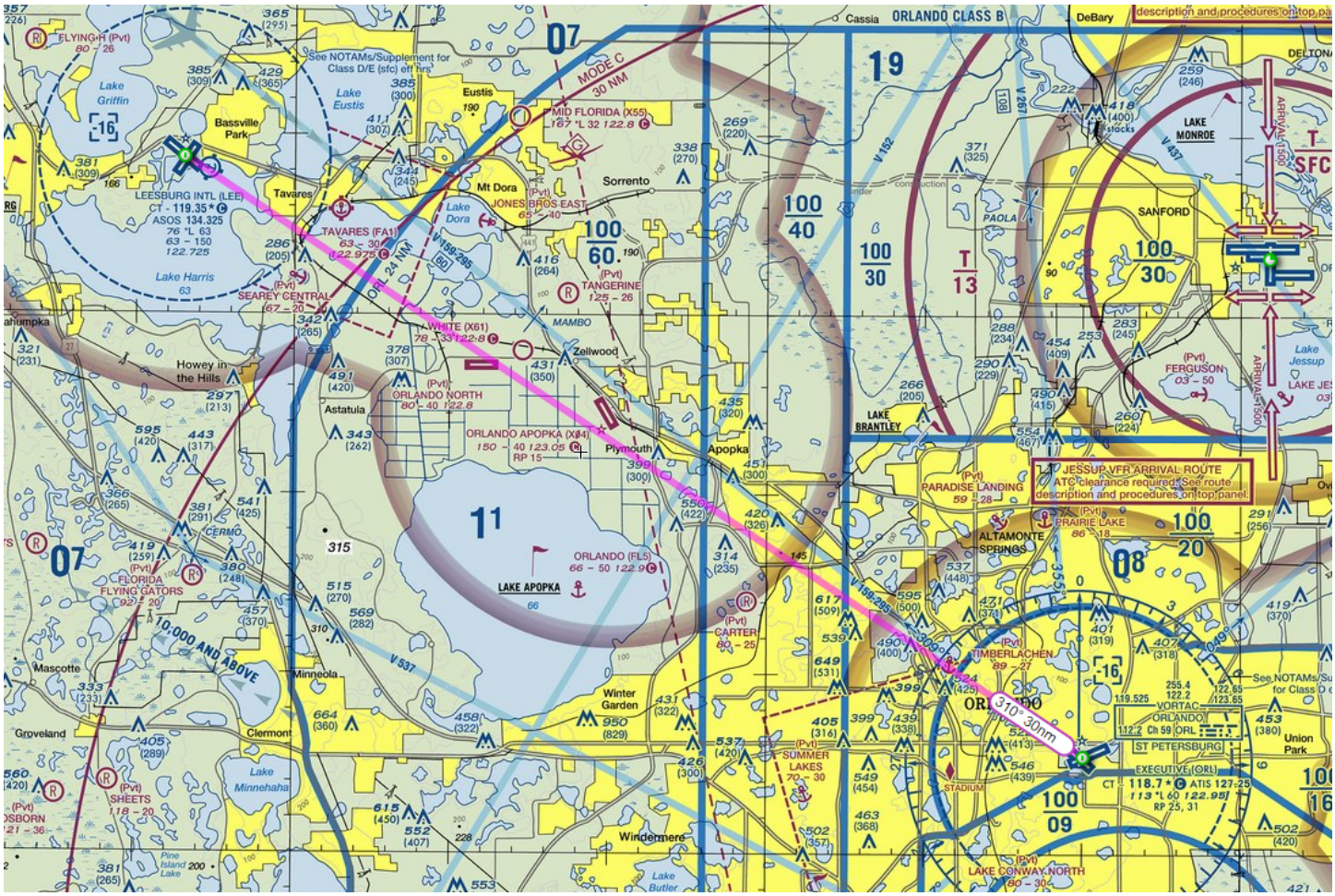
CRUISE PERFORMANCE

CONDITIONS:
2400 Pounds
Recommended Lean Mixture (See Section 4, Cruise)

PRESSURE ALTITUDE FT	RPM	20°C BELOW STANDARD TEMP			STANDARD TEMPERATURE			20°C ABOVE STANDARD TEMP		
		% BHP	KTAS	GPH	% BHP	KTAS	GPH	% BHP	KTAS	GPH
2000	2500	- - -	- - -	- - -	76	114	8.5	72	114	8.1
	2400	72	110	8.1	69	109	7.7	65	108	7.3
	2300	65	104	7.3	62	103	6.9	59	102	6.6
	2200	58	99	6.6	55	97	6.3	53	96	6.1
	2100	52	92	6.0	50	91	5.8	48	89	5.7
4000	2550	- - -	- - -	- - -	76	117	8.5	72	116	8.1
	2500	77	115	8.6	73	114	8.1	69	113	7.7
	2400	69	109	7.8	65	108	7.3	62	107	7.0
	2300	62	104	7.0	59	102	6.6	57	101	6.4
	2200	56	98	6.3	54	96	6.1	51	94	5.9
	2100	51	91	5.8	48	89	5.7	47	88	5.5



- **Charts and Plotting a Course**



- **E6B and Plotter**

- **VFR Checkpoints**