FOGLALKOZÁSI TERV

NYÍREGYHÁZI EGYETEM

Műszaki és Agrártudományi Intézet
Közlekedéstudományi és Infotechnológiai Tanszék

Tantárgy: **VFR navigáció**
Navigáció II.
2024/2025 tanév II. félév
Tantárgy kód: FRF1108
BHR2006

Tanítási hetek száma: **14** **Tantárgy kredit értéke:4**

Előadás: heti **3** óra, félévi **42** óra

Előadó: **Bujdosó László**

Gyakorlat: heti **3** óra, félévi **42** óra, Csoportszám: **2**

Gyakorlatvezető(k): **Bujdosó László**

A zárthelyi dolgozatok száma: **2 db**

A megíratás időpontjai:7. és 13. tanulmányi hét

Kötelező és ajánlott szakirodalom:

- Oxford: 060 Navigation 1 - General Navigation – 2014
- Nordian: General Navigation
- Bristol Ground School General Navigation

A félévelismerés feltételei (címszavakban):

Foglalkozásokon a jelenlét, fegyelmezett viselkedés és aktív munkavégzés a Tanulmányi és Vizsga-szabályzat szerint.
Hiányzás max. 3 heti óraszámnak megfelelő óráról

Gyakorlati jegy értékének meghatározása:

Használható kézi jegyzet készítése elméleti és gyakorlati órákon	25p
ATP Q progress test (max. 10db)	25p
Zárthelyi dolgozat 1. szerezhető	25p
Zárthelyi dolgozat 2. szerezhető	25p
A maximálisan elérhető pontszám	100 p

Minden fenti követelményben legalább elégséges szintet el kell érni.

Pontszámok és érdemjegyek:

85p		2/elégséges
86p	89p	3/közepes
90p	95p	4/jó
96p	100p	5/jeles

Nyíregyháza, 2025.02.03

Bujdosó László s.k.
műszaki oktató

Dr. Sikolya László
tanszékvezető

Tanulmányi Hét	Előadás tárgykör	óraszám	időpont	Tantárgyi gyakorlat tárgykör	óraszám	időpont
1.	**061.00.00.00 GENERAL NAVIGATION** **061.01.00.00 BASICS OF NAVIGATION** **061.01.01.00 The Earth** ***061.01.01.01 Form*** 061.01.01.01.01 State that the geoid is an irregular shape based on the surface of the oceans influenced only by gravity and centrifugal force. 061.01.01.01.02 State that a number of different ellipsoids are used to describe the shape of the Earth for mapping but that WGS-84 is the reference ellipsoid required for geographical coordinates. 061.01.01.01.03 State that the circumference of the Earth is approximately 40 000 km or approximately 21 600 NM. ***061.01.01.02 Earth rotation*** 061.01.01.02.01 Describe the rotation of the Earth around its own spin axis and the plane of the ecliptic (including the relationship of the spin axis to the plane of the ecliptic). 061.01.01.02.02 Explain the effect that the inclination of the Earth's spin axis has on insolation and duration of daylight.	3		Oxford videó prezentáció és ATPL teszt	3	
2.	**061.01.02.00 Position** ***061.01.02.01 Position reference system*** 061.01.02.01.01 State that geodetic latitude and longitude is used to define a position on the WGS-84 ellipsoid. 061.01.02.01.02 Define geographic (geodetic) latitude and parallels of latitude. 061.01.02.01.03 Calculate the difference in latitude between any two given positions. 061.01.02.01.04 Define geographic (geodetic) longitude and meridians. 061.01.02.01.05 Calculate the difference in longitude between any two given positions.	3		Oxford videó prezentáció és ATPL teszt	3	

	061.01.03.00	**Direction**				
	061.01.03.01	***Datums***				
	061.01.03.01.01	Define 'true north' (TN).				
	061.01.03.01.02	Measure a true direction on any given aeronautical chart.				
	061.01.03.01.03	Define 'magnetic north' (MN).				
	061.01.03.01.04	Define and apply variation.				
	061.01.03.01.05	Explain changes of variation with time and position.				
	061.01.03.01.06	Define 'compass north' (CN).				
	061.01.03.01.07	Apply deviation.				
	061.01.03.02	***Track and heading***				
	061.01.03.02.01	Calculate XWC by: trigonometry; and MDR.				
	061.01.03.02.02	Explain and apply the concepts of drift and WCA.				
	061.01.03.02.03	Calculate the actual track with appropriate data of heading and drift.				
	061.01.03.02.04	Calculate TKE with appropriate data of WCA and drift.				
	061.01.03.02.05	Calculate the heading change at an off-course fix to directly reach the next waypoint using the 1:60 rule.				
	061.01.03.02.06	Calculate the average drift angle based upon an off-course fix observation.				
	061.01.04.00	**Distance**				
	061.01.04.01	***WGS-84 ellipsoid***				
	061.01.04.01.01	State that 1 NM is equal to 1.852 km, which is the average distance of 1' of latitude change on the WGS-84 ellipsoid.				

