FALL 2019

REGISTRATION ANNOUNCEMENT

411 B.H. GOETHERT PARKWAY

TULLAHOMA, TN 37388-9700

SPACE INSTITUTE

www.utsi.edu

888-822-8874 Ext. 37228

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CALENDAR - 2019 FALL SEMESTER

Priority Registration..... March 11, 2019 – August 20, 2019
Admission to Candidacy Forms for Fall 2019 Commencement.....August 9, 2019
Fall 2019 Graduation Application Deadline (submit online at MyUTK).....August 9, 2019
Graduation Fee Payment Deadline (MS $30, PhD $75).....August 9, 2019
Payment Due for Priority Registration.....August 19, 2019
Late Registration and late fees ($100 Late Fee) ..... August 21- September 3, 2019
Classes begin.....August 21, 2019
Last Day to final register, add, change grading options or drop without a "W".....August 30, 2019
Payment Due for Late Registration.....August 30, 2019
Labor Day ..... September 2, 2019
Late Registration after 14th day ($200 Late Fee) ..... September 4, 2019 - Forward
Preliminary Thesis/Dissertation Review Deadline (thesis@utk.edu)..... October 2, 2019
Fall Break (No Classes) ..... October 17 - 18, 2019
Last day to schedule final exam (non-thesis/thesis/dissertation) ..... October 29, 2019
Register to attend the Graduate Hooding Ceremony (http://gradschool.utk.edu/graduation/) .. TBD
Purchase cap and gown and order hood (865-974-3459)..... TBD
Last day to take final exam (non-thesis/thesis/dissertation) ..... November 5, 2019
Drop with a "W" ..... November 12, 2019
Thesis/Dissertation Deadline 5:00 p.m. EST ..... November 19, 2019
Submit report of final examination (Pass/Fail) form ..... November 19, 2019
Thanksgiving Holidays ..... November 28 – 29, 2019
No Class Day ..... November 27, 2019
Deadline for Submission of Admission to Candidacy for students
Graduating Spring 2020 and Graduation Application .....December 4, 2019
All "INCOMPLETE" must be removed for Graduation.....December 4, 2019
Classes End.....December 4, 2019
Total Withdraw from the University Deadline .....December 4, 2019
Study Day .....December 5, 2019
Final Exam Period.....December 6, 9 & 10, 2019
Graduate Hooding Ceremony (UTK) .....December 12, 2019
COMMENCEMENT (UTK) .....December 13, 2019
Official Graduation Date.....December 14, 2019

Second thesis/dissertation deadlines
Defense Completed by December 4, 2019
Second Deadline Application Submitted by December 4, 2019
http://gradschool.utk.edu/forms-central/
Thesis/Dissertation Submitted and Accepted by January 7, 2020 5:00 p.m. EST
(Student will receive diploma spring 2020 semester, but will not be required to register for thesis/dissertation credits)
A new graduation application must be submitted for Spring graduation. For more Information on graduation steps see http://gradschool.utk.edu/graduation.shtml

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SPRING SEMESTER 2020

Priority Registration..... TBD
Final Registration ..... TBD
Classes Begin.....January 8, 2020
Martin Luther King Day (Holiday).....January 20, 2020
Spring Break .....March 16 – 20, 2020
No Class Day .....April 9, 2020

Spring Recess.....April 10, 2020
Classes End.....April 24, 2020
Study Day .....April 27, 2020
Exam Period.....April 28 - 30, 2020
Graduate Hooding Ceremony (UTK) .....May 7, 2020
University College Commencement Ceremonies .....May 7 – 9, 2020
Official Graduation Date on Transcript .....May 9, 2020

Dates may be revised without notice. Please refer to the following sites for updates:
http://registrar.tennessee.edu/academic_calendar/index.shtml

FALL SEMESTER 2019
STUDY PERIOD AND FINAL EXAM SCHEDULE

LAST DAY OF CLASSES.....December 4, 2019

STUDY DAY .....December 5, 2019

FINAL EXAMS

REGULAR CLASS TIME	(Same Classroom)	EXAM TIME
1st Day – Friday, December 6, 2019		
7:45 - 9:00	M/Th	7:45 - 9:45
10:45 - 12:00	M/Th	10:15 - 12:15
9:15 - 10:30	M/Th	1:00 - 3:00
2:30 - 3:45	M/Th	3:30 - 5:30
2nd Day – Monday, December 9, 2019		
9:15 - 10:30	Tu/Fri	7:45 - 9:45
10:45 - 12:00	Tu/Fri	10:15 - 12:15
1:00 - 2:15	Tu/Fri	1:00 - 3:00
2:30 - 3:45	Tu/Fri	3:30 - 5:30
3rd Day – Tuesday, December 10, 2019		
7:45 - 9:00	Tu/Fri	7:45 - 9:45
1:00 - 2:15	M/Th	10:15 - 12:15

**** ATTENTION ****

ALL STUDENTS TAKING VIDEOTAPE COURSES
CONTACT INSTRUCTOR FOR DATE AND TIME OF FINAL EXAM
NO CLASSES WILL BE IN SESSION
AT THIS TIME

REGISTRATION ANNOUNCEMENT
FALL SEMESTER 2019

REGISTRATION PROCEDURE

GRADUATE ACADEMIC ADVISING

Graduate students should contact your departmental faculty to arrange an advising appointment. If you're not accepted into a specific program, the assistant to the dean of graduate studies or the designee may act as your advisor. When the web registration system asks if you've discussed your program with your advisor, you must answer yes to continue with the registration process.

REGISTRATION

Students will register at http://my.utk.edu. You will need to log in using your NetID and your NetID password. If you do not know your NetID and NetID password, go to http://onestop.utk.edu/your-classes/registering-for-classes/ .

*Log in to MyUTK. You can find a link by looking under "M" on the A-Z index (http://www.utk.edu/alpha/) or by typing myutk.utk.edu directly into your browser. You will need to log in by typing utk\your NetID in the "username" field and then your NetID password in the "password" field.

*Before you attempt to register, clear and pay any financial holds (parking tickets, library fines, fees, etc.).

*Look under the "For Your Review" heading on the MyUTK portal page (located in the upper right-hand corner) for notification of any holds you may have.

*Once you are logged into "My UTK," scroll down to "UTK Student Registration Links." Click on "Search for Classes" to look up sections and then register.

