DESCRIPTION OF THE COURSE

Name of the course: Aeroelasticity and Vibrations	Code: **BASEe21**	Semester: 5
Type of teaching: Lectures (L) Laboratory work (LW) Course work (CW)	Hours per semester: L – 15 hours S – 0 hours LW – 30 hours	Number of credits: **5**

LECTURER(S):
Prof. Eng. Ivan Kralov, PhD, DSc (FT), tel.: 965 2540, e-mail: kralov@tu-sofia.bg
Assist. Prof. Eng. Ivo Angelov, PhD (FT), tel. 965 2234, e-mail: i.angelov@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Compulsory subject from the curriculum for training of students to obtain Bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The aim of the cource "Aeroelasticity and vibrations" is to give to students knowledge for the main methods for modelling and investigation of the elastic and vibrational characteristics of the elements and systems of machines.

DESCRIPTION OF THE COURSE: The main Acxioms and laws of elasticity and vibrations are treated. Students are modelling, determining elastic and vibrating parameters of elements and systems and are able to improve them.

PREREQUISITES: Advanced Mathematics I, Advanced Mathematics II, Engineering Mechanics I, Engineering Mechanics II.

TEACHING METHODS: Lectures, using PowerPoint slides and demo programs, laboratory work.

METHOD OF ASSESSMENT: Preparation of a problem solution, presentation and defense t the exam sesseion.

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: 1. Kralov., I., Mechanics II (Dynamics), TU-Sofia, Sofia, 2015; 2. Rao, S. S., Mechanical Vibrations, Pearson, 2018; 3. Geradin, M., Rixen, D., Mechanical vibrations – Theory and Application to Structural Dynamics – 3rd Edition, Willey, 2015; 4. Johanson, Beer, Vector Mechanics for Engineers, part I and II, McGrawHill, USA, 1995; Ugural, A., Fenster, S., Advansed Mechanics of Materials and Applied Elasticity, 6th Edition, 2019.

DESCRIPTION OF THE COURSE

Name of the course: **Communication and navigation systems I (in space)**	Code: **BASEe22**	Semester: **5**
Type of teaching: Lections (L), Tutorials (T)	Hours per semester: L – 15 hours S – 30 hours	Number of credits: **5**

LECTURER(S):

Доц. д-р инж. Петър Петков (ФТК), тел.: 965 2870, , e-mail: pjpetkov@tu-sofia.bg
Гл. ас. д-р инж. Ивайло Начев (ФТК), tel.: 965 1260, e-mail: ivaylonachev@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Compulsory subject from the curriculum for training of students to obtain Bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The aim of the course is to present fundamental knowledge in the field of excitation and propagation of electromagnetic waves, antenna and transmission lines, wireless transmission of energy and information, modulations, transmitters and receivers, and their specifics in space applications for communication, remote sensing and navigation.

DESCRIPTION OF THE COURSE: Main topics: Orbital mechanics, propagators, two-line file with the elements of satellite position; Satellite and ground segment; Link equation considering the effect of noise and radio channel parameters; Occupied bandwidth of information signals and signal-to-noise ratio in different types of modulations; Modulation, multiplexing and multi-station access methods used in satellite communications and transmission error protection codes; Know the different types of terrestrial and satellite antennas used for MSS, S-PCN and GNSS; Modern satellite networks, constellations and applications; Mobile satellite communications.

PREREQUISITES: Advanced Mathematics I, Advanced Mathematics II, Engineering Computer Science I.

TEACHING METHODS: Lectures, using PowerPoint slides, case studies, laboratory and course work description preparation and defence.

METHOD OF ASSESSMENT: Exam (70%), seminar exercises (10%), course work (20%).

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: 1. Dennis Roddy, Satellite Communications, Fifth Edition,5th Edition, 2024, ISBN: 978126537254; 2. G. Maral, M. Bousquet, Z. Sun, Satellite Communications Systems: Systems, Techniques and Technology, Sixth Edition, Willey, 2020, ISBN:9781119673811; 3. William Hayt and John Buck, Engineering Electromagnetics, 9th Edition, 2019, ISBN: 9780078028151; 4. T. Jade Morton et al, Position, Navigation, and Timing Technologies in the 21st Century: Integrated Satellite Navigation, Sensor Systems, and Civil Applications, 2021, ISBN: 9781119458418; 5. Teresa M. Braun, Walter R. Braun, Satellite Communications Payload and System, 2021, ISBN:9781119384311.

