University of Turkish Aeronautical Association

Astronautical Engineering Core and Elective Course Descriptions[1]

Contents

[1] The information provided in this document is subject to change without any notice, and is intended for informational purposes only.

Astronautical Engineering Principles, AST 104

One of the main aims of the course is to let students get acquainted with the spacecraft, satellites and space environments. Course includes visits to the production plants. Course contents are space missions, spacecraft requirements, ground systems, satellite units, rocket propulsion, launchers, payloads, integration and management. Learning outcomes are:

1. To introduce academic ethics and engineering ethics
2. To introduce the scope of engineering and in particular astronautical engineering. To give a general understanding about basic knowledge set of engineering and astronautical engineering, and to discuss general techniques that an engineer use in problem solving. To introduce the history of engineering and astronautical engineering.
3. Under the general title of aerodynamics, to introduce Archimedes principle, the lift created by moving air, the drag force
4. To introduce the parts and the performance criteria of an airplane, the equations of motion of an airplane
5. To introduce engineering structures; force, torque and static equilibrium concepts; structural supports; strength of materials
6. To introduce aircraft propulsion under the titles of propeller, jet engines, rocket engines
7. To introduce static and dynamic stability, aircraft coordinate systems and control surfaces, linear static stability
8. To introduce space environment by discussing the topics and concepts of Earth's atmosphere, the beginning of space, the temperature in space, microgravity, space radiation, magnetosphere, radiation shielding for spacecraft, meteoroids and micrometeoroids, space debris
9. To give an introduction to orbital mechanics by discussing the two-body problem, Kepler's Laws, conic sections, Kepler's orbit equation
10. To give an introduction on artificial satellites and their uses, satellite subsystems, orbits of satellites
11. To give an introduction on extravehicular activity, spacesuit design, life support systems
12. To observe the technical activities in the companies and institutions working in the area of astronautical engineering

Academic Presentation Skills, ENG 105

The aim of this course is to enable students to communicate more effectively in seminars, presentations and group work by equipping them with necessary academic speaking skills. Although the course mainly focuses on improvement of speaking skills, improvement on listening, writing and reading skills will also be included to complement communication skills. The course balances language focus and academic input with practice to enhance students' competence and to help them communicate effectively in different academic situations. Learning outcomes of the course are:

1. Develop critical thinking skills through reading, reflection, discussion, oral presentation and writing.
2. Prepare appropriate media for presentations.
3. Demonstrate increased confidence in speaking.
4. Develop skills to learn from other persons' oral presentations.
5. Demonstrate teamwork and group presentation skills as a contributing member of a team.

Engineering Mathematics I, MAT 123

The aim of this course is learning calculus fundamentals with an engineering perspective and applying to real-life problems using tools such as Wolfram Alpha, and MATLAB. Discussions include but not limited to functions, limits and continuity, differentiation, applications of derivatives, integration, applications of definition integrals, and techniques of integration. Applied math part includes numerical assignments to be solved with MATLAB and Wolfram Alpha. The official book used in the course is *Thomas' Calculus: Global Edition, 12/e by George B. Thomas, Jr., Maurice D. Weir, and Joel Hass.* Learning outcomes of the course are:

1. Explain functions, composite functions and their uses in systems with an engineering perspective
2. Explain continuity of functions in connection with limits followed by limit theorems
3. Explain relation between a secant line of a function and its tangent line which is then expanded to derivatives
4. Explain integration and fundamental theorem of calculus built upon antiderivatives
5. Ability to apply derivative and integration to physical problems (such as displacement and optimization) and develop/generate numerical solutions to otherwise hard-to-solve-algebraically math problems using tools such as Wolfram Alpha and MATLAB.

Physics I, PHY 101

Objectives of the course is to have students comprehend well the physics related to mechanics. Course content consists of Measurement and Unit Systems, Vectors and Scalars, Kinematics in One Dimensions, Kinematics in Two and Three Dimensions, Newton's Laws of Motion, Newton's Law of Universal Gravitation, Work and Energy, Conservation of Energy, Linear Momentum, Rotational Motion, Angular Momentum and General Rotation. The official books used in the course are *Physics for Scientist & Engineers with Modern Physics, D. Giancoli, Fourth Edition* and lecture notes. Learning outcomes of the course are:

1. Analyzing the static, kinematic and dynamic processes.
2. Making solution to the problems related to static, kinematic and dynamic processes.
3. Applying these processes to other disciplines in physics.
4. Proposing new models for the static, kinematic and dynamic systems.

Principles of Atatürk and History of the Revolutions I, ATA 103

Course objectives are to make students understand, comment and analyze the basic principles of Atatürk’s revolutions. Course contents are modernization activities in the process of disintegration of the Ottoman Empire, of the Ottoman Empire Participate in World War I, The Armistice Agreement, The beginning of the national struggle, Congresses, Opening of TBMM.

Turkish I, TUR 105

Objective of the course are to make students understand, comment and analyze the basic principles of Turkish language and use the Turkish language in a proper and effective way within the rules of diction. Content of the course can be sorted such as following: Description of Language, Origin of Language, Features of Language, Relationship between Language-Thought-Culture-Society, Turkish Languages and Dialects, Languages on Earth, Text Analysis, Novel Analysis, Written Expression, Forms of Verbal Expression and Practice, Speech Genres, Spelling Rules and Practice, and Sound Features of Turkish.

At the end of this course; students will be able to: Understand the features and rules of Turkish language and give examples, learn the rules of comprehending accurately the texts they read programs they listen to, achieve the habit and skill of showing their emotions, thoughts, plans, impressions, observations, and experiences accurately and efficiently in writing and verbally, achieve the habit of observing the spelling (orthographic) rules and accurate usage of punctuations, achieve the habit of book reading, achieve the skill of scientific, critical, constructive and creative thinking skills.