*Print a copy of your schedule when you are finished registering.

If you have any questions, call the Office of the University Registrar at 865-974-2101 or contact Charlene Hane in Student Services room D-100, phone 931-393-7228, email chane@utsi.edu.

TOLL-FREE NUMBERS

For a specific office: .....1-888-822-UTSI (8874) and the extension number.
For general information: 1-888-822-UTSI (8874)
Admissions Office: ..... 1-888-822-UTSI (8874)-37234
Budget and Finance Office: ..... 1-888-822-UTSI (8874)-37297
Student Services..... 1-888-822-UTSI (8874)-37228

APPLICATION FOR ADMISSION

No student will be allowed to register unless a completed Application to the Graduate School of the University of Tennessee, Knoxville (UTK) is on file in the Registrar's Office. An Application for Admission to the UTK Graduate School must be completed online at https://www.applyweb.com/utg and accompanied by a $60.00 non-refundable application fee made payable to The University of Tennessee Space Institute. All applicants are required to provide one official transcript of all undergraduate and graduate records, GRE test scores and

three letters of recommendation when applying. International applicants will also need to include TOEFL scores. GRE scores are a requirement of all departments at UTSI except the Master of Science degree in Industrial Engineering/Engineering Management concentration. Please select UT Space Institute if you plan to attend the Tullahoma campus location. All applications need to be submitted online to the office of Graduate Admissions Knoxville, TN.

Graduate Research Assistantship applications need to be submitted to Clara Ferguson, Office of Admissions and Recruiting, University of Tennessee Space Institute, MS-6, Tullahoma, TN 37388-9700. Assistantship applications must include GRE test scores and three letters of recommendation. All International applicants will need to provide TOEFL test scores in addition to GRE's. Official transcripts and test scores should be sent to College Code 1843, Graduate Admissions Office, 201 Student Services Building, Knoxville, TN 37996-0221. Once admitted, a full admission will not be granted until all official test scores and degree confirmation are received in the Graduate Admissions Office in Knoxville. Please contact Clara Ferguson at (931) 393-7234 or 888-822-8874 ext. 37234 if you have questions.

TOTAL WITHDRAWAL FROM THE UNIVERSITY

If, after registering for classes and either returning your fee payment or your Confirmation of Attendance form to the Bursar's Office, you decide not to enroll for this term, you must immediately notify Charlene Hane, Student Services, at UTSI. If you withdraw officially on or before a Change of Registration deadline, but after the no "W" deadline for a particular session, the grade of "W" will be issued.

GRADES

Students may obtain their grades through the web at MyUTK or contact Charlene Hane, Student Services, Office D-100, (931) 393-7228.

GRADUATE STUDENTS CHANGE OF REGISTRATION AFTER THE DEADLINE

To change registration in any way after the deadline, a graduate student must present a request, signed by the instructor(s) and adviser as evidence of their knowledge of the request to Charlene Hane, Student Services at UTSI. Graduate students must verify that ALL changes have been approved by their academic adviser. If the Office of Graduate Student Services approves the change of registration, the change will be noted on the student's permanent record. THE DROP DEADLINE FOR GRADES AND THE DROP DEADLINE FOR FEE REFUNDS ARE NOT THE SAME.

FULL-TIME STUDENTS

Students enrolled in at least 9 semester hours during the Fall/Spring/Summer semesters are considered full-time. Full-time enrollment (9 hours) for two consecutive semesters or part-time enrollment (6 hours) is required to full fill the admission to candidacy doctoral degree residency requirement. Graduate Research Assistants (GRAs) must be enrolled for 9 hours during the Fall/Spring semesters and 6 hours during the Summer. GRAs must also enroll in one of the MABE 595 seminars or a PHYS 599 seminar each semester in which seminars are offered, unless a waiver is granted by the Associate Executive Director.

REMOVAL OF INCOMPLETE GRADES

All Incomplete Grades (I) must be removed prior to graduation. The instructor, in consultation with the student, decides the terms for the removal of the I, including the time limit for removal. If the I is not removed within one calendar year, the grade will be changed to an F. The course

will not be counted in the cumulative grade point average until a final grade is assigned. No student may graduate with an I on the record. Students planning to graduate Fall Semester 2019 must remove all INCOMPLETE GRADES by December 4, 2019. Contact Charlene Hane, Student Services, to remove an Incomplete Grade.

REPEATING A COURSE

No graduate student may repeat a course for the purpose of raising a grade already received, with the exception of a NC course. A graduate student cannot do additional work nor repeat an examination to raise a final grade.

ADMISSION TO CANDIDACY

MASTER OF SCIENCE DEGREE:

Each M.S. student, including IE Capstone Project students, is responsible for submitting a completed and signed Admission to Candidacy Application at least one semester prior to receiving the degree.

Candidacy committee changes or course changes must be submitted to the committee chairman using a Revision form. If changing from a thesis option to a non-thesis option or vice versa, a new Admission to Candidacy Application must be submitted. All forms must be processed through Student Services.

DOCTORAL DEGREE:

A Doctoral Committee should be formed during the student's first year of doctoral study. Any changes to the doctoral committee (deletions or additions) must be submitted to the Committee Chairman using a Revision form for approval. Each doctoral student is responsible for submitting a completed Admission to Candidacy form signed by the doctoral committee at least one semester prior to receiving the degree. All forms must be processed through Student Services.

CONTINUOUS ENROLLMENT

All degree-seeking graduate students are expected to make a full commitment to their graduate and professional study in order to ensure that they can complete all degree requirements without unnecessary delay. Graduate students are therefore required to maintain an active status through continuous enrollment from the time of first enrollment until graduation.

Continuous enrollment is maintained by registering for a minimum of one graduate credit hour per semester (excluding the summer, unless stipulated otherwise by the program or department). However, students who have started taking dissertation hours (course 600) must maintain a minimum of three credit hours per semester during all semesters, including the summer, as stipulated in the policy on "Registration for Course 600 (Doctoral Research and Dissertation)" in order to comply with the Continuous Enrollment requirement (see under Doctoral Programs for details).

The minimum enrollment for international students may be different, and international students always need to check with the Center for International Education (CIE) in order to determine what minimum enrollment they need to maintain in order to satisfy all enrollment requirements attached to their specific visa.