	061.01.04.01.02	State that 1' of longitude change at the equator on the WGS-84 ellipsoid is approximately equal to 1 NM.					
	061.01.04.02	***Units***					
	061.01.04.02.01	Convert between units of distance (nautical mile (NM), kilometre (km), statute mile (SM), feet (ft), inches (in)).					
	061.01.04.03	***Graticule distances***					
	061.01.04.03.01	Calculate the distance between positions on the same meridian, on opposite (antipodal) meridians, on the same parallel of latitude, and calculate new latitude/longitude when given distances north-south and east-west.					
	061.01.04.04	***Air mile***					
	061.01.04.04.01	Evaluate the effect of wind and altitude on air distance.					
	061.01.04.04.02	Convert between ground distance (NM) and air distance (NAM) using the formula: NAM = NM × TAS/GS.					
3.	**061.05.00.00**	**TIME**	3		Oxford videó prezentáció és ATPL teszt	3	
	061.05.01.00	**Local Mean Time (LMT)**					
	061.05.01.01	***Mean solar day***					
	061.05.01.01.01	Explain the concepts of a mean solar day and LMT.					
	061.05.01.02	***Local Mean Time (LMT) and Universal Time Coordinated (UTC)***					
	061.05.01.02.01	Perform LMT and UTC calculations.					
	061.05.02.00	**Standard time**					
	061.05.02.01	***Standard time and daylight saving time***					
	061.05.02.01.01	Explain and apply the concept of standard time and daylight saving time, and perform standard time and daylight saving time calculations.					
	061.05.02.02	***International Date Line***					
	061.05.02.02.01	State the changes when crossing the International Date Line.					

	061.05.03.00 **Sunrise and sunset** ***061.05.03.01*** ***Sunrise and sunset times*** 061.05.03.01.01 Define sunrise, sunset, and civil twilight, and extract times from a suitable source (e.g. an almanac). 061.05.03.01.02 Explain the changes to sunrise, sunset, and civil twilight times with date, latitude and altitude. 061.05.03.01.03 Explain at which time of the year the duration of daylight changes at the highest rate.					
4.	**061.04.00.00** **CHARTS** **061.04.01.00** **Chart requirements** ***061.04.01.01*** ***ICAO Annex 4 'Aeronautical Charts'*** 061.04.01.01.01 State the requirement for conformality and for a straight line to approximate a great circle. ***061.04.01.02*** ***Convergence*** 061.04.01.02.01 Explain and calculate the constant of the cone (sine of parallel of origin). 061.04.01.02.02 Explain the relationship between Earth and chart convergence with respect to the ICAO requirement for a straight line to approximate a great circle. ***061.04.01.03*** ***Scale*** 061.04.01.03.01 Recognise methods of representing scale on aero-nautical charts. 061.04.01.03.02 Perform scale calculations based on typical en-route chart scales. **061.04.02.00** **Projections** ***061.04.02.01*** ***Methods of projection*** 061.04.02.01.01 Identify azimuthal, cylindrical and conical projecti-ons.	3		Oxford videó prezentáció és ATPL teszt	3	
5.	**061.03.00.00** **GREAT CIRCLES AND RHUMB LINES** **061.03.01.00** **Great circles** ***061.03.01.01*** ***Properties*** 061.03.01.01.01 Describe the geometric properties of a great circle (including the vertex) and a small circle.	3		Oxford videó prezentáció és ATPL teszt	3	