DESCRIPTION OF THE COURSE

Name of the course: **Spacecraft Attitude Dynamics and Control)**	Code: **BASEe23**	Semester: 5
Type of teaching: Lectures (L) Laboratory work (LW) Course work (CW)	Hours per semester: L – 30 hours S – 0 hours LW – 30 hours	Number of credits: 6

LECTURER(S):
Prof. Eng. Michael Todorov, PhD (FT), tel.: 965 2531, e-mail: michael.todorov@tu-sofia.bg
Assist. Eng. Gabriel Georgiev, MSE (FT), tel. 965 [3124], e-mail: gabgeorgiev@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Compulsory subject from the curriculum for training of students to obtain bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The main objective of this course is to provide students with fundamental knowledge about the mathematical modelling of the kinematics and dynamics of space vehicles performing flights in the free atmosphere and the means of stabilizing a predetermined trajectory.

DESCRIPTION OF THE COURSE: ***1. Spacecraft Attitude Kinematics and Dynamics:*** 1.1. Attitude kinematics equations of motion for a spacecraft, 2.2. Attitude dynamic equations of motion for a satellite. ***2. Gravity Gradient Stabilization:*** 2.1. The basic attitude control equation, 2.2. Gravity Gradient Attitude Control. ***3. Attitude Manoeuvres in Space:*** 3.1**.** Equations for basic control laws, 3.2. Control with momentum exchange devices, 3.3. Magnetic Attitude Control, 3.4. Magnetic Unloading of Momentum Exchange Devices, 3.5. Time-optimal attitude control. ***4. Momentum-Biased Attitude Stabilization:*** **4.1.** Stabilization without active control, **4.2.** Stabilization with active control. ***5. Reaction thruster attitude control:*** 5.1. Set-up of reaction thruster control, 5.2. Reaction torques and attitude control loops…

PREREQUISITES: Advanced Mathematics I, Advanced Mathematics II, Advanced Mathematics III, Engineering Mechanics I - Statics and Kinematics, Engineering Mechanics II – Dynamics…

TEACHING METHODS: Lectures delivered in terms of computer presentations.

METHOD OF ASSESSMENT: Exam (total 70%), laboratory work (30%).

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY:
1. Modern Spacecraft Dynamics and Control, Marshall Kaplan, John Willey, and Sons, New York, 1976.

2. Spacecraft Dynamics and Control, Marcel J. Sidi, Cambridge University Press, U.K Modern Spacecraft Dynamics and Control, 1997.

3. Spacecraft Dynamics and Control: An Introduction, Anton H.J. de Ruiter, Christopher J. Damaren, and James R. Forbes, John Willey, and Sons, 2013.

DESCRIPTION OF THE COURSE

Name of the course: **Orbital Mechanics**	Code: **BASEe24**	Semester: 5
Type of teaching: Lectures (L) Seminar work (S) Course work (CW)	Hours per semester: L – 30 hours S – 15 hours LW – 0 hours	Number of credits: **5**

LECTURER(S):
Prof. Michael Todorov, PhD (FT), tel.: 965 2531, e-mail: michael.todorov@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Compulsory subject from the curriculum for training of students to obtain Bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The purpose of the course is to familiarize students with the theory of orbital motion, including the study of the motions of artificial satellites and other spacecraft vehicles moving under the influence of gravity, motor thrust, atmospheric drag, solar winds, and any other effects that may are present. Engineering applications include launch ascent, reentry and landing trajectories, rendezvous calculations, orbital design, and lunar and planetary trajectories.

DESCRIPTION OF THE COURSE: The two-body problem, orbital position as a function of time, types of orbital perturbations, orbital perturbation theory applied to Earth satellites, orbital transfers, interplanetary trajectories, and Lambert's theorem are successively presented in the course..

PREREQUISITES: It is assumed that students have general knowledge of mathematics, mechanics and computr programming.

TEACHING METHODS: Lectures, using PowerPoint slides, seminars and course work description preparation and defence.

METHOD OF ASSESSMENT: Exam (70%), course work (30%).

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: 1. H. Curtis, Orbital Mechanics for Engineering Students, Elsevier Butterworth-Heinemann,2005. 2. R. H. Tolson, Space Flight Mechanics. NC State University, 2005. 3. W. T. Thomson, Introduction to Space Dynamics, Dover Publcatios, 1986. 4. G. Tommei and S. Maro, Lecture notes of SPACE MECHANICS, based on the notes for the SPACECRAFT ORBITAL DYNAMICS AND CONTROL course of the University of Bologna, written by Dr. Elisa Maria Alessi and Dr. Dario Modenini, 2019.

DESCRIPTION OF THE COURSE

Name of the course: **Space Engineering English**	Code: **BASEe25.1**	Semester: **5**
Type of teaching: Tutorials (Tut)	Hours per semester: S – 30 hours	Number of credits: **4**

LECTURER(S):
Sen. Lect. Ivan Naidenov - EL (DFLAL), tel.:965 3162, e-mail: ivan_naidenov@tu-sofia.bg
Sen. Lect. Todor Todorov - EL (DFLAL), tel.: 965 3162, e-mail: todobg@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Elective subject from the curriculum for training of students to obtain Bachelor's degree, specialty Aerospace Engineering in English, Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field 5 Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The aim of the foreign language education is to enable students to use scientific literature and specialized texts, as well as to enhance their communicative competence.

DESCRIPTION OF THE COURSE: The students are taught according to a flexible modular system, adjusted to the proficiency levels identified by an entry test in the respective language. The programme of study consolidates and enriches the linguistic knowledge acquired in secondary schools with new categories, notions and lexis characteristic for the specialty. By means of authentic course books the students gain in-depth knowledge in grammar, syntax, word formation, phraseology, and specialized terminology. Foreign language education builds up communicative skills and competence allowing students to socialize and function effectively in real-life professional situations. They continue to develop the four language skills aiming at facilitating their adequate auditory and visual comprehension of information, offered in a foreign language, as well as their active ability to respond in keep with the stylistics and norms of multicultural communication.

PREREQUISITES: The course of study requires basic knowledge of the language and elementary rules of grammar in combination with the correct use of lexical items and skills, taught at secondary level of education.

TEACHING METHODS: In the selection and structuring of the syllabus an integrated theoretical-practical communicative approach is used, taking into consideration the functional needs of students to use the language competently in cross-cultural and professional media. The modular principle of foreign language teaching allows for a synthesis of a learner-centred seminar work on a given topic with other forms of study and self-study.

Various interactive methods of classroom management are applied, such as discussions, case studies, role plays, presentations and individual and group assignments on a given topic.

METHOD OF ASSESSMENT: The final grade (continuous assessment) is formed on the basis of two written tests, one in the middle and one at the end of the semester, (an overall of 80%) and active participation in seminars and workshops and work on individual and group assignments (an overall of 20%)

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: Bonamy D., Technical English 1–4, Pearson Longman, 2011; Emery H, Roberts A., Aviation English, Macmillan, 2012; Ibbotson, M. (2018). Professional English in Use. Engineering. CUP; Emery, H. and Roberts, A. (2012). Aviation English for ICAO compliance. Macmillan; Ellis, S. and Gerighty, T. (2012). English for aviation for Pilots and Air Traffic Controllers. Oxford; Lloyd, C., Frasier, J. A. (2011) Career Paths: Engineering. Express Publishing;

Brieger, N., Pohl, A. (2008). Technical English Vocabulary and Grammar. Oxford: Summertown; Federal Aviation Administration (Author), U.S. Department of Transportation (Author)Pilot’s, 2023;Pilot's Handbook of Aeronautical Knowledge (2024): FAA-H-8083-25C (ASA FAA Handbook Series), 2023; Valasek, John. Morphing aerospace vehicles and structures. Chichester, West Sussex : Reston, VA : John Wiley & Sons ; American Institute of Aeronautics and Astronautics, 2012.; Bukley, Angie. Artificial gravity [electronic resource/ Ed. by Gilles Clement, New York, NY : Springer Science+Business Media, LLC, 2007.

DESCRIPTION OF THE COURSE

Name of the course: **Space Engineering German**	Code: **BASEe25.2**	Semester: **5**
Type of teaching: Tutorials (Tut)	Hours per semester: S – 30 hours	Number of credits: **4**

LECTURER(S):
Sen. Lect. Veselin Vapordjiev - GL (DFLAL), tel.:965 3178, e-mail: vapordjiev@tu-sofia.bg
Sen. Lect. Krasimira Mancheva - GL (DFLAL), tel.: 965 3178, e-mail: kmancheva@fdiba.tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Elective subject from the curriculum for training of students to obtain Bachelor's degree, specialty Aerospace Engineering in English, Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field 5 Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The aim of the foreign language education is to enable students to use scientific literature and specialized texts, as well as to enhance their communicative competence.

DESCRIPTION OF THE COURSE: The students are taught according to a flexible modular system, adjusted to the proficiency levels identified by an entry test in the respective language. The programme of study consolidates and enriches the linguistic knowledge acquired in secondary schools with new categories, notions and lexis characteristic for the specialty. By means of authentic course books the students gain in-depth knowledge in grammar, syntax, word formation, phraseology, and specialized terminology. Foreign language education builds up communicative skills and competence allowing students to socialize and function effectively in real-life professional situations. They continue to develop the four language skills aiming at facilitating their adequate auditory and visual comprehension of information, offered in a foreign language, as well as their active ability to respond in keep with the stylistics and norms of multicultural communication.

PREREQUISITES: The course of study requires basic knowledge of the language and elementary rules of grammar in combination with the correct use of lexical items and skills, taught at secondary level of education.

TEACHING METHODS: In the selection and structuring of the syllabus an integrated theoretical-practical communicative approach is used, taking into consideration the functional needs of students to use the language competently in cross-cultural and professional media. The modular principle of foreign language teaching allows for a synthesis of a learner-centred seminar work on a given topic with other forms of study and self-study.

Various interactive methods of classroom management are applied, such as discussions, case studies, role plays, presentations and individual and group assignments on a given topic.

METHOD OF ASSESSMENT: The final grade (continuous assessment) is formed on the basis of two written tests, one in the middle and one at the end of the semester, (an overall of 80%) and active participation in seminars and workshops and work on individual and group assignments (an overall of 20%)

INSTRUCTION LANGUAGE: German.

BIBLIOGRAPHY: Vapordjiev V., Mancheva K., Deutsch für Ingenieurstudenten, 2018; Motta, G. (2014). Direkt zur Grammatik.Klett; Steinzel, M., Dintera, H. (2014). Deutsch für Ingenieure. Springer Vieweg ;Flugregelung- Walter Fichter, Johannes Stephan; Technisches Wörterbuch für die Luftfahrt от Lufthansa Technical Training; Technologie des Flugzeuges от Klaus Engmann.

DESCRIPTION OF THE COURSE

Name of the course: **Spacecraft Control Systems)**	Code: **BASEe27**	Semester: 6
Type of teaching: Lectures (L) Seminars (S) Laboratory work (LW)	Hours per semester: L – 30 hours S – 0 hours LW – 30 hours	Number of credits: **5**

LECTURER(S):
Prof. Eng. Michael Todorov, PhD (FT), tel.: 965 2531, e-mail: michael.todorov@tu-sofia.bg
Assist. Eng. Gabriel Georgiev, MSE (FT), tel. 965 [3124], e-mail: gabgeorgiev@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Compulsory subject from the curriculum for training of students to obtain Bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: This course aims to provide basic theory of orbital mechanics, introducing various orbital maneuvers and corrections, deriving attitude dynamics and kinematics, introducing different satellite stabilization methods, to give students basic knowledge about attitude maneuvers in space as well as various attitude control systems..

DESCRIPTION OF THE COURSE: Main topics: An introduction to orbit dynamics; orbital transfer; spacecraft angular motion modelling; passive and active stabilization methods; Attitude maneuver in space; momentum-biased attitude stabilization; reaction thruster attitude control systems..

PREREQUISITES: Advanced Mathematics I, Advanced Mathematics II, Control Systems Engineering.

TEACHING METHODS: Lectures, using PowerPoint slides, case studies, laboratory work description preparation and defence.

METHOD OF ASSESSMENT: Exam (70%), laboratories (30%)

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: 1. Marcel Sidi, Spacecraft Dynamics and Control,1997; 2. Vladimir Chobotov, spacecraft attitude dynamics and control, 1991, 3.T.R.Kane, Spacecraft Dynamics, 1995; 4. C.Kluever, Spaceflight Dynamics, 2018.

DESCRIPTION OF THE COURSE

Name of the course: **Spacecraft Control Systems Project)**	Code: **BASEe28**	Semester: 6
Type of teaching: Lectures (L) Laboratory work (LW) Course Project	Hours per semester: L – 0 hours S – 0 hours LW – 60 hours	Number of credits: **6**

LECTURER(S):
Prof. Eng. Michael Todorov, PhD (FT), tel.: 965 2531, e-mail: michael.todorov@tu-sofia.bg
Assist. Eng. Gabriel Georgiev, MSE (FT), tel. 965 [3124], e-mail: gabgeorgiev@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Compulsory subject from the curriculum for training of students to obtain Bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The objective of the project is to train students practical skill for mathematical modelling of angular as well as translational motion of spacecrafts, to give them ability for developing motion simulation programs, providing insight for choosing main elements of spacecraft control systems for a specified mission, learning design procedure of spacecraft stabilization/control system in pseudo-real cases, and to get ability to check their designed spacecraft control system performance via developed simulations..

DESCRIPTION OF THE COURSE: Main topics: Mission definition, Developing mathematical models and relevant simulation program according to the specified mission; Selecting type/structure of the spacecraft control system; Choosing appropriate sensors and actuators according to real available elements in the market and other technical requirements; Performing spacecraft control system design procedure; Testing the designed control system via developed simulation.

PREREQUISITES: Spacecraft Control Systems

TEACHING METHODS: Case studies, laboratory and project reports description, preparation and defence.

METHOD OF ASSESSMENT: Project defence (70%), on-going assessment (30%)

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: 1. Marcel Sidi, Spacecraft Dynamics and Control,1997; 2. Vladimir Chobotov, spacecraft attitude dynamics and control, 1991, 3.T.R.Kane, Spacecraft Dynamics, 1995; 4. C.Kluever, Spaceflight Dynamics, 2018.

DESCRIPTION OF THE COURSE

Name of the course: **Spacecraft Communications**	Code: **BASEe29**	Semester: 6
Type of teaching: Lectures (L) Lab exercises (LE)	Hours per semester: L – 15 hours LE – 30 hours	Number of credits: **5**

LECTURER(S):

Доц. д-р инж. Георги Балабанов (ФТК), tel.: 965 3456, e-mail: grb@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Compulsory subject from the curriculum for training of students to obtain Bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The aim of the course is to present fundamental knowledge in the field of design, analysis, and simulation of the next generation of advanced space and ground networks, communication system concepts, and architectures using the latest networking technologies and tools, and the development of new resilient space networking concepts, algorithms, and protocols in the areas of space communications.

DESCRIPTION OF THE COURSE: Main topics: Satellite Communication Systems; Deep Space Communication Protocols; Error Control Coding in Space Communications; Spacecraft Networking Architectures; Interplanetary Internet; Security Challenges in Space Communications; Software-Defined Networks (SDN) in Space Communications; Integration of AI in Space Communications; Next-Generation Space Communication Technologies; Standardization and Regulation in Space Communications.

PREREQUISITES: Communication and navigation systems I, Communication and navigation systems II.

TEACHING METHODS: Lectures, using PowerPoint slides, case studies, laboratory exercises with protocol defence.

METHOD OF ASSESSMENT: One written test (60%), Lab exercises (40%).

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: 1. Dennis Roddy, Satellite Communications, Fifth Edition,5th Edition, 2024, ISBN: 978126537254; 2. G. Maral, M. Bousquet, Z. Sun, Satellite Communications Systems: Systems, Techniques and Technology, Sixth Edition, Willey, 2020, ISBN:9781119673811; 3. Jim Taylor, Deep Space Communications, John Wiley & Sons, 2019, ISBN:9781119169024; 4. Geoff Varrall, 5G and Satellite Spectrum, Standards, and Scale, Artech House Publishers 2018, ISBN: 978-1630815028; 5. Teresa M. Braun, Walter R. Braun, Satellite Communications Payload and System, 2021, ISBN:9781119384311.

DESCRIPTION OF THE COURSE

Name of the course: **Space Propulsion Systems**	Code: **BASEe30**	Semester: 6
Type of teaching: Lectures (L) Seminars (S) Laboratory work (LW)	Hours per semester: L – 15 hours S – 15 hours LW – 0 hours	Number of credits: **4**

LECTURER(S):
Assoc. Prof. Eng. Vladimir Serbezov, PhD (FT), tel.: 965 3078, e-mail: vserbezov@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Compulsory subject from the curriculum for training of students to obtain Bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The purpose of the course is to familiarize students with the space propulsion fundamentals and performance metrics, types of propulsion systems for satellites and spacecraft. Main focus is on propulsion for orbital maneuvering and corrections, but also propulsion for interplanetary flights, descend and soft landings on extraterrestrial bodies is included..

DESCRIPTION OF THE COURSE: Propulsion Fundamentals; Chemical Propulsion Systems (mono-, bi, solid-, hybrid- propellant); Electric Propulsion Systems (Electrothermal, Electrostatic, Electromagentic); Propellant-less propulsion (Electrodynamic tethers, Solar sails, etc.); Micropropulsion; Nuclear Propulsion Systems.

PREREQUISITES: General knowledge of Engineering Chemistry, Electrical Engineering and Electronics, Thermodynamics and heat transfer, Fluid Mechanics.

TEACHING METHODS: Lectures and seminar works.

METHOD OF ASSESSMENT: Midterm and final written exams.

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: 1. Tajmar, M. Advanced space propulsion systems. Springer Science & Business Media, 2012. 2. Brown, Charles D. Spacecraft propulsion. Aiaa, 1996. 3. Krejci, David, and Paulo Lozano. "Space propulsion technology for small spacecraft." Proceedings of the IEEE 106.3 (2018): 362-378. 4. Ahedo, Eduardo. "Plasmas for space propulsion." Plasma Physics and Controlled Fusion 53.12 (2011): 124037.

DESCRIPTION OF THE COURSE

Name of the course: **Space Environment**	Code: **BASEe31**	Semester: 6
Type of teaching: Lectures (L)	Hours per semester: L – 30 hours	Number of credits: 5

LECTURER(S):
Assoc. Prof. Ivan Stefanov, PhD (FAMI), tel.: 965 3379, e-mail: d_ivanov@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Compulsory subject from the curriculum for training of students to obtain Bachelor's degree, specialty Aerospace Engineering", Professional orientation 5.5 Transport, Shipping and Navigation, Field 5 Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: At the end of the course the students are expected to be able to apply the methods and tools to understand and address conditions existing in space that affect the design and operation of spacecraft.

DESCRIPTION OF THE COURSE: The main topics concern: General Introduction to Space Science, Space Mission Design, Earth Geomagnetic Field, Spacecraft Electrostatic and Plasma Environment, Geomagnetic Shielding, Space Components Selection Criteria and etc.

PREREQUISITES: Aerospace Materials Science and Processing, Communication and navigation systems, Spacecraft Attitude Dynamics and Control.

TEACHING METHODS: Lectures, using slides and case studies.

METHOD OF ASSESSMENT: One assessment at the end of semester (60%) and online test (40%) at the end.

INSTRUCTION LANGUAGE: English

BIBLIOGRAPHY:
1. Alan C. Tribble, The Space Environment: Implications for Spacecraft Design - Revised and Expanded Edition, ISBN: 9780691213071, Book, Princeton University Press;
2. Y. Lu, Qi Shao, Honghao Yue, Fei Yang, A review of the space environment effects on spacecraft in different orbits, DOI 10.1109/ACCESS.2019.2927811, 2019 IEEE Access,
3. ESA's Space Environment Report 2023 ESA - ESA's Space Environment Report 2023,
4. Andrew Williams, Aaron Boley, Giuliana Rotola, Richard Green, Sustainable Skies and the Earth-Space Environment, https://doi.org/10.48550/arXiv.2403.15081

DESCRIPTION OF THE COURSE

Name of the course: **Remote Sensing**	Code: **BASEe32.1**	Semester: 6
Type of teaching: Lectures (L) Laboratory work (LW) Course work (CW)	Hours per semester: L – 30 hours S – 0 hours LW – 30 hours	Number of credits: **5**

LECTURER(S):
Assoc. Prof. Eng. Krasin Georgiev, PhD (FT), tel.: 965 3124, e-mail: krasin@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Elective subject from the curriculum for training of students to obtain Bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The aim of the course is to acquire fundamental knowledge about the acquiring of information from a distance via remote sensors on satellites and aircrafts that detect and record reflected or emitted energy. Understand techniques for processing and analyzing remote sensing data.

DESCRIPTION OF THE COURSE: General concepts of remote sensing. History and basics of remote sensing of the Earth and its atmosphere. Remote Sensing Platforms.

Physical Principles of Remote Sensing: Electromagnetic principles, Emission/radiation theory, Radar backscattering theory.

Remote Sensing Technology: Passive remote sensing (Basics of camera technology; Visible and infrared techniques; Microwave radiometry). Active remote sensing (Radar remote sensing; Lider remote sensing). Basics of satellite remote sensing.

Applications for exploration of the earth and its atmosphere, urban and land use, water and geology.

Processing and classification of remote sensing data - data formats, retrieval algorithms, analysis and image interpretations. Practice with radar target generation and detection. Estimate the range and velocity of the target. Tracking image features..

PREREQUISITES: Engineering Computer Science; Circuits, Signals and Systems; Communication and Navigation Systems; Orbital Mechanics.

TEACHING METHODS: Lectures, using PowerPoint slides and demonstratons, laboratory work.

METHOD OF ASSESSMENT: On-going assessment (30%), mid-term and end of term tests (70%).

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: 1. Campbell, J.B., Introduction to Remote Sensing, 6th Ed., 2022, The Guilford Press. 2. W.G. Rees, Physical Principles of Remote Sensing (Topics in Remote Sensing), 2nd edition. 3. Stimson, G.W., Griffiths H.D., Baker C.J. , Adamy D., Stimson's Introduction to Airborne Radar, 3rd Edition, 2014. 4. NASA, Your Gateway to NASA Earth Observation Data, https://www.earthdata.nasa.gov, Accessed 2024.

DESCRIPTION OF THE COURSE

Name of the course: **Artificial Intelligence for Aerospace Engineering**	Code: **BASEe32.2**	Semester: 6
Type of teaching: Lectures (L) Laboratory work (LW) Course work (CW)	Hours per semester: L – 30 hours S – 0 hours LW – 30 hours	Number of credits: **5**

LECTURER(S):
Assoc. Prof. Eng. Krasin Georgiev, PhD (FT), tel.: 965 3124, e-mail: krasin@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Elective subject from the curriculum for training of students to obtain Bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The aim of the course is to understand artificial intelligence technologies and their applications in aerospace engineering.

DESCRIPTION OF THE COURSE: Artificial Intelligence and Aerospace Engineering" is an interdisciplinary course that explores the integration of artificial intelligence (AI) technologies within the field of aerospace engineering. This course delves into the application of AI algorithms, machine learning techniques, and data analytics to address challenges and optimize processes in various aspects of aerospace engineering, including spacecraft design, resource management, trajectory planning, flight systems, navigation, control, and autonomous operation. Students will gain insights into cutting-edge AI advancements and their practical implementation in enhancing efficiency, safety, and innovation within the aerospace industry. Through theoretical lectures, practical exercises and case studies, participants will develop a comprehensive understanding of how AI is revolutionizing aerospace engineering, preparing them for future roles in this dynamic and rapidly evolving field.

Main topics: Understand AI technologies and their applications. Applications of AI in space. Deep learning fundamentals. Learn how to easily build AI applications using open source models.

PREREQUISITES: Mathematics, Engineering Computer Science; Circuits, Signals and Systems; Communication and Navigation Systems.

TEACHING METHODS: Lectures, using PowerPoint slides and demonstratons, laboratory work.

METHOD OF ASSESSMENT: On-going assessment (30%), mid-term and end of term tests (70%).

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: 1. Madi M., Sokolova O., Artificial Intelligence for Space: AI4SPACE: Trends, Applications, and Perspectives, CRC Press, 2023. 2. Shmelova T., Sikirda Y., Sterenharz A., Handbook of Research on Artificial Intelligence Applications in the Aviation and Aerospace Industries, IGI Global, 2020. 3. Thawar Arif, Aerospace Technologies Advancements, InTech, China, 2010. https://www.intechopen.com/books/3716. 4. Paul D. Harrison, AI in Aerospace Engineering: A Beginner's Guide, 2023. 5. Hugging Face, Learn, https://huggingface.co/learn.

DESCRIPTION OF THE COURSE

Name of the course: **Launch Trajectory, Control and Guidance**	Code: **BASEe32.3**	Semester: 6
Type of teaching: Lectures (L) Seminars (S) Laboratory work (LW)	Hours per semester: L – 30 hours S – 0 hours LW – 30 hours	Number of credits: **5**

LECTURER(S):
Prof. Michael Todorov, PhD (FT), tel.: 965 2531, e-mail: michael.todorov@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Elective subject from the curriculum for training of students to obtain Bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: The objective of the course is to provide basic theory of launch trajectory modelling and simulation, discussing attitude dynamics of launch vehicles and the relevant control methods, introducing control features of an aeroelastic launch vehicle, to give students basic knowledge about guidance methods applied to space launch vehicles..

DESCRIPTION OF THE COURSE: Main topics: An introduction to space launch trajectory modelling and simulation; Attitude dynamics and control of space launch vehicles; Control of a space launch vehicle considering flexibility of the structure; Guidance methods for space launch vehicles.

PREREQUISITES: Spacecraft control systems.

TEACHING METHODS: Lectures, using PowerPoint slides and demonstratons, laboratory work.

METHOD OF ASSESSMENT: On-going assessment (30%), mid-term and end of term tests (70%).

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: 1. R.Battin, An introduction to the Mathematics and Methods of Astrodynamics, 2001. 2. G.Siouris, Missile Guidance and Control, 2004. 3. V.Malyshev, Aerospace Vehicle Control, 1995. 4.R.Battin, Astronautical Guidance, 1986. 5. C.Kluever, Spaceflight Dymamics, 2018

DESCRIPTION OF THE COURSE

Name of the course: **Guidance and Navigation in Space**	Code: **BASEe32.4**	Semester: 6
Type of teaching: Lectures (L) Seminars (S) Laboratory work (LW)	Hours per semester: L – 30 hours S – 0 hours LW – 30 hours	Number of credits: **5**

LECTURER(S):

Prof. Mihail Jeliazov, PhD (FT), tel.: 965 2531, e-mail: mikael@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Elective subject from the curriculum for training of students to obtain Bachelor's degree, specialty "Aerospace Engineering in English", Faculty of Transport, Professional Field 5.5 Transport, Navigation and Aviation, Field of Higher Education 5. Technical Sciences.

AIMS AND OBJECTIVES OF THE COURSE: This course aims to provide definitions and applications for guidance and navigation in space, introducing various guidance methods for satellites and spacecraft motion including orbital corrections, discussing different navigation methods suitable for space missions, to give students basic knowledge about the main sensors and instruments of space navigations.

DESCRIPTION OF THE COURSE: Main topics: An introduction to space guidance and navigation; trajectories and missions for space flight; perturbation methods; celestial navigation and star sensor; interplanetary guidance and navigation.

PREREQUISITES: Orbital mechanics, Communication and navigation in space

TEACHING METHODS: Lectures, using PowerPoint slides and demonstratons, laboratory work.

METHOD OF ASSESSMENT: On-going assessment (30%), mid-term and end of term tests (70%).

INSTRUCTION LANGUAGE: English.

BIBLIOGRAPHY: 1. C.Fang Lin, Modern Navigation Guidance and Control, 2004. 2. R.Battin, Astronautical Guidance, 1964. 3. C.S. Draper, Space navigation, Guidance and Control, 1966. 4. C.Kluever, Spaceflight Dymamics, 2018.

DESCRIPTION OF THE COURSE

Name of the course: **Control Systems Engineering**	Code: **BASEe32.5**	Semester: 6
Type of teaching: Lectures (L) Laboratory work (LW)/Seminars (S)	Hours per semester: L – 30 hours S – 0 hours LW – 30 hours	Number of credits: **5**

LECTURER(S):
Assoc. Prof. Eng, PhD Vesela Karlova (FA),tel.: 965 3941, e-mail: vaks@tu-sofia.bg
Assoc. Prof. Eng, PhD Stanislav Enev (FA), tel.: 965 3941, e-mail: enev@tu-sofia.bg
Technical University of Sofia

COURSE STATUS IN THE CURRICULUM: Elective subject from the curriculum / curricula for training of students to obtain Bachelor's degree, specialty Aero-Space Engineering,

AIMS AND OBJECTIVES OF THE COURSE: At the end of the course, the students are expected to be able to apply the methods for analysis and synthesis of continuous and discrete control systems applied in aero-space. The course aims knowledge and skills to define and solve problems related to the design, configuration, implementation, testing and validation of control systems for aircraft, drones, spacecraft, satellites, rockets, and missiles. Students should have expertise to deal with various aspects of the control system, such as system analysis and integration with other subsystems, such as avionics, propulsion, guidance, navigation, communication, and sensors, and other subsystems related with control systems stability, performance, robustness, reliability, fault tolerance and redundancy, safety and compliance, using methods and tools of control theory and systems engineering.

DESCRIPTION OF THE COURSE: The main topics concern: mathematical modelling of aerospace systems; first and second order dynamic systems; stability; accuracy in steady state, performance indicators; frequency domain analysis, complex plane analysis; compensators; regulators; main blocks in the regulating circuits; frequency domain synthesis methods; methods for synthesis and adjustment of PID controllers; robust control, adaptive control, nonlinear elements in control systems, etc. The course simultaneously expands theoretical knowledge and develops applied skills in the design and construction of control systems using continuous, discrete and digital computing, electrical, pneumatic and hydraulic elements.

PREREQUISITES: Advanced Mathematics II and III, Engineering Mechanics II and III, Electrical Engineering and Electronics', Spacecraft Control Systems, Cuircuits Signal and Systems.

TEACHING METHODS: Lectures, using slides, case studies, laboratory work, work in teams, protocols preparation and defence.

METHOD OF ASSESSMENT: Written exam lasting 1 hour and 30 minutes - forming 70% of the final grade. The remaining 30% is formed by current control in laboratory exercises and assessment of personal laboratory protocols

INSTRUCTION LANGUAGE: English

BIBLIOGRAPHY: 1. Flight Stability and Automatic Control 1989, Robert Nelson 2.Dorf, D.C. Modern Control Systems, Prentice Hall, 12 ed. 2011. 3. Norman S. Nise. Control Systems Engineering, 6th Ed.. 2010. 4. Sami Fadali, Antonio Visioli. Digital Control Engineering, 2 ed: Analysis and Design,2012 .5. Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, 2015, Brian L. Stevens, Frank L. Lewis. .