CONSEQUENCES OF NON-ENROLLMENT WITHOUT LEAVE OF ABSENCE

Graduate students who do not maintain continuous enrollment as stipulated in the "Continuous Enrollment" policy will lose their active student status. A student who has lost his or her active status without having been granted a Leave of Absence for the period of non-enrollment ahead of time will not be allowed to continue in his her graduate program until readmitted. (see policy on "Readmission" in the Graduate Catalog for more details).

Non-enrollment other than during an approved Leave of Absence (LOA) does not alter or affect any of the milestone deadlines, such as admission to candidacy, time to degree, etc.

Upon approval for readmission to complete the interrupted degree program, students will be retroactively enrolled in every semester of missed enrollment for one graduate credit hour of Course 502 or for three graduate credit hours of Course 600 (whichever is appropriate). Students will be responsible for paying the past tuition charges and fees as well as the current university per semester late registration penalty. All past due charges will need to be paid before the Graduate School will approve the student for any future enrollment.

FINAL EXAM FOR NON-THESIS, CAPSTONE PROJECT STUDENTS, THESIS AND DISSERTATION STUDENTS

A candidate presenting a thesis or dissertation must pass a final oral examination on all work offered for the degree. The examination is scheduled through Student Services. Failure to notify Student Services of the examination date will put the student at risk for graduating that semester. Final examinations not properly scheduled MUST be repeated. The final draft of the thesis must be distributed to the committee members at least two weeks prior to the date of the final examination. In case of a grade of "Fail", the candidate may not apply for re-examination until the following semester. The result of the second examination is final.

UT POLICY ON INSURANCE FOR INTERNATIONAL STUDENTS

All foreign national students registered with the University of Tennessee, Knoxville, are required to have comprehensive medical insurance. The policy for the 2018-2019 academic year is provided by United HealthCare Student Resources. The premium must be paid before registration. Contact the Student Services Office (room D-100 ext. 37228) for further information.

GENERAL SEMINAR

A number of seminars of interest to all UTSI students and general public will be offered throughout the semester.

FINAL EXAM DATES

Study Day –December 5, 2019
Final Exams – December 6, 9, & 10, 2019

FINANCIAL CALENDAR, FEES, REFUNDS, AND TUITION

Please click http://onestop.utk.edu/tuition-fees/ link to the most current information. You may also contact Tonya Travis in the Business and Finance Office at ttravis@utsi.edu or phone number 931-393-7297.

The UTSI Budget and Finance Accounts Receivable Office will no longer accept payment for tuition and fees by credit card. All students will need to login to MyUTK One Stop to make secure payments online.

Please see One Stop - Paying Tuition and Fees webpage for more details http://onestop.utk.edu/pay/ .

Credit or Debit Cards

There is a 2.75% service fee for these payments. UT has a contract with an outside vendor to provide this service. The vendor retains the fee in full.

HONOR STATEMENT

The following Honor Statement is signed by all students applying to The Graduate School:

"An essential feature of The University of Tennessee, Knoxville is a commitment to maintaining an atmosphere of intellectual integrity and academic honesty. As a student of the University, I pledge that I will neither knowingly give nor receive any inappropriate assistance in academic work, thus affirming my own personal commitment to honor and integrity."

For official information on all UTK Graduate School policies, refer to the current UTK Graduate Catalog available at http://catalog.utk.edu. The student handbook "Hilltopics" is available online at https://hilltopics.utk.edu/

The University of Tennessee Space Institute reserves the right to cancel any class with an insufficient number of students, or for other reasons.

THE UNIVERSITY OF TENNESSEE POLICY ON A DRUG-FREE CAMPUS AND WORKPLACE

In support of the Drug-Free Workplace Act of 1988 (Public Law 100-690) and the Drug-Free Schools and communities Act of 1989, the University of Tennessee is notifying all students, faculty, and staff of the following university policy approved by the UT Board of Trustees on 21 June 1990.

It is the policy of the University of Tennessee to maintain a safe and healthful environment for its students and employees. Therefore, university policy prohibits the unlawful use, manufacture, possession, distribution, or dispensing of drugs ("controlled substances" as defined in the Controlled Substances Act, 21 U.S.C. 812) and alcohol on university property or during university activities.

Violation of this policy is grounds for disciplinary action--up to and including immediate discharge for an employee and permanent dismissal of a student. Federal and state laws provide additional penalties for such unlawful activities, including fines and imprisonment (21 U.S.C. 841 et seq.; T.C.A. 39-6-401 et seq.). Local ordinances also provide various penalties for drug- and alcohol-related offenses. The university is bound to take all appropriate actions against violators, which may include referral for legal prosecution or requiring the individual to participate satisfactorily in an approved drug use or alcohol abuse assistance or rehabilitation program.

THE UNIVERSITY RESERVES THE RIGHT TO REVISE
ANY INFORMATION LISTED IN THIS TIMETABLE OF CLASSES

The University of Tennessee Space Institute
Fall 2019 Course Listings

AEROSPACE ENGINEERING

AE 500 Master's Thesis (1-15)
SEC. 001 CRN 42565 Abedi
009 CRN 42581 Balas
010 CRN 42585 Brooks
011 CRN 42587 Kreth
012 CRN 42590 Moeller
013 CRN 42591 Schmisseur
014 CRN 42592 Solies
015 CRN 42595 Vakili
021 CRN 42605 Zhang

Grading Restriction: P/NP only.
Repeatability: May be repeated.
Credit Level Restriction: Graduate credit only.
Registration Restriction(s): Minimum student level – graduate.

AE 502 Registration for Use of Facilities (1-15)
SEC. 002 CRN 42610 Moeller

Required for the student not otherwise registered during any semester when student uses university facilities and/or faculty time before degree is completed.
Grading Restriction: Satisfactory/No Credit grading only.
Repeatability: May be repeated.
Credit Restriction: May not be used toward degree requirements.
Credit Level Restriction: Graduate credit only.
Registration Restriction(s): Minimum student level – graduate

AE 511 Inviscid Flow (3)
SEC. 002 CRN 45752
TEXT: Katz and Plotkin, "Low-Speed Aerodynamics", Cambridge University Press, ISBN 978-0511810329
Alan Pope, "Basic Wing and Airfoil Theory," Dover Books, ISBN 978-0486471884
Abbott and von Doenhoff, "Theory of Wing Sections: Including a Summary of Airfoil Data," Dover Books, ISBN 978-0486605869
TIME: Tuesday & Thursday 10:10 – 11:25 E-110
PROF: Dr. James Coder

Kinematics and dynamics of inviscid fluids; potential flow about body, conformal mapping.
(DE) Prerequisite(s): 541 and Mathematics 425.

Overview of Aerodynamics: Lift and Drag

   a. Airfoils and wings
   b. Definitions of force/moment/pressure coefficients
   c. Types of drag and their nature
   d. Phenomenological flow regimes
2. Derivation of Governing Flow Equations
   a. Navier-Stokes equations
   b. Incompressibility assumption
   c. Inviscid assumption
   d. Helmholtz vorticity theorems
   e. Bernoulli's equation
   f. Linear potential and streamfunction equations
3. Fundamental Solutions to Linear Potential Equation
   a. Green's functions
   b. Cartesian- and polar-coordinate solutions
   c. Composite solutions via linear superposition
   d. Kutta-Joukowsky Theorem
   e. D'Alembert's Paradox
4. Thin Airfoil Theory
   a. Simplifying approximations
   b. Vorticity sheets
   c. Kutta condition
   d. Analytical solutions
   e. Leading-edge suction
   f. Panel methods
5. Wing Theories
   a. Vortex-induced drag
   b. Lifting surface
   c. Lifting-Line Theory
   d. Schrenk's Approximation
   e. Slender-Wing Theory
   f. Vortex-Lattice Method
6. Conformal Mapping
   a. Complex analytic function theory
   b. Complex potential functions
   c. Classical airfoil transformations
   d. Theodorsen's airfoil analysis method
   e. Lighthill/Eppler airfoil design method

AE 515 Air Vehicle Aerodynamics and Performance (3)
SEC. 001 CRN 44907
TEXT: M. Asselin; *An Introduction to Aircraft Performance*; AIAA Education Series, Reston, VA 1997; 1st Edition; ISBN 1-56347-221-X
TIME: Tuesday & Friday 11:00 – 12:15 E-111
PROF: Dr. Peter Solies

Application of aerodynamics principles to air vehicles to provide estimates of performance, stability, and control characteristics for subsonic to hypersonic speeds. Relations among thrust, drag, lift and attitude, propulsion systems, vehicle performance characteristics, and trajectory optimization.

AE 517 Finite Elements for Engineering Applications (3)
SEC. 001 CRN 49976 (Same as ME 517 001 CRN 49955)

TEXT: All required course materials will be provided. Recommended references:
Zienkiewicz, Olek C., and Robert L. Taylor. The finite element method for solid and structural mechanics. Elsevier, 2005
K. J. Bathe; *Finite Element Procedures*. Cambridge, MA: Klaus-Jurgen Bathe, 2007
ISBN: 9780979004902
T. J. R. Hughes; *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*, Dover Publications, 2000. ISBN: 978-0486411811
TIME: Monday & Wednesday 1:10 – 2:25 E-110
PROF: Dr. Reza Abedi

Modern computational theory applied to conservation principles across the engineering sciences. Weak forms, extremization, boundary conditions, discrete implementation via finite element, finite difference, finite volume methods. Asymptotic error estimates, accuracy, convergence, stability. Linear problem applications in 1, 2 and 3 dimensions, extensions to non-linearity, non-smooth data, unsteady, spectral analysis techniques, coupled equation systems. Computer projects in heat transfer, structural mechanics, mechanical vibrations, fluid mechanics, heat/mass transport.
Cross-listed: (Same as Mechanical Engineering 517)
Comment(s): Bachelor's degree in engineering or natural science required.
Registration Permission: Consent of instructor.

AE 521 Aerodynamics of Compressible Fluids I (3)
SEC. 001 CRN 45564
TEXT: John D. Anderson; *Modern Compressible Flow: With Historical Perspectives*; 3rd Edition; McGraw Hill; ISBN-13: 063-9785500452 ,ISBN-10: 0072424435. Augmented with additional material from other texts and archival research publications.
TIME: Monday & Wednesday 8:40 – 9:55 E-110
PROF: Dr. Phillip Kreth

One-dimensional internal and external flow; waves; small perturbation theory; slender body theory; similarity rules; method of characteristics.
Revision of the course content for AE 521: Aerodynamics of Compressible Fluids I will accelerate and broaden course content to provide a more comprehensive knowledge of compressible fluid dynamics for graduate students who have prior course experience covering compressible flows. Historically, for a non-trivial percentage of students in the course with Mechanical Engineering backgrounds the course has been the students' first exposure to the theory of compressible flow. With the planned development of an ME599 Gas Dynamics course to provide an appropriate introduction to the material for graduate students, the course content of AE521 can be enhanced to cover a much broader range of material at an accelerated pace.
Topics to be covered in the revised AE521 course include the following:

- A review of normal and oblique shocks and Prandtl Meyer expansions
- A review of Fanno and Rayleigh Flow
- Shock Interactions and Reflections
- A review of nozzle flows
- Unsteady wave motion
- Crocco's Theorem and the Velocity Potential Equation
- Linearized Flow
- Conical Flow
- Method of Characteristics
- An introduction to Hypersonics / Newtonian Theory if time permits

Recommend pre-requisite compressible flow course.

AE 536 Continuum Mechanics (3)
SEC. 001 CRN 51006
TEXT: All required course materials will be provided.
TIME: Monday & Wednesday 11:40 – 12:55 E-110
PROF: Dr. Reza Abedi

Cartesian tensors, transformation laws, basic continuum mechanics concepts; stress, strain, deformation, constitutive equations. Conservation laws for mass, momentum, energy. Applications in solid and fluid mechanics.
Cross-listed: (Same as Mechanical Engineering 536.)
Registration Permission: Consent of instructor.

AE 566 Electric Propulsion (3)
SEC. 001 CRN 53017
TEXT: *Physics of Electric Propulsion* (textbook is available from Amazon.com); Robert G. Jahn; Dover Publications; ISBN 10:0486450406; 13: 978-0486450407
TIME: Tuesday & Friday 1:00 – 2:15 E-113
PROF: Dr. Trevor Moeller

Engineering concepts of electric propulsion and its application to modern satellites and deep space probes. Topics include physical principles, practical designs, and performance levels of electrically-powered space propulsion thrusters including: ion engines; pulsed and steady-state (fixed field) plasma and MHD thrusters, including Hall Thrusters, and others.
Recommended Background: Rocket propulsion.
Registration Permission: Consent of Instructor.

AE 590 Selected Engineering Problems (2-6)
SEC. 002 CRN 42618 Abedi
003 CRN 42619 Balas
004 CRN 45565 Brooks
005 CRN 45566 Kreth
006 CRN 45567 Moeller
007 CRN 45568 Schmisseur
008 CRN 45569 Solies
009 CRN 45570 Vakili
010 CRN 47235 Zhang

Repeatability: May be repeated. Maximum 6 hours.
Comment(s): Enrollment limited to students in problems option.
Registration Permission: Consent of advisor.

AE 595 Aerospace Engineering Seminar (1)
SEC. 001 CRN 42622
TEXT: None
TIME: Will be announced through email
PROF: Dr. Trevor Moeller

All phases of aerospace engineering, reports on current research at the University of Tennessee, Knoxville, and UTSI.

Grading Restriction: Satisfactory/No Credit grading only.
Repeatability: May be repeated. Maximum 20 hours.

AE 599 Special Topics in Aerospace Engineering: Astronautics (3)
SEC. 001 CRN 42625 (Same as ME 599 010 CRN 47594)
TEXT: Astrodynamics (WIKIBOOKS, 2019)
TIME: Monday & Thursday 10:00 – 11:15 E-111
PROF: Dr. Gary Flandro

Important Historical Notes, Trajectory Analysis and Design, Trajectory Optimization, Vehicle Ascent and Landing Dynamics, Orbital Maneuvers, Lunar and Interplanetary Mission Design, Flight Dynamics in Planetary Atmospheric and Gravitational Fields, Gravity Assist Maneuvers, Application of Optimal Low-Thrust Propulsion (including solar-sail and electric propulsion systems), Review of Key Analytical and Computational Tools, Demonstration of the Tools by Means of Case Studies.
Repeatability: May be repeated. Maximum 6 hours.

AE 599 Special Topics in Aerospace Engineering: Data Measurement & Analysis (3)
SEC. 002 CRN 42626 (Same as ME 599 001 CRN 43306) CANCELLED
TEXT: *Random Data: Analysis and Measurement Procedures*; Julius S. Bendat and Allan G. Piersol; Wiley; 4th Edition; ISBN 978-0-470-24877-5
TIME: Tuesday & Thursday 8:40 – 9:55 E113
PROF: Dr. Phil Kreth

Tools for random data analysis (including types of random data, mean values, mean-square values, probability density and distribution functions, moments and characteristic functions, spectral and correlation analyses); bias and random error estimates in data measurements; input-output system models; measurement examples.
Repeatability: May be repeated. Maximum 6 hours.

AE 599 Special Topics in Aerospace Engineering: Experimental Flight Mechanics: Fixed Wing Stability and Control (3)
SEC. 006 CRN 48403 (Same as AS 522 001 CRN 45576)
TEXT: *Flight Testing of Fixed Wing Aircraft*; Ralph D. Kimberlin; AIAA; First Edition; ISBN 1-56347-564-2
TIME: Tuesday & Friday 1:00 – 2:15 E-111
PROF: Dr. Peter Solies

Fundamental theories, flight test techniques, and data collection and analyses for fixed wing aircraft stability and control. Topics: static and dynamic longitudinal stability, longitudinal maneuvering stability and control, static and dynamic lateral-directional stability, lateral control power, and departure testing. Weekly classroom academics with approximately 4-6 flight labs.
(DE) Prerequisite(s): 516 and 521.
Repeatability: May be repeated. Maximum 6 hours.

AE 599 Special Topics in AE: Micro/Nano Electro Mechanical Systems/Sensors (3)
SEC. 010 CRN 51223 (Same as ME 599 008 CRN 46712, BME 599 005 CRN 48210)
TEXT: Liu, C., *Foundations of MEMS*, 2nd Edition, Pearson Education: New Jersey, 2010, ISBN 10: 0132497360, ISBN 13: 9780132497367.
Reference:

Marc J. Madou, *Fundamentals of Microfabrication and Nanotechnology*; 3rd Edition, CRC Press, 2011; ISBN 9780849331800.
G. Kovacs, *Micromachined Transducer Sourcebook*, McGraw-Hill, 1998.
Nadim Maluf, *An Introduction to Microelectromechanical Systems Engineering*, 2nd Edition, Artech House Publishers; 2004, ISBN 978-1-58053-590-8.
Sami Franssila; *Introduction to Microfabrication*, Wiley, 2010; ISBN 978-0-470-74983-8.

TIME: Monday & Wednesday 2:40 – 3:55 E-110
PROF: Dr. Feng-Yuan Zhang

The lectures will cover fundamentals and elements of micro/nano-scale design, fabrication, integration, and systems, including lithography, deposition, etching, thin film, surface modification, bonding, and characterization. The videos/movies will be presented to introduce the state-of-the-art fabrication process and integration. Their applications to transducers and actuators will be discussed.
Repeatability: May be repeated. Maximum 6 hours.

AE 600 Doctoral Research/Dissertation (3-15)
SEC. 004 CRN 42636 Abedi
005 CRN 42638 Balas
006 CRN 42640 Brooks
007 CRN 42642 Kreth
008 CRN 42644 Moeller
014 CRN 42650 Schmisseur
015 CRN 42651 Solies
017 CRN 45759 Vakili
018 CRN 45760 Zhang

Grading Restriction: P/NP only.
Repeatability: May be repeated.
Registration Restriction(s): Minimum student level – graduate.

AE 601 Doctoral Research Methodology (3)
SEC. 002 CRN 48677
TEXT: TBD
TIME: TBD
PROF: Dr. Kivanc Ekici

Methods of planning and conducting original research and proposal writing.
Registration Restriction(s): Minimum student level – graduate / doctoral students.
Registration Permission: Departmental approval.

AE 690 Advanced Topics in AE: Linear Systems Theory and Control (3)
SEC. 003 CRN 47446
TEXT: Lecture Notes and Joao Hespanha, *Linear Systems Theory*, Princeton University Press, 2009.
Reference:
C.T. Chen, *Linear System Theory and Design*, Oxford University Press, 1999
Wm. Brogan, *Modern Control Theory* 3rd Edition, Prentice-Hall, 1991
TIME: Monday & Wednesday 2:30 – 3:45 E-111
PROF: Dr. Mark Balas

Topics: Finite Dimensional Dynamical Systems, Linear Vector Space and Linear Operator Theory, Normed and Inner Product Spaces, Hilbert Spaces, Matrix Analysis, Linear Time Invariant State Space

Descriptions, Solving Linear Matrix Systems and Linear Differential Systems, Controllability and Observability, Linear Stability, State Space Control and Linear State Estimators
Prerequisites: ME451 or consent of instructor
Repeatability: May be repeated. Maximum 9 hours.
Registration Restriction(s): Minimum student level – graduate.
Registration Permission: Consent of instructor.

AVIATION SYSTEMS

AS 515 Aviation Human Factors (3)
SEC. 001 CRN 48170
TEXT: *Human Factors in Aviation*; 2nd Edition; Salas and Maurino; ISBN 978-0123745187
TIME: Monday & Wednesday 1:00 – 2:15 E-111
PROF: Dr. Steve Brooks

Human factors pertinent to aviation: concept of human factors, human error, fatigue, body rhythms, performances, motivation, vision and visual illusions, communication, attitudes, training and devices, displays and controls, space and layout, anthropometry, flight deck design and evaluation, aircraft cabin design and evaluation, flying qualities evaluation, and performance measurement techniques. Applied aviation systems.

AS 522 Experimental Flight Mechanics: Fix Wing Stability and Control (3)
SEC. 001 CRN 45576 (Same as AE 599 006 CRN 48403)
TEXT: *Flight Testing of Fixed Wing Aircraft*; Ralph D. Kimberlin; AIAA; First Edition; ISBN 1-56347-564-2
TIME: Tuesday & Friday 1:00 – 2:15 E-111
PROF: Dr. Peter Solies

Fundamental theories, flight test techniques, and data collection and analyses for fixed wing aircraft stability and control. Topics: static and dynamic longitudinal stability, longitudinal maneuvering stability and control, static and dynamic lateral-directional stability, lateral control power, and departure testing. Weekly classroom academics with approximately 4-6 flight labs.
(*DE) Prerequisite(s): 516 and 521.*

BIOMEDICAL ENGINEERING

BME 500 Master's Thesis (1-15)
SEC. 012 CRN 46481 Johnson

Grading Restriction: P/NP only.
Repeatability: May be repeated.
Credit Level Restriction: Graduate credit only.
Registration Restriction(s): Minimum student level – graduate.

BME 529 Applications of Linear Algebra in Engineering Systems (3)
SEC. 002 CRN 46568 (Video Recorded)
TEXT: *Advanced Linear Algebra for Engineers with MATLAB*; Sohail A. Dianat and Eli S. Saber; CRC Press; Latest Edition; ISBN 978-1-4200-9523-4
TIME: Tuesday & Friday 9:30 – 10:45 E-111
PROF: Dr. Monty Smith

Fundamental concepts of linear algebra to problems in engineering systems: steady state and dynamic systems. Geometric and physical interpretations of relevant concepts: least square problems, LU, QR, and SVD decompositions of system matrix, eigenvalue problems, and similarity transformations in solving difference and differential equations; numerical stability aspects of various algorithms; application of linear algebra concepts in control and optimization studies; introduction to linear programming. Computer projects.
Methods of linear algebra with application to engineering problems. Systems of linear equations: matrix-vector notation, solutions to linear equations, determinants, matrix inversion, LU decomposition. Vector spaces: spanning sets, orthogonality, QR factorization, linear transformations. Eigenvalues and eigenvectors: characteristic polynomials, singular value decomposition. The Cayley-Hamilton theorem: matrix polynomials, functions of matrices. Optimization: least-squares and weighted least-squares methods.
Cross-listed: (Same as Chemical and Biomolecular Engineering 529; Civil Engineering 529, Electrical and Computer Engineering 529; Environmental Engineering 529; Industrial Engineering 529; Materials Science and Engineering 529; Mechanical Engineering 529; Nuclear Engineering 529).
Comment(s): Graduate standing or consent of instructor required.

BME 574 Medical Imaging
SEC. 002 CRN 50862
TEXT: TBD
TIME: Tuesday & Thursday 1:10 – 2:25 E-110
PROF: Dr. Mahfouz

Introduction is provided of the basic principles of image acquisition, formation, and processing, along with clinical applications of different imaging modalities for predicting disease outcome and treatment evaluation. Clinical site visits provide experience with imaging modalities covered in class.
(DE) Prerequisite(s): 503.

BME 578 Advanced Biomaterials: Biological Applications of Nanomaterials (3)
SEC. 001 CRN 53057
TEXT: Nanomaterials; Dieter Vollath; Wiley; 2nd Edition; ISBN 978-3-527-33379-0
TIME: Monday & Wednesday Zoom.com
PROF: Dr. Jacqueline Johnson

Focuses on the biological/medical uses of nanoscale materials. Includes the following topics: 0-d, 1-d, and 2-d nanomaterials synthesis and characterization with an emphasis on surface properties. Chemical and biological functionalization of nanomaterials and nano-bio interfaces. Biological and biomedical application of nanomaterials. The state-of-the-art research papers will be reviewed and discussed.
Recommended Background: 474.
Comment(s): Prior knowledge may satisfy prerequisites, with consent of instructor.

BME 590 Selected Biomedical Engineering Problems (2-6)
SEC. 001 CRN 46880
TEXT: TBD
TIME: TBD
PROF: Dr. Jacqueline Johnson

Grading Restriction: Satisfactory/No Credit grading only.
Repeatability: May be repeated. Maximum 6 hours.
Comment(s): Enrollment is limited to students in the non-thesis option.
Credit Level Restriction: Graduate credit only.

Registration Restriction(s): Minimum student level – graduate.
Registration Permission: Consent of instructor.

BME 595 Biomedical Seminar (1)
SEC. 002 CRN 46179
TEXT: None
TIME: Will be announced through email
PROF: Dr. Jacqueline Johnson

All phases of biomedical engineering, reports on current research at UTK and UTSI.
Grading Restriction: Satisfactory/No Credit grading only.
Repeatability: May be repeated. Maximum 20 hours.
Credit Level Restriction: Graduate credit only.
Registration Restriction(s): Minimum student level – graduate.

BME 599 Special Topics in BME: Micro/Nano Electro Mechanical Systems/Sensors (3)
SEC. 005 CRN 48210 (Same as AE 599 010 CRN 51223, ME 599 008 CRN 46712)
TEXT: Liu, C. *Foundations of MEMS*, 2nd Edition, Pearson Education: New Jersey, 2010, ISBN 10: 0132497360, ISBN 13: 9780132497367.
Reference:
Marc J. Madou, *Fundamentals of Microfabrication and Nanotechnology*, 3rd Edition, CRC Press, 2011; ISBN 9780849331800.
G. Kovacs, *Micromachined Transducer Sourcebook*, McGraw-Hill, 1998.
Nadim Maluf, *An Introduction to Microelectromechanical Systems Engineering*, 2nd Edition, Artech House Publishers; 2004, ISBN 978-1-58053-590-8.
Sami Franssila; *Introduction to Microfabrication*, Wiley, 2010; ISBN 978-0-470-74983-8.
TIME: Monday & Wednesday 2:40 – 3:55 E-110
PROF: Dr. Feng-Yuan Zhang

The lectures will cover fundamentals and elements of micro/nano-scale design, fabrication, integration, and systems, including lithography, deposition, etching, thin film, surface modification, bonding, and characterization. The videos/movies will be presented to introduce the state-of-the-art fabrication process and integration. Their applications to transducers and actuators will be discussed.
Repeatability: May be repeated. Maximum 6 hours.

BME 600 Doctoral Research/Dissertation (3-15)
SEC. 011 CRN 46180 Johnson

Grading Restriction: P/NP only.
Repeatability: May be repeated.
Registration Restriction(s): Minimum student level – graduate.

BME 601 Doctoral Research Methodology (3)
SEC. 002 CRN 48678
TEXT: TBD
TIME: TBD
PROF: Dr. Jeffrey Reinbolt

Intensive, individualized experience in reviewing literature, evaluating experimental or theoretical methods, planning a research project, and presenting research project plans orally and in writing.

Registration Restriction(s): Minimum student level – graduate. PhD students only.
Registration Permission: Consent of instructor.

ENGINEERING MANAGEMENT

EM 500 Master's Thesis (1-15)
SEC. 001 CRN 47446 Simonton
002 CRN 49097 Yu

Restriction: P/NP only.
Repeatability: May be repeated.
Credit Level Restriction: Graduate credit only.
Registration Restriction(s): Minimum student level – graduate.

EM 501 Capstone Project (3-6)
SEC. 001 CRN 42980 Tolk

Application-oriented project to show competence in major academic area.
Grading Restriction: Satisfactory/No Credit grading only.
Repeatability: May be repeated. Maximum 6 hours.
Comment(s): Requires enrollment in engineering management.
Credit Level Restriction: Graduate credit only.
Registration Restriction(s): Minimum student level – graduate.

EM 502 Registration for Use of Facilities (1-15)
SEC. 001 CRN 42981 Simonton
002 CRN 49099 Yu

Required for the student not otherwise registered during any semester when student uses university facilities and/or faculty time before degree is completed.
Grading Restriction: Satisfactory/No Credit grading only.
Repeatability: May be repeated.
Credit Restriction: May not be used toward degree requirements.
Credit Level Restriction: Graduate credit only.
Registration Restriction(s): Minimum student level – graduate.

EM 532 Productivity and Quality Engineering (3)
SEC. 001 CRN 44956 UT Space Institute Campus
003 CRN 44958 UT Knoxville Campus
004 CRN 44959 Distance Education Campus
TEXT: *Improving Performance: How to Manage the White Space on the Organization Chart*, Geary A. Rummler and Alan P. Brache, 3rd Edition
The Principles of Scientific Management, Taylor, F. W. (1998, 1911). Mineola, NY: Dover Publications, Inc.
The New Economics for Industry, Government, Education, Deming, W. E., *2nd Edition* (1994). Cambridge, MA: The MIT Press.
TIME: TBD
PROF: Dr. Tonya Brown

Productivity and quality measures defined and used to analyze current competitive position of important sectors of American industry with respect to national and international competition. Study of management theories and systems which promote or inhibit productivity or quality improvements.

EM 537 Analytical Methods for Engineering Managers (3)
SEC. 001 CRN 44960 UT Space Institute Campus
004 CRN 44963 Distance Education Campus
006 CRN 52998 UT Knoxville Campus
TEXT: *Operations Management*; William Stevenson; McGraw-Hill; January 7, 2014; Edition 12th; ISBN 13:978-0078024108, ISBN 10:0078024102
TIME: Monday 4:00 – 6:35 E-113
PROF: Dr. Denise Jackson

Survey of management analysis and control systems through industrial engineering techniques. Qualitative and quantitative systems: methods analysis, work measurement, incentive systems, wage and salary development, production and inventory control, facility layout, linear programming, and applied operations research techniques.
Credit Restriction: No credit for student with undergraduate degrees in industrial engineering.

EM 539 Strategic Management in Technical Organizations (3)
SEC. 001 CRN 44964 UT Space Institute Campus
003 CRN 44966 UT Knoxville Campus
004 CRN 44967 Distance Education Campus
TEXT: *Strategic Management: Concepts;* Frank Rothaermel; 3rdt Edition; McGraw-Hill; ISBN-13: 978-1259420474, ISBN-10: 1259420477
TIME: Tuesday 10:30 – 12:30 E-113
PROF: Dr. Sandra Affare

Strategic planning process and strategic management in practice; corporate vision and mission; product, market, organizational, and financial strategies; external factors; commercialization of new technologies; and competition and beyond.
Recommended Background: Graduate standing in Engineering or Business.

EM 542 Design of Experiments for Engineering Managers (3) CANCELLED
SEC. 001 CRN 53010 UT Space Institute Campus
002 CRN 53011 UT Knoxville Campus
003 CRN 53012 Distance Education Campus
TEXT: *Design and Analysis of Experiments*; Douglas C. Montgomery; 8th Edition; John Wiley & Sons; ISBN 13:978-1118146927, ISBN 10:1118146921
TIME: Monday 10:30 – 12:30 E-113
PROF: Dr. Andrew Yu

Methodology for experiments in product, service, and process improvements. Factorial experiments, screening designs, variance reduction, and other selected topics for engineering managers. Taguchi philosophy and concepts. Optimization and response surface methods. Case studies.
(RE) Prerequisite(s): Industrial Engineering 516.

EM 543 Legal and Ethical Aspects of Engineering Management (3)
SEC. 001 CRN 50844 UT Space Institute Campus
004 CRN 53008 UT Knoxville Campus
005 CRN 53009 Distance Education Campus

TEXT: *Business Ethics (Ethical Decision Making and Cases)*; 12th Edition; O.C. Ferrell, John Fraedrich, and Linda Ferrell; ISBN 978-1-337-61443-6
TIME: Thursday 10:30 – 12:30 E-113
PROF: Dr. Sandra Affare

Legal aspects imposed by government and ethical considerations in engineering practice. Selected readings, lecture, discussion, and student presentations. Current topics from government and industry.

EM 600 Doctoral Research/Dissertation (3-15)
SEC. 001 CRN 44970 Simonton
002 CRN 44972 Yu

Grading Restriction: P/NP only.
Repeatability: May be repeated.
Registration Restriction(s): Minimum student level – graduate.

EM 602 Supply Chain and Logistics Systems Engineering (3)
SEC. 001 CRN 51849 UT Space Institute Campus
003 CRN 51851 UT Knoxville Campus
004 CRN 53254 Distance Education Campus
TEXT: Instructor will provide electronic files through Canvas
TIME: Monday 10:30 – 12:30 E-113
PROF: Dr. Andrew Yu

This course introduces the concepts, methods and techniques of supply chain management and logistics support from a systems engineering perspective. The discussion of different topics in the course will focus on the different stages in a system life cycle.
(RE) Prerequisite(s): 537

INDUSTRIAL ENGINEERING

IE 516 Statistical Methods in Industrial Engineering (3)
SEC. 001 CRN 45037 UT Knoxville Campus
002 CRN 45038 Distance Education Campus
003 CRN 45039 UT Space Institute Campus
TEXT: TBD
TIME: Monday & Wednesday 11:10 – 12:25 EST UTK
PROF: Dr. Oleg Shylo

Application of classical statistical techniques to industrial engineering problems. Statistics and statistical thinking in managerial context of organizational improvement; descriptive statistics and distribution theory; relationship between statistical process control techniques and classical statistical tools; parameter estimation and hypothesis testing; goodness-of-fit testing; linear regression and correlation; analysis of variance; single and multiple factor experimental design.
Recommended Background: Statistics 251 or equivalent

IE 526 Advanced Applications of Systems Modeling and Simulation (3)
SEC. 001 CRN 45048 UT Knoxville Campus
002 CRN 45050 Distance Education Campus
003 CRN 45051 UT Space Institute Campus
TEXT: TBD

TIME: Thursday 9:45 – 11:00 EST UTK
PROF: Dr. Xueping Li

Modeling and simulation of business and industry systems to enhance management, strategic, and operational decision-making. Hands-on experiences of simulation software package (e.g., Arena) will be provided with case studies in manufacturing, supply chain and logistics, healthcare, etc.
Recommended Background: 306.

IE 529 Applications of Linear Algebra in Engineering Systems (3)
SEC. 001 CRN 43205 UT Knoxville Campus (Video Recorded)
002 CRN 46570 UT Space Institute Campus
003 CRN 52425 Distance Education Campus
TEXT: *Advanced Linear Algebra for Engineers with MATLAB*; Sohail A. Dianat and Eli S. Saber; CRC Press; Latest Edition; ISBN 978-1-4200-9523-4
TIME: Tuesday & Friday 9:30 – 10:45 E-111
PROF: Dr. Monty Smith

Fundamental concepts of linear algebra to problems in engineering systems: steady state and dynamic systems. Geometric and physical interpretations of relevant concepts: least square problems, LU, QR, and SVD decompositions of system matrix, eigenvalue problems, and similarity transformations in solving difference and differential equations; numerical stability aspects of various algorithms; application of linear algebra concepts in control and optimization studies; introduction to linear programming. Computer projects.
Methods of linear algebra with application to engineering problems. Systems of linear equations: matrix-vector notation, solutions to linear equations, determinants, matrix inversion, LU decomposition. Vector spaces: spanning sets, orthogonality, QR factorization, linear transformations. Eigenvalues and eigenvectors: characteristic polynomials, singular value decomposition. The Cayley-Hamilton theorem: matrix polynomials, functions of matrices. Optimization: least-squares and weighted least-squares methods.
Cross-listed: (Same as Chemical and Biomolecular Engineering 529; Civil Engineering 529, Electrical and Computer Engineering 529; Environmental Engineering 529; Materials Science and Engineering 529; Mechanical Engineering 529; Nuclear Engineering 529).
Comment(s): Graduate standing or consent of instructor required.

IE 550 Graduate Seminar (1)
SEC. 001 CRN 45416 UT Knoxville Campus
002 CRN 45417 Distance Education Campus
003 CRN 45418 UT Space Institute
TEXT: TBD
TIME: Friday 2:30 – 3:30 EST UTK
PROF: Dr. Ming Jing

Seminar provides an opportunity for Master's and Doctoral students to acquaint themselves with research being conducted by both faculty and graduate students in the Industrial and Systems Engineering Department, as well as select campus-wide and off-campus researchers from both academia and industry. Research work and relevant results are presented in a professional environment that promotes continued interaction among interested parties. Presentations are not restricted to thesis and dissertation work.
Grading Restriction: Satisfactory/No Credit grading only.
Repeatability: May be repeated. Maximum 6 hours.
Comment(s): Admission to graduate program required.

MECHANICAL ENGINEERING

ME 476 Fuel Cell Engines (3)
SEC. 002 CRN 52350
TEXT: TBD
TIME: Tuesday & Thursday 8:40 – 9:55 E-110
PROF: Dr. Matthew Mench

Introduction to fundamentals of fuel cells with an emphasis on polymer electrolyte fuel cells. Includes fundamentals of electrochemistry, thermodynamics, fluid mechanics, heat transfer, materials, and manufacturing issues of PEFCs. A brief survey of other fuel cell