	061.03.01.01.02	Describe the geometric properties of a great circle and a small circle, up to 30 degrees difference of longitude.					
	061.03.01.01.03	Explain why a great-circle route is the shortest distance between any two positions on the Earth.					
	061.03.01.01.04	Name examples of great circles on the surface of the Earth.					
	061.03.01.02	***Convergence***					
	061.03.01.02.01	Explain why the track direction of a great-circle route (other than following a meridian or the equator) changes.					
	061.03.01.02.02	State the formula used to approximate the value of Earth convergence as change of longitude × sine mean latitude.					
	061.03.01.02.03	Calculate the approximate value of Earth convergence between any two positions, up to 30 degrees difference of longitude.					
	061.03.02.00	**Rhumb lines**					
	061.03.02.01	***Properties***					
	061.03.02.01.01	Describe the geometric properties of a rhumb line.					
	061.03.02.01.02	State that a rhumb-line route is not the shortest distance between any two positions on the Earth (excluding meridians and equator).					
	061.03.03.00	**Relationship**					
	061.03.03.01	***Distances***					
	061.03.03.01.01	Explain that the variation in distance of the great-circle route and rhumb-line route between any two positions increases with increasing latitude or change in longitude.					
	061.03.03.02	***Conversion angle***					
	061.03.03.02.01	Calculate and apply the conversion angle.					
6.	***061.04.02.02***	***Polar stereographic***	3		Oxford videó prezentáció és ATPL teszt	3	
	061.04.02.02.01	State the properties of a polar stereographic projection.					

	061.04.02.02.02	Calculate straight line track changes on a polar stereographic chart.					
	061.04.02.03	***Direct Mercator***					
	061.04.02.03.01	State the properties of a direct Mercator projection.					
	061.04.02.03.02	Given the scale at one latitude, calculate the scale at different latitudes.					
	061.04.02.03.03	Given a chart length at one latitude, show that it represents a different Earth distance at other latitu-des.					
7.	**061.03.00.00**	**GREAT CIRCLES AND RHUMB LINES**	3		I. Zárthelyi	3	
	061.03.01.00	**Great circles**					
	061.03.01.01	***Properties***					
	061.03.01.01.01	Describe the geometric properties of a great circle (including the vertex) and a small circle.					
	061.03.01.01.02	Describe the geometric properties of a great circle and a small circle, up to 30 degrees difference of longitude.					
	061.03.01.01.03	Explain why a great-circle route is the shortest dis-tance between any two positions on the Earth.					
	061.03.01.01.04	Name examples of great circles on the surface of the Earth.					
	061.03.01.02	***Convergence***					
	061.03.01.02.01	Explain why the track direction of a great-circle route (other than following a meridian or the equa-tor) changes.					
	061.03.01.02.02	State the formula used to approximate the value of Earth convergence as change of longitude × sine mean latitude.					
	061.03.01.02.03	Calculate the approximate value of Earth conver-gence between any two positions, up to 30 degrees difference of longitude.					
	061.03.02.00	**Rhumb lines**					
	061.03.02.01	***Properties***					
	061.03.02.01.01	Describe the geometric properties of a rhumb line.					

	061.03.02.01.02 State that a rhumb-line route is not the shortest distance between any two positions on the Earth (excluding meridians and equator). **061.03.03.00 Relationship** ***061.03.03.01 Distances*** 061.03.03.01.01 Explain that the variation in distance of the great-circle route and rhumb-line route between any two positions increases with increasing latitude or change in longitude. ***061.03.03.02 Conversion angle*** 061.03.03.02.01 Calculate and apply the conversion angle.					
8.	***061.04.02.02 Polar stereographic*** 061.04.02.02.01 State the properties of a polar stereographic projection. 061.04.02.02.02 Calculate straight line track changes on a polar stereographic chart. ***061.04.02.03 Direct Mercator*** 061.04.02.03.01 State the properties of a direct Mercator projection. 061.04.02.03.02 Given the scale at one latitude, calculate the scale at different latitudes. 061.04.02.03.03 Given a chart length at one latitude, show that it represents a different Earth distance at other latitudes.	3		Oxford videó prezentáció és ATPL teszt	3	
9.	**061.04.03.00 Practical use** ***061.04.03.01 Symbology*** 061.04.03.01.01 Recognise ICAO Annex 4 symbology. ***061.04.03.02 Plotting*** 061.04.03.02.01 Measure tracks and distances on VFR and IFR en-route charts. 061.04.03.02.02 Fix the aircraft position on an en-route chart with information from VOR and DME equipment. 061.04.03.02.03 Resolve bearings of an NDB station for plotting on an aeronautical chart.	3		Oxford videó prezentáció és ATPL teszt	-	

10.	**061.01.05.00** **Speed** ***061.01.05.01*** ***True airspeed (TAS)*** 061.01.05.01.01 Calculate TAS from CAS, and CAS from TAS by: mechanical computer; and rule of thumb (2 per cent per 1 000 ft). ***061.01.05.02*** ***Mach number (M)*** 061.01.05.02.01 Calculate TAS from M, and M from TAS. ***061.01.05.03*** ***CAS/TAS/M relationship*** 061.01.05.03.01 Deduce the CAS, TAS and M relationship in climb/descent/cruise (flying at constant CAS or M). 061.01.05.03.02 Deduce CAS and TAS in climb/descent/cruise (flying at constant CAS). ***061.01.05.04*** ***Ground speed (GS)*** 061.01.05.04.01 Calculate headwind component (HWC) and tailwind component (TWC) by: trigonometry; and MDR. 061.01.05.04.02 Apply HWC and TWC to determine GS from TAS and vice versa. 061.01.05.04.03 Explain the relationship between GS and TAS with increasing WCA. 061.01.05.04.04 Calculate GS with: mechanical computer (TOV solution); and MDR (given track, TAS and WV). 061.01.05.04.05 Perform GS, distance and time calculations. 061.01.05.04.06 Calculate revised GS to reach a waypoint at a specific time.	3		Navigáció számolótárcsa	3	

	061.01.05.04.07	Calculate the average GS based on two observed fixes.					
11.	**061.01.05.00**	**Speed**	3		Május 1.	3	
	061.01.05.01	***True airspeed (TAS)***					
	061.01.05.01.01	Calculate TAS from CAS, and CAS from TAS by: mechanical computer; and rule of thumb (2 per cent per 1 000 ft).					
	061.01.05.02	***Mach number (M)***					
	061.01.05.02.01	Calculate TAS from M, and M from TAS.					
	061.01.05.03	***CAS/TAS/M relationship***					
	061.01.05.03.01	Deduce the CAS, TAS and M relationship in climb/descent/cruise (flying at constant CAS or M).					
	061.01.05.03.02	Deduce CAS and TAS in climb/descent/cruise (flying at constant CAS).					
	061.01.05.04	***Ground speed (GS)***					
	061.01.05.04.01	Calculate headwind component (HWC) and tailwind component (TWC) by: trigonometry; and MDR.					
	061.01.05.04.02	Apply HWC and TWC to determine GS from TAS and vice versa.					
	061.01.05.04.03	Explain the relationship between GS and TAS with increasing WCA.					
	061.01.05.04.04	Calculate GS with: mechanical computer (TOV solution); and MDR (given track, TAS and WV).					
	061.01.05.04.05	Perform GS, distance and time calculations.					

	061.01.05.04.06	Calculate revised GS to reach a waypoint at a specific time.					
	061.01.05.04.07	Calculate the average GS based on two observed fixes.					
12.	***061.01.05.05***	***Flight log***	3		Oxford videó prezentáció és ATPL teszt	3	
	061.01.05.05.01	Enter revised navigational en-route data, for the legs concerned, into the flight plan (e.g. updated wind and GS and correspondingly losses or gains in time and fuel consumption).					
	061.01.05.06	***Gradient versus rate of climb/descent***					
	061.01.05.06.01	Estimate average climb/descent gradient (per cent) or glide path degrees according to the following rule of thumb: Gradient in degrees = (vertical distance (ft) / 100) / ground distance (NM)) Gradient in per cent = (vertical distance (ft) / 60) / ground distance (NM)) Gradient in degrees = arctan (altitude difference (ft) / ground distance (ft)). N.B. These rules of thumb approximate 1 NM to 6 000 ft and are based on the 1:60 rule.					
	061.01.05.06.02	Calculate rate of descent (ROD) on a given glide-path angle or gradient using the following rule of thumb formulae: ROD (ft/min) = GP degrees × GS (NM/min) × 100 ROD (ft/min) = GP per cent × GS (kt)					
	061.01.05.06.03	Calculate climb/descent gradient (ft/NM, per cent and degrees), GS or vertical speed according to the following formula: Vertical speed (ft/min) = (GS (kt) × gradient (ft/NM)) / 60.					
	061.01.05.06.04	State that it is necessary to determine the position of the aircraft accurately before commencing descent in order to ensure safe ground clearance.					
	061.01.06.00	**Triangle of velocities (TOV)**					
	061.01.06.01	***Construction***					
	061.01.06.01.01	Draw and correctly label the TOV.					
	061.01.06.02	***Solutions***					

	061.01.06.02.01	Resolve the TOV for: heading and GS (with mechanical computer and MDR); WV (with mechanical computer); and track and GS (with mechanical computer and MDR.					
13.	**061.01.07.00**	**Dead reckoning (DR)**	3		Oxford videó prezentáció és ATPL teszt	3	
	061.01.07.01	***Dead reckoning (DR) technique***					
	061.01.07.01.01	Determine a DR position.					
	061.01.07.01.02	Evaluate the difference between a DR and a fix position.					
	061.01.07.01.03	Define 'speed factor' (SF). Speed divided by 60, used for mental flight-path calculations.					
	061.01.07.01.04	Calculate wind correction angle (WCA) using the formula: WCA = XWC (crosswind component)/SF					
	061.01.08.00	**Navigation in climb and descent**					
	061.01.08.01	***Average airspeed***					
	061.01.08.01.01	Average TAS used for climb problems is calculated at the altitude 2/3 of the cruising altitude.					
	061.01.08.01.02	Average TAS used for descent problems is calculated at the altitude 1/2 of the descent altitude.					
	061.01.08.02	***Average wind velocity (WV)***					
	061.01.08.02.01	WV used for climb problems is the WV at the altitude 2/3 of the cruising altitude.					
	061.01.08.02.02	WV used for descent problems is the WV at the altitude 1/2 of the descent altitude.					
	061.01.08.02.03	Calculate the average climb/descent GS from given TAS at various altitudes, and WV at various altitudes and true track.					
	061.01.08.03	***Ground speed (GS)/distance covered during climb or descent***					

	061.01.08.03.01	State that most aircraft operating handbooks supply graphical material to calculate climb and descent problems.					
	061.01.08.03.02	Calculate the flying time and distance during climb/descent from given average rate of climb/descent and using average GS using the following formulae valid for a 3-degree-glide path: rate of descent = (GS × 10) / 2 rate of descent = speed factor (SF) × glide-path angle × 100					
	061.01.08.03.03	Given distance, speed and present altitude, calculate the rate of climb/descent in order to reach a certain position at a given altitude.					
	061.01.08.03.04	Given speed, rate of climb/descent and altitude, calculate the distance required in order to reach a certain position at a given altitude.					
	061.01.08.03.05	Given speed, distance to go and altitude to climb/descent, calculate the rate of climb/descent.					
14.	**061.02.00.00**	**VISUAL FLIGHT RULES (VFR) NAVIGATION**	3		2. Zárthelyi	3	
	061.02.01.00	**Ground features**					
	061.02.01.01	***Ground features***					
	061.02.01.01.01	Recognise which elements would make a ground feature suitable for use for VFR navigation.					
	061.02.01.02	***Visual identification***					
	061.02.01.02.01	Describe the problems of VFR navigation at lower levels and the causes of reduced visibility.					
	061.02.01.02.02	Describe the problems of VFR navigation at night.					
	061.02.02.00	**VFR navigation techniques**					
	061.02.02.01	***Use of visual observations and application to in-flight navigation***					
	061.02.02.01.01	Describe what is meant by the term ‘map reading’.					
	061.02.02.01.02	Define the term ‘visual checkpoint’.					
	061.02.02.01.03	Discuss the general features of a visual checkpoint and give examples.					

	061.02.02.01.04	State that the evaluation of the differences between DR positions and actual position can refine flight performance and navigation.					
	061.02.02.01.05	Establish fixes on navigational charts by plotting visually derived intersecting lines of position.					
	061.02.02.01.06	Describe the use of a single observed position line to check flight progress.					
	061.02.02.01.07	Describe how to prepare and align a map/chart for use in visual navigation.					
	061.02.02.01.08	Describe visual-navigation techniques including: use of DR position to locate identifiable landmarks; identification of charted features/landmarks; factors affecting the selection of landmarks; an understanding of seasonal and meteorological effects on the appearance and visibility of landmarks; selection of suitable landmarks; estimation of distance from landmarks from successive bearings; estimation of the distance from a landmark using an approximation of the sighting angle and the flight altitude.					
	061.02.02.01.09	Describe the action to be taken if there is no visual checkpoint available at a scheduled turning point.					
	061.02.02.01.10	Understand the difficulties and limitations that may be encountered in map reading in some geographical areas due to the nature of terrain, lack of distinctive landmarks, or lack of detailed and accurate charted data.					
	061.02.02.01.11	State the function of contour lines on a topographical chart.					
	061.02.02.01.12	Indicate the role of ‘layer tinting’ (colour gradient) in relation to the depiction of topography on a chart.					
	061.02.02.01.13	Using the contours shown on a chart, describe the appearance of a significant feature.					

	061.02.02.01.14 Apply the techniques of DR, map reading, orientation, timing and revision of ETAs and headings. ***061.02.02.02 Unplanned events*** 061.02.02.02.01 Explain what needs to be considered in case of diversion, when unsure of position and when lost.					

Bujdosó László s.k.

műszaki oktató