Computer Aided Engineering Graphics, AEE 123

This course presents technical drafts essentials and use this data to design solid models for manufacturing. Course contents are geometric sketches, orthographic projection fundamentals, drawing techniques for basic manufacturing processes and standard features, 3D drawing techniques, principles of dimensioning, principles of sectioning, principles of auxiliary views, fasteners, tolerances and usage, drawing of mechanical elements, assembly drawings, preparing of letterhead, materials and symbols, creating an industrial product working assembly with animation, modelling a system in the market of aeronautics and astronautics from the point of geometrical structures using SOLIDWORKS and submitting them as a project approach. The book that is used as a resource is *Technical Drawing with Engineering Graphics, by F.E Giesecke, Pearson :International 14th edition.* Learning outcomes are:

1. Understanding the engineering design processes
2. Modelling geometric constructions from the point of technical drawing
3. Applying drawing techniques for basic manufacturing processes and standard features
4. Developing three dimensional drawing techniques
5. Arranging drawings of objects in accordance with dimensioning principles
6. Obtaining sections of objects
7. Using required tolerances and ISO tolerance system
8. Drawing machine elements
9. Drawing assembly drawings

Principles of Atatürk and History of the Revolutions II, ATA 104

Course objectives are to make students understand, comment and analyze the basic principles of Atatürk's revolutions. Contents of the course include the declaration of the Republic, Lausanne Conference, trials in multi-party system, Atatürk's foreign policy.

Turkish II, TUR 106

Objectives of the course is to make students understand, interpret and analyze the basic principles of Turkish, and use Turkish language correctly. Course content consists of Written Expression, Verbal Expression, Erroneous Expressions, Text Analysis, Novel Analysis, Template Text, Methods of Thinking, Ways of Improving Thought, Semantics I, Semantics II, and Misuses in Turkish and Practices.

Academic Writing Skills, ENG 106

The aim of this course is to familiarize students with the discoursal and cognitive aspects of writing academic essays, projects and research articles. Starting from the academic writing processes, the course presents an organization from introduction of an overview of the major elements involved in academic writing, differences between academic and personal styles of writing, grammar of academic writing, strategies to produce increasingly more complex texts to creation of whole texts. The course focuses on the creation of bibliographies and the structure of research report and papers. Learning outcomes are:

1. Developing skills for solving problems and generating ideas to compose these ideas into a written text that efficiently convey ideas within academic appropriateness
2. Recognizing academic discourse, academic vocabulary together with processes of academic writing
3. Exploring ways of organizing data
4. Planning how comparisons and contrasts can lead to evaluations
5. Exploring how principles of clarity, honesty, reality and relevance improve texts

Engineering Mathematics II, MAT 124

Students will be able to make analysis by using the various advanced calculus methodologies at the end of the course. Techniques of integration, first order differential equations, infinite sequences and series, polar coordinates, vectors, partial derivatives of functions of several variables, multiple integrals are the subjects of course content. The official book used in the course is *Thomas, G. B., Weir, M. D. and Hass, J. R. (2010) Thomas' Calculus: 12th edition.* Learning outcomes are:

1. Understand and explain concepts of integration and multiple integration,
2. Understand and explain concepts of first order differential equations,
3. Understand and explain concepts of infinite sequences and series,
4. Understand and explain concepts of polar coordinates and vectors,
5. Understand and explain concepts of partial derivatives of functions of several variables.

Physics II, PHY 102

Objectives of the course is having students gain the background for electricity and magnetism necessary in the engineering education. Content of the course are Coulomb’s force, the electric field, electric flux, Gauss law, electric potential, capacitors, current and resistivity, direct current circuits, Kirchhoff’s rules, magnetic field, Biot-Savart’s law, Ampere’s law, induction, Faraday’s law, Lenz’s law, inductance, energy in magnetic field, oscillations in the LC circuit, electromagnetic waves. Students can do the following after the course is taken:

1. Analyses the electrical charge and being neutral.
2. Analyses the forces and electric fields produced by charged systems.
3. Determine the technological uses of the capacitors.
4. Makes analysis about the electrical current and conductivity.
5. Understands how magnetic forces and fields are produced.
6. Applies the electromagnetic induction, Faraday and Lenz law to electrical circuits.
7. Analyses the alternating and direct current circuits.

Chemistry, CHEM 101

The aim of this course is to inform students about basic principles of chemistry such as chemical properties, measuring these properties, naming, classifications, and reactions of matter and to gain ability to correlate these information with daily life applications. Course contents consist of Matter properties and classifications, physical measurements, significant numbers; Atoms, Molecules and Ions, Atomic Theory; formulas and naming, Chemical Reaction Equations; Chemical Reaction, Calculation with Chemical Formulas and Equations, Mass and Moles of Substances, Determination of Formulas, Working with Solutions; Gaseous State, Gas Laws; Thermochemistry, Heat of Reaction, Using Heat of Reaction, Quantum Theory of the Atom. Light Waves, Photons and Bohr Theory, Quantum Mechanics and Quantum Numbers; Electronic Configurations and Periodicity; Ionic and Covalent Bonding; Molecular Geometry and Chemical Bonding Theory. Molecular Orbital Theory.

Learning outcomes of the course are:

1. To have knowledge on the atomic and molecular structures
2. To be aware of the bonding patterns of molecules from simple to complex.
3. To have skill of doing calculations in chemistry
4. To be aware of the properties of gases and solutions.
5. To have knowledge on relations between heat and chemical reactions.
6. To know basic principles of quantum chemistry
7. To gain ability to correlate chemistry knowledge with real life applications

Computer Programming for Aviation, CENG 113

This is an introductory course for computer programming using Java. The course covers the fundamentals of algorithmic problem solving for a variety of problems involving the use of basic control and data structures. Other topics include fundamental data types, control structures including conditions and iteration, arrays, input and output. Learning outcomes of the course are:

1. Use an integrated development environment to design and write code in the Java programming language
2. Define and correctly use data types, arrays, conditionals and loops
3. Understand the use of predefined classes
4. Design objects and write new classes
5. Illustrate the principles of object-oriented programming

Statics, AEE 261

Course objective is to teach the fundamentals of vector mechanics of stationary rigid structures. Course contents are Statics of Particles, Rigid Bodies: Equivalent Systems of Forces, Equilibrium of Rigid Bodies, and Distributed Forces: Centroids and Centers of Gravity, Analysis of Structures, Forces in Beams and Cables, Friction, Distributed Forces: Moments of Inertia. The official book used in the course is *Beer, F. P., Johnston, Jr., E. R., Mazurek, D. F., "Vector Mechanics for Engineers: Statics", 10th Ed. In SI Units, McGraw Hill Inc., 2013.* Learning outcomes are:

1. Developing student's ability to analyze any problem in a simple and logical manner and to apply to its solution a few, well-understood, basic principles.
2. Understanding the fundamentals of vector analysis.
3. Learning the concept of rigid body equilibrium and idea of how to sustain rigid body equilibrium.
4. Learning how to calculate the centroid of a geometry and center of gravity of a rigid, homogeneous body. Understanding the importance of the moment of inertia in vector mechanics.
5. Understanding the basic principles of vector analysis structures such as trusses, frames, etc.
6. Being familiar with the friction phenomena.

Thermodynamics, MEC 225

Objectives of the course are to address the basic principles of thermodynamics, and to give an idea about the use thermodynamics in the engineering applications with real-life examples. System and environment, properties of pure material, property diagrams and tables, phase equation, energy and work fundamentals, energy transfer between the system and environment, thermodynamic process, reversible and irreversible processes, first law of thermodynamics for closed and open systems, heat pumps, coolers, Carnot cycle, second law of thermodynamics and entropy can be listed as the contents of the course. *Thermodynamics: An Engineering Approach 8th Edition by Yunus Cengel, and Michael Boles* is the book that is used for resource. Learning outcomes of this course are:

1. Having knowledge about fundamental thermodynamic concepts such as open, closed and isolated systems, state of a system in equilibrium and extensive and intensive properties of the system in equilibrium.
2. Comprehending properties of pure substances, phase diagrams and phase transitions.
3. Understanding the energy transfer by heat and work.
4. Being acquainted with energy conservation (First Law of Thermodynamics), increased entropy (Second Law of Thermodynamics) and energy conversion.
5. Being familiar with energy conversion devices and machines such as compressors, turbines, boilers, heat exchangers, combustion chambers, etc. and their energy balance analysis.
6. Grasping thermodynamic cycles and conduct their thermodynamic analysis.

Aerospace Materials, AST 261

Objective of the course is to teach the basic concepts of aerospace materials' science and technology, and to help students with this fundamentals, to gain ability to evaluate and make connection between the behaviors of aerospace engineering materials. Content of the course includes Materials and Material Strengthening of Metal Alloys, Phase Diagrams, Phase Transformations, Mechanical and Durability

Testing of Aerospace Materials, Polymers for Aerospace Structures, Fibre-Polymer Composites for Aerospace Structures and Engines and so on. The official books used in the course is *Introduction to Aerospace Materials; A.P. Mouritz, 2012, Woodhead Publishing Materials Science and Engineering: An Introduction; W.D. Callister, John Wiley & Sons.* At the end of the course, students should

1. Be able to analyze particle kinematics for motion of atoms.
2. Have a solid basic knowledge of the metal's crystal structures, defects.
3. Be able to understand the basics of the phase diagrams and phase transformations.
4. Have a basic knowledge about the manufacturing steps of a metal structure.
5. Have a basic knowledge about the polymer materials used in aerospace industry.
6. Have a basic knowledge about the composite structures manufacturing and concepts.
7. Be able to formulate and solve some basic composite mechanics.

Linear Algebra, MAT 221

Aim of this course is to introduce basic concepts of linear algebra including vectors, vector spaces, matrices and determinants, systems of linear equations, eigenvectors and linear transformations. Other than those gains, one experiences following subjects: Systems of Linear Equations, Gaussian Elimination, Matrix Operations and Matrix Types, Applications of Matrices, Determinants, Cramer's Rule, Vector Spaces, Matrix Transformations, and last but not least, *Eigenvalues and Eigenvectors. Elementary Linear Algebra: Applications Version, (10th edition) H. Anton and C. Rorres, Wiley (2010)* and lecture notes are main resources for this course. Learning outcomes can be sorted as

1. Solving systems of linear equations.
2. Computing determinants, eigenvalues and eigenvectors.
3. Performing and explaining uses of diagonalization and quadratic forms.
4. Ability to use eigenvalues and eigenvectors on engineering problems.
5. Ability to work cooperatively in groups.

Probability and Statistics, MAT 301

Objectives of this course is to introduce the basic probability concepts such as probability, random variables, and their distribution functions and to teach basic statistical techniques used in parameter estimation. Course content consists of Random Variables, Discrete and Continuous Probability Distributions, Sampling Distributions, Sample Statistics, Hypothesis Testing and p-value. At the end of the course, student

1. Comprehends the basic concepts of probability such as conditionality, independence of events, expected value and randomness.
2. Decides in which situations to apply discrete and continuous distributions.
3. Computes measures of central tendency (mean, median) and deviation (range, standard deviation) of a given sample and population
4. Formulates an appropriate one two sided hypotheses test, performs the test and clearly states the result of the test in the problem context
5. Comprehends the meaning of P- value and decides on whether to reject the null hypothesis based on P-value

Fundamentals of Electrical and Electronic Circuits, EEE 222

Objective of the course is to introduce the basic concepts in electrical engineering to nonelectrical engineering students. Students will learn the fundamentals of circuit theory, semiconductor devices, and simple electronic circuits like single stage amplifiers. Course contents are Basic electrical quantities and circuit elements, DC and AC analysis of linear circuits, RLC circuits and resonance, semiconductor devices, power supplies and single transistor amplifiers, logic gates, measurement techniques, DC motors. Learning outcomes can be sorted such as following:

1. Learning the basic electrical quantities and basic circuit elements.
2. Learning the basic techniques for the analysis of electrical circuits.
3. Learning the fundamentals of diodes and transistors and simple electronic circuits.

Summer Practice I, AST 250

Content of the second year internship is on maintenance and production. For this internship, the internship student must scrutinize the processes of organization and planning of the maintenance and/or production operations for aircraft and/or spacecraft elements and/or subsystems. In addition, the student must take role in one of these processes, if possible.

Dynamics, AEE 262

Teaching the fundamentals of vector mechanics of rigid structures in various motion types is the main objective of this course. Kinematics of Particles, Kinetics of Particles: Newton’s Second Law, Energy and Momentum Methods, Systems of Particles, Kinematics of Rigid Bodies, Plane Motion of Rigid Bodies, Kinetics of Rigid Bodies in Three Dimensions are the contents of this course. *Beer, F. P., Johnston, Jr., E. R., Cornwell, P. J., “Vector Mechanics for Engineers: Dynamics”, 10th Ed. In SI Units, McGraw Hill Inc., 2013* is used as a main resource. Learning outcomes of the course can be sorted as:

1. Develop in the engineering student the ability to analyze any problem in a simple and logical manner and to apply to its solution a few, well-understood, basic principles.
2. Learning the concepts of rigid body motion by means of kinetics and kinematics.
3. Understanding the fundamentals of principles of energy and momentum.
4. To be able to conduct kinetics and kinematics analysis on structures.
5. Applying principles of kinetics and kinematics on three dimensional rigid bodies.

Strength of Materials, MEC 226

In this course students are expected to learn the basics of structural engineering principles such as stress and strain definitions, deflection and displacement of structures, stress-strain transformations. Stress and strain concepts, Axial loading, Statically Indeterminate Axially Loaded Members, Thermal Stress, Torsion, Torsion Angle, Statically Indeterminate Torque Components, Bending, Eccentric Axial Loading, Vertical Shear, Shear Flow in Elements, Combined Loadings, Stress and Strain Transformation, Deflection of Beams and Shafts, Statically Indeterminate Beams and Shafts are the subjects covered in this course. Learning abilities of the course are:

1. Ability to define mechanical properties of a material using a prismatic bar

2. Ability to define the materials obeying the Hooke's law
3. Ability to calculate changes in length of a prismatic bar under non-uniform conditions
4. Ability to define elasticity and plasticity and to calculate the change in length of a prismatic bar under elasto-plastic conditions
5. Ability to solve statically indeterminate problems including temperature effects
6. Ability to calculate normal and shear stresses on inclined sections of prismatic bar.

Differential Equations, MAT 224

Main purpose of this course is to improve mathematical thinking of students and make the students to use this skill in order to solve the problems which are met in mathematics, physic sand mechanical engineering problems. Course content can be listed such that: Definition and Classification of Differential Equations; Examples from Practical Science; 1st Order Differential Equations; Separable into Variables, Homogenized Differential Equations; 1st Order Linear Differential Equations; Exact Differential Equation, Integrating Factors and Solution Methods; High-order Equations; Factorization Method; To Determine Single Solution; Differential Equations with lack of one Variable; High order Linear Differential Equations; Homogeneous and Non-homogeneous Differential Equations; Undefined Coefficients Method; Changing of Parameters (Lagrange) Method; Operator Method; Linear and Non-linear Differential Equations with Variable Coefficients; Cauchy-Euler Equations; Equations with lack of dependent and independent variables; Sarrus Method; Laplace Transform; Calculation of Initial Value Problems by Laplace Transform; 1st order Linear Equation Systems; Elimination and Determinant Methods, Homogeneous Linear Equation Systems with Constant Coefficients; Undefined Coefficients and Changing of Parameters Method.

Introduction to Ordinary Differential Equations, Shepley L. Ross, 4th Edition, Elementary to Differential Equations and Boundary Value Problems, William E. Boyce and Richard C.Di Prima, 5th Edition is the course book. Learning outcomes of the course are:

1. Gaining ability to use differential equations terminology accurately.
2. Solving first order differential equations and use
3. Solving first order differential equations and use them in engineering applications.
4. Learning the all solution methods of differential equations which consist of functions of one variable.

Fluid Mechanics, AEE 241

In this course, basic principles of fluid mechanics, fundamental conservation laws and types of fluid flow are covered. Course contents are Fluid Statics, Fluid Kinematics, Governing Integral Equations of Fluid Flow, Governing Differential Equations of Fluid Flow, and Fluid Flow in Pipes. *Fundamentals of Fluid Mechanics, 7th Edition by Bruce R. Munson, Alric P. Rothmayer, Theodore H. Okiishi, Wade W. Huebsch* is used as the official book. Learning outcomes are:

1. Knowledge of fluid concept and classification of the flow types should be gained
2. Calculating the hydrostatic forces and moments over submerged bodies
3. Understanding the conservation laws of fluid flow
4. Understanding the control volume concept and Reynold's transport theorem
5. Basic knowledge of moody diagrams and pipes flow equations should be learned.

Computational Methods, AEE 307

One of the objectives of this course is to teach students the mathematical bases of numerical analysis used in the solution of engineering problems. Course content consists of solutions of linear and non-linear systems of equations, Interpolation polynomials, numerical differentiation and integration, Numerical solution of ordinary differential equations. Learning outcomes are:

1. Understanding the approximate solution of mathematical and engineering problems with iterative approach
2. Representing numerical solution techniques in algorithms
3. Computer programming for the solution of mathematical and engineering problems

Orbital Mechanics, AST 301

This course presents a fundamental understanding of basic topics in orbital mechanics, the low Earth orbits and special Earth orbits, calculations of the interplanetary orbits. Dynamics of point masses, Two body problem, Time dependent orbital position, Three dimensional orbits, Orbit determination, Orbital maneuvers, Interplanetary orbits are the main subjects covered in this crucial course. *Orbital Mechanics for Engineering Students, Second Edition (Aerospace Engineering) by Howard D. Curtis (Nov 9, 2009) Orbital Mechanics by John E. Prussing and Bruce A. Conway (Sep 23, 1993)* is the book that is used for this course. Learning outcomes of this course are:

1. Understanding the natural laws related with orbital mechanics
2. Understanding the basic physical properties related with orbital mechanics
3. Knowing the orbital elements
4. Knowing the Low Earth Orbits and their usages
5. Knowing the coordinate systems and performs the transformations among them
6. Determining the orbit in central force approximation (such as Gibbs method, etc.)
7. Calculating the time passing in orbit
8. Calculating the speed changes related with orbital maneuvers
9. Calculating the basic design parameters (time, speed changes) related with the interplanetary orbits.

Control Systems, AST 303

This is the first course in Control Theory for undergraduate students which will cover basic fundamentals of classical control theory. Course contents are; Continuous-time control systems, including frequency response approach, root-locus approach, and state-space approach to analysis and design of control systems. A gradual development of control theory, solving computational problems with MATLAB, examples and worked problems are featured throughout the course.

The official book used in the course is *Modern Control Engineering 5th Edition, Katsuhiko Ogata.* Learning outcomes of the course are:

1. Understanding the properties of open-loop and closed-loop control architecture.
2. Understanding the importance of performance, robustness and stability in control design.
3. Understanding of the link between the ODE representations, the s-domain representation.
4. Working with block diagram representations of control systems.

5. Designing PID controllers.
6. Understanding Root-Locus method.
7. Computing gain and phase margins.
8. Designing Lead-Lag compensators.
9. Understanding the state-space paradigm and models.

Heat Transfer, MEC 321

Main objective of this course is to teach basics of heat transfer and heat transfer mechanisms. Content of the course include mechanisms of heat transfer, steady one-dimensional heat conduction, thermal resistance, heat transfer systems, analytical and numerical solution of two-dimensional systems, unsteady heat conduction, forced and natural convection heat transfer and radiation heat transfer. The official books used in the course is *Heat Transfer* by J.P. Holman. At the end of the course, students are expected to

1. Learn the mechanisms of heat transfer
2. Know steady one-dimensional heat conduction, thermal resistance, heat transfer systems, analytical and numerical solution of two dimensional systems
3. Know unsteady heat conduction, forced and natural convection heat transfer, radiation heat transfer.

Summer Practice II, AST 350

Third year internship is on engineering duties/activities/works such as research & development, production development, quality control, project management, logistics management, engineering management, etc. For example, for research & development or production development kind of internship work, the internship student must contribute to the design and production processes in the company by using programming languages (such as FORTRAN, Java, MATLAB, etc.) and/or engineering softwares (such as SOLIDWORKS, CATIA, ANSYS, etc.). In other areas of engineering work, similar duties are expected from the students.

Rocket Propulsion, AST 312

The purpose of this course is giving Astronautical engineering students a firm understanding of rocket propulsion, the assumptions behind it, and the resulting limitations and applications. Classification, Definition and Fundamentals, Nozzle Theory and Thermodynamic Relations, Flight Performance, Chemical Rocket Propellant Performance Analysis, Liquid Propellant Rocket Engine Fundamentals, Solid Propellant Rocket Fundamentals, Electric Propulsion are some subjects that are covered throughout the course. The official book used in the course is *George P. Sutton and Oscar Biblarz, “Rocket Propulsion Elements”, Wiley, 8 edition 2010.* Learning outcomes are:

1. Gaining ability to identify the basic forms of propulsion and have a basic knowledge on the application of rocket propulsion
2. Gaining basic knowledge on fundamentals of rocket propulsion such as thrust, exhaust velocity and efficiencies

3. Gaining ability to calculate nozzle flow properties, exit velocity and thrust coefficient using isentropic relations
4. Gaining basic understanding of different nozzle configurations, off-design conditions and resulting characteristics
5. Gaining basic knowledge on flight performance for space vehicles with rocket propulsion systems
6. Gaining basic understanding of thermo-chemical reactions taking place in a rocket combustion chamber and be able to calculate combustion temperature and composition for a simplified H2-O2 reaction
7. Gaining ability to calculate nozzle exit velocity in a reacting nozzle flow for equilibrium and frozen flow cases for simple H2-O2 reaction
8. Gaining basic knowledge on liquid rocket engine fundamentals such as propellants, propellant feed systems, propellant tanks, tank pressurization, turbo-pump feed systems and engine cycles, valves and pipe lines, and engine support structure
9. Gaining basic knowledge on solid propellant rocket fundamentals such as propellant burning rate, propellant grain and grain configuration, propellant grain stress and strain, and attitude control and maneuvers with solid propellant rocket motors
10. Gaining basic knowledge on electric propulsion such as ideal flight performance, electro-thermal thrusters, and non-thermal electric thrusters

Space Environment, AST 314

This course presents a fundamental understanding space environment, and its effects on the spacecraft and crew.

Space environment fundamentals, Earth in space, neutral environment, plasma environment, introduction to Sun and its atmosphere, solar radiation, visible, infrared, UV, EUV, and X rays and their variability, solar wind and solar activity, sun spots, solar flares, geomagnetic and ionized environment, radio wave propagation and communication, magnetosphere, radiation belts, trapped radiation, cosmic rays, geomagnetic storms and sub storms, geomagnetic indices, space weather concept, parameters used for space weather prediction, techniques to observe space, modelling in space weather, spacecraft orbits (LEO, MEO, Polar, and GEO), spacecraft and ground systems, spacecraft neutral atmosphere interaction, neutral gas flow around spacecraft, atmospheric drag, contamination, erosion by atomic oxygen, vehicle glow effect, spacecraft plasma interactions, spacecraft charging, effects of ionospheric and magnetospheric storms on the spacecraft. *The Space Environment: Implications for Spacecraft Design by Alan C. Tribble(Sep 22, 2003)* is the source book of the course. Learning outcomes are:

1. Understanding and discussing the characteristics of Space Environment where spacecraft moves
2. Understanding and discussing the structure of the neutral atmosphere, analyze its variability, and determining and discussing their effects on the spacecraft systems
3. Understanding the principles of solar electromagnetic radiation and its characteristics and effects on the environment and spacecraft
4. Understanding the magnetosphere, magnetic and magnetospheric storms and analyzing their variability, determining and discussing their effects on the spacecraft systems
5. Understanding the ionosphere and analyzing ionospheric variability, determining and discussing its effects on the spacecraft ground communication systems
6. Understanding and analyzing the solar variability and its consequences in space environment
7. Recognizing and distinguishing between spacecraft orbits and their associated space regions

8. Analyzing solar and magnetospheric effects on spacecraft and distinguishing between the spacecraft effects in different regions of space environment
9. Understanding and evaluating the space weather conditions from the spacecraft operations point of view
10. Distinguishing between the different space environment regions using spacecraft data, analyzing and interpreting results from the spacecraft operations point.

Attitude Determination and Control, AST 411

Main topics of this course are spacecraft attitude and orbit control. Content of the course consists of objective and types of the attitude determination and control systems, Coordinate systems, external forces and moments affecting the space vehicle, attitude dynamics and Euler's equations, using reference directions in attitude determination, attitude hardware, attitude determination methods, error analysis of attitude determination, attitude control devices, momentum exchange techniques, attitude stabilization methods and attitude maneuver control. Learning outcomes of the course are:

1. Gaining basic knowledge on the structure and operating principles of the attitude determination and control systems
2. Gaining basic knowledge on the coordinate systems, orbital parameters and reference directions
3. Gaining ability to select reference directions and reference sensors for attitude determination and control system
4. Gaining basic knowledge on the rotational kinematics (direction cosine matrix, Euler angles, quaternions, kinematic
5. Gaining ability to transform from one attitude parameter to another (Euler angles to quaternions and opposite)
6. Gaining basic knowledge on the inertial instruments for attitude determination (gyroscopes, three axis free gyroscope, two axis integrating gyroscope)
7. Gaining basic knowledge on the algebraic method for attitude determination and be able to determine the Earth s magnetic field and Sun vectors
8. Gaining ability to determine attitude angles via two-vector algorithm and to perform error analysis
9. Gaining ability to investigate the satellite attitude dynamics, understand the attitude control and stabilization principles

Spacecraft Structures, AST 413

This course presents the basic structural analysis principles of aerospace structures with special emphasis on aircraft structures. Course content consists of an introduction, Energy Methods in Structural Analysis, and Structural Analysis for Thin Walled Open Section Beams, Structural Analysis for Thin Walled Closed Section Beams, Bending of Unsymmetrical Sections, and Structural Analysis of Aircraft Sub-Structures. Learning outcomes are:

1. Gaining a basic understanding on the aerospace structures
2. Understanding about the basic analysis principals on the aerospace structures
3. Applying analysis principals to thin walled members which form the components of sub-structures of aerospace structures
4. Applying analysis principals to main building blocks of the aerospace structures
5. Ability to apply numerical solution of complex built-up aerospace structures

Spacecraft Communications, AST 402

This course is intended to give an overview of the methods used for spacecraft communications, in addition to present recent trends and future directions in the field. Course contents are Fourier analysis of the Signals, Generation and Emission of the Electromagnetic Waves, Transition angle and Modulus of Transition, Analog/Digital Communication, Antennas, Ground Stations, Orbits used for Communications, Code Errors, Communication Budget, Multiple Input Methods, Spacecraft Communications Reliability, and Advanced Communication Systems. Learning outcomes are

1. Learning the basics of the spacecraft communications
2. Learning the spacecraft communication uses, their types and signaling processes
3. Researching and learning the technology under the spacecraft communication systems
4. Learning the networks and the signals used for the spacecraft communication systems
5. Gaining knowledge about the future expectations for the spacecraft communication system

Graduation Design Project, AST 496

One term duration research/design project on selected topics in Astronautical engineering by an individual or a group of students. The course involves detailed literature survey on the selected topic, detailed research /design activity, and giving presentations and report writing. The detailed research/design activity may include either numerical study with computational work and analysis, experimental study with laboratory work and analysis, or preliminary/comprehensive hands on engineering design study. At the end of the course, students are expected to gain

1. An ability to apply knowledge of mathematics, science, and engineering
2. An ability to design and conduct experiments, as well as to analyze and interpret data
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. An ability to function on multidisciplinary teams
5. An ability to identify, formulate, and solve engineering problems
6. An ability to communicate effectively
7. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
8. A recognition of the need for, and an ability to engage in life-long learning
9. A recognition of the need for, and an ability to engage in life-long learning
10. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Introduction to Plasma Physics and Engineering, AST 442

This course's aim is giving the general insight into the plasma physics, applications of plasma physics and different models of plasma. The course emphasizes relations between microscopic and macroscopic description of plasma. This course introduces the basic principles of plasma physics underlying a wide variety of phenomena mainly for undergraduates, with applications to energy generation by controlled thermonuclear fusion, space physics, satellite communications, aerosphere physics, and astrophysics. It covers basic plasma properties and collective behavior, motion of charged particles in magnetic fields, fluid models, wave propagation, Coulomb collisions and transport processes, simple equilibrium and stability theory. *Introduction to Plasma Physics*, by R J Goldston, P H Rutherford, IoP, 1995 is the main book of the course.

Learning outcomes are:

1. Understanding and use the basic mathematical formalism needed for describing the dynamics of continuous media
2. Distinguishing the dynamics of plasmas and neutral fluid media
3. Formulating and modify the basic dynamic fluid equations to account for the dynamics of plasma media
4. Describing the propagation of waves in plasmas, and derive the dispersion relation for these waves
5. Making a simplified model for the Earth's magnetosphere, and obtain analytical expressions for some characteristic quantities

Radar Systems, AST 481

This course includes a comprehensive introduction to modern radar systems. Course covers a range of new topics in the field of radar technology. Moving Target Indicator (MTI), phased-array radar, detection in the clutter, synthetic aperture radar (SAR), HF over-the-horizon radar, height-finding radar, 3D radar, millimeter wave radars, tracking radars, and target classification are some of the subjects of the course. *Merrill I. Skolnik, Introduction to Radar Systems* is the official book used in the course. Learning outcomes are:

1. Understanding the working principles of surveillance radar
2. Understanding pulsed radar transmitter/receiver configurations
3. Understanding signal processing techniques
4. Understanding radar antenna systems.

Gas Dynamics, AST 441

One of the main objectives of this course is to develop theoretical framework for describing compressible flows and to discuss the basic principles behind compressible flow applications. Content of the course consists of review of fluid mechanics and thermodynamics, one-dimensional gas dynamics, shock waves, steady and two-dimensional supersonic flows. H. W. Liepmann and A. Roshko, *Elements of Gas Dynamics*, Dover Publications, 2001 is the official book used in the course. At the end of the course, student

1. understands compressible flow phenomena
2. understands one-dimensional gas dynamics
3. gains an understanding on two-dimensional compressible flows

Viscous Flow, AST 443

Main objective of this course is to develop theoretical framework for describing viscous flows, in particular boundary layer theory. Content of the course consists of Navier-Stokes equations, boundary layer theory, laminar boundary layers for compressible flow and turbulent flows. F. White, *Viscous Fluid Flow*, 3rd Edition, McGraw-Hill, 2005 is the official book used in the course. At the end of the course, student

1. Understands the viscous flow phenomena.
2. Understands boundary layer concept, laminar-turbulent transition, basics of turbulence.
3. Can study exact solutions for Navies-Stokes and boundary layer equations for simple flows.

Hypersonic Flow, AST 444

This course develops an understanding of inviscid hypersonic flows, viscous hypersonic flows and high temperature effects as they apply to hypersonic aerodynamics. Content of the course includes general characterization of hypersonic flows, Ideal hypersonic flow and high temperature effects. “Hypersonic Flow” by Maurice Rasmussen and M. L. Rasmussen is the official book used in the course. At the end of the semester, students are expected to develop

1. An ability to solve problems involving inviscid hypersonic flows
2. An ability to solve problems involving viscous hypersonic flows
3. An understanding of high temperature effects in hypersonic aerodynamics
4. An understanding of the design issues for hypersonic wings
5. An ability to use computational tools to evaluate hypersonic flows
6. A knowledge of recent developments in hypersonic aerodynamics with application to astronautical systems

Guided Missile Design, AST 451

Main objectives of this course include designing a tactical missile system using detection, computation, launching and damaging mechanisms together. Content of course include an introduction to tactical missile units, develop a scenario, guidance laws, radar design, warhead design and propulsion requirements. “*Tactical Missile Design*” of Prof. Gerald H. Lindsey, Lt. Dan. R. Redmon is the main resource of the course. At the end of the course, students learn

1. different defense scenarios
2. historical progress in guided missiles
3. aerodynamic aspects
4. warheads
5. navigation laws
6. propulsion unit

Hybrid Rocket Design, AST 452

This course gives astronautical engineering students an introduction of designing a hybrid rocket vehicle of a specific mission profile. Course content includes a review of chemical rockets and gas dynamics and chemistry of rockets, hybrid rockets, rocket testing, rocket component design and optimization, system integration, health and safety aspects of rockets. *Fundamentals of Hybrid Rocket Combustion and Propulsion* is the official book used in the course. At the end of the course, students become familiar with

1. Review of Rocket Principles, Gas Dynamics, and Chemistry.
2. Solid Propellant Rocket Propulsion.
3. Hybrid Rockets
4. Rocket Nozzle Design
5. Tanks, Valves, and Actuators of Rockets.
6. Rocket External Aerodynamics. CFD techniques.
7. Rocket Telemetry Systems, Guidance, and Control
8. Hybrid Rocket Design.
9. Assembly, Transport and launch process of rockets. Legal and Health and Saftey aspects of Rockets.

Spacecraft Thermal Control, AST 471

This course addresses how to control the operating temperature environment of spacecraft systems. Content of the course include a presentation of the basic and specific concepts of a space mission, its development phases, the environment it must withstand, the orbits and trajectories needed to accomplish the mission, and the subsystems that help to achieve this. *Spacecraft Thermal Control* of J. Meseguer, I. Pérez-Grande and A. Sanz-Andrés is the main resource of the course. Learning outcomes are

1. Understanding of conductive heat transfer fundamentals
2. Understanding of radiative heat transfer fundamentals
3. Thermal analysis of spacecraft
4. Understanding the working principles of the thermal control sub-systems
5. An ability to use computational tools to evaluate heat transfer problems
6. Design an spacecraft thermal control system

High Power Lasers, AST 472

This course gives a comprehensive details on the latest advances in high-power laser development and applications. Content of the course includes performance parameters for each major class of lasers, high-power gas, chemical, and free-electron lasers and then discusses semiconductor diode lasers, along with the associated technologies of packaging, reliability, and beam shaping and delivery. Current research and development in solid-state lasers as well as scaling approaches for high CW powers, high pulse energies, and high peak powers are also discussed. *High Power*

Laser Handbook of Hagop Injeyan, Gregory D. Goodno is the official book used in the course. At the end of the course, students

1. develop an understanding the Laser physics
2. develop understanding the gain medium and cavity
3. develop understanding continuous and pulsed modes of operation
4. develop understanding propagation medium
5. learn high power laser beam focusing
6. learn Power Supplies of high power lasers

Remote Sensing, AST 482

This course provides an introduction to remote sensing and image interpretation, and as a reference for the burgeoning number of practitioners who use geospatial information and analysis in their work. Content of the course include digital image acquisition and analysis, while retaining basic information about earlier analog sensors and methods (from which a vast amount of archival data exist, increasingly valuable as a source for studies of long-term change). Expanded coverage of radar systems and of 3D remote sensing more generally, including digital photogrammetric methods such as structure-from-motion (SFM). "*Remote Sensing and Image Interpretation*" of Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman is the main resource of the course. At the end of the course, students

1. develop an understanding of the Energy Sources and Radiation Principles
2. develop an understanding of Energy Interactions in the Atmosphere
3. develop an understanding of Energy Interactions with Earth Surface
4. develop an understanding of Data Acquisition and Digital Image Concepts
5. learn Characteristics of Remote Sensing Systems
6. learn Successful Application of Remote Sensing

Aerospace Control Systems, AST 483

The main objective of this course is to present a unified approach for automatic control of atmospheric and space flight vehicles. Content of the course includes Plant Model, Properties of a System, Automatic Controllers, Linear Systems, Aerospace Vehicle Guidance and Control, Flight Dynamic Models, Control Design Techniques, Automatic Control of Spacecraft and Rockets. *Automatic Control of Atmospheric and Space Flight Vehicles Design and Analysis with MATLAB and Simulink* of Ashish Tewari is the official book used in the course. At the end of the course, students

1. Predict the response of a linear system to an arbitrary input
2. Understand the concept and significance of the modes of a system and their relation to the nature and duration of the transient response
3. Determine the shape of the Bode diagrams of a system from its transfer function, and conversely, be able to determine the transfer function from the Bode diagrams

4. Determine the stability and performance characteristics of a feedback system, and how these properties change as a function of the loop gain
5. Design a feedback control loop and compensator for a given dynamic system, so that the overall system meets specified transient and steady-state performance targets, as well as robust stability requirements
6. Confidently use MATLAB to carry out the calculations required for

Impact Dynamics and Spacecraft Protection, AST 484

This course presents an introduction to spacecraft which operate in densely populated altitude regimes and which are experiencing a steady debris and meteoroid particle flux which strongly increases with decreasing particle sizes. The consequences of resulting impacts can range from small surface pits for µm-size impactors, via clear hole penetrations for mm-size objects, to partial or complete destruction via shockwaves for projectiles larger than a few centimeters. The most probable impact velocities are in the range from 0 to 15 km/s for space debris, and between 5 km/s and 30 km/s for meteoroids (denoted as hypervelocity impacts or HVI). At such speeds, the impact of an aluminum sphere of 1 cm diameter deploys the same energy as an exploding hand-grenade, with equally devastating consequences, unless special protection measures are applied. Learning outcomes are

1. Understanding the space MMOD environment
2. Understanding the collision models
3. Understanding the high-speed collision physics
4. Understanding the damage mechanism
5. Design of protection techniques
6. Collision avoidance maneuvers

Numerical Methods for Partial Differential Equations, AST 405

This course provides an insight to student reader how to formulate a partial differential equation from the physical problem (constructing the mathematical model) and how to solve the equation (along with initial and boundary conditions). Content of the course consists of an introduction to partial differential equations, heat equation, separation of variables, boundary conditions, integral transform, Fourier and Laplace transforms and Duhamel’s principle. At the end of the course, students are able to

1. Identify an partial differential equation and its order
2. Classify partial differential equations into linear and nonlinear equations
3. Find solutions of separable partial differential equations
4. Solve simple eigenvalue problems of Sturm-Liouville type
5. Find the Fourier series of periodic functions
6. Find the Fourier sine and cosine series for functions
7. Identify parabolic, hyperbolic and elliptic PDEs

Composite Materials, AEE 491

The purpose of the course is to introduce composite materials. Matrix materials, reinforcement materials, polymer matrix composites, metal matrix composites, ceramic matrix composites and carbon-carbon composites will be introduced. Course content consists of Composites, matrix and reinforcement materials, polymer, metal and ceramic matrixes. Latest edition of *Composite Materials: Science and Engineering* by Chawla is the main textbook of the course. At the end of the course, students learn

1. Composites
2. Matrix materials
3. Reinforcement materials
4. Polymer, metal and ceramic matrixes
5. Application of composite materials in aerospace industry

Acoustics and Noise Control Engineering, AEE 465

The aim of this course is to introduce the students the fundamentals of acoustics and noise control engineering. Content of the course includes wave motion, wave equation and its solutions, acoustic plane waves, spherical waves, the energy relations, sound transmission and the transmission loss, the mechanism of hearing, sound perception, noise limits and legislation, room acoustics, echo, `Sabine equation, Wave theory, transmission path from the source and receiver noise control, Noise limit design principles. Latest edition of *Engineering Noise Control: Theory and Practice* of David Bies is the main textbook of the course. Learning outcomes of the course are

1. Learning the fundamentals of noise
2. Learning wave types and wave propagation
3. Being able to recognize the acoustic and noise measurement devices and the measurement standards
4. Understanding the effect of noise in human life
5. Learning the techniques of noise isolation and reduction

Computational Fluid Dynamics, AEE 446

The aim of this course is to teach numerical solutions of the fluid flow equations. Course content includes simplification of the Navier-Stokes equations for steady, attached flows, integral formulation of inviscid, irrotational flow equations for subsonic flows, panel methods, Design optimization of an airfoil with a panel method, Inverse airfoil design based on a panel method, Characteristic lines, Discretization of the Transonic Small Disturbance equation on Cartesian grids using Finite Difference methods, upwind differencing in supersonic regions, numerical solution of transonic flows over airfoil profiles, numerical solution of unsteady Full Potential Flow equation in curvilinear coordinate systems. Latest edition of *Low-Speed Aerodynamics* by Joseph Katz and Allen Plotkin is the main textbook of the course. At the end of the course,

1. The use of panel method in computational aerodynamics should be understood
2. The concept of design optimization in aerodynamics point of view should be learned

3. The numerical solution methods of the transonic small disturbance equation should be examined
4. The general numerical solution of the full potential flow equation should be took for granted.

Finite Element Analysis, AEE 464

One of the aims of this course is to teach fundamentals of finite element method, and giving students the ability to encode their finite element method based on finite element method. A commercial software will be introduced to students within the scope of the course. Content of course includes an introduction to finite element analysis, one dimensional elements, 1D finite element method based computer programming, finite element form of Rayleigh Ritz Method, general derivation of the element stiffness matrix, interpolation and shape functions, FE software applications of aerospace structures. Latest edition of *Concepts and Applications of Finite Element Analysis* by Robert D. Cook, David S. Malkus, Michael E. Plesha is the main textbook of the course. Learning outcomes are

1. Understanding the fundamentals of finite element method (FEM)
2. Solving 1D and 2D structural problems with FEM
3. Solving real life problems with FEM
4. Effectively use a commercial FE software
5. Reading the results of FEA
6. Strengthen structural modeling, problem solving and report preparation abilities

Mechanical Vibrations, AEE 463

One of the aims of this course is to prepare the students about vibration problems by teaching the general principles of mechanical vibrations, isolation and calculation of vibrations. Content of the course includes forced and free vibrations of single degree of freedom linear undamped systems, types of damping, properties of damping and effects on the response characteristics, two degree of freedom systems, coordinate transformations, coupling, response to harmonic excitation, multi degree of freedom systems, eigenvalue problems, eigenvectors and orthogonality, vibration of continuous systems, transverse vibration of beams, effects of boundary conditions on response characteristics, vibration measurement and isolation. Latest edition of *Fundamentals of Vibrations* by L. Meirovitch is main textbook of the course. Learning outcomes of the course are

1. Learning the fundamentals of mechanical vibrations
2. Learning the concept and calculation of free and forced vibrations
3. Understanding the importance of mechanical vibrations in aircraft design
4. Gaining information about vibration isolation and damping
5. Understanding the techniques beneath the vibration measurements and FFT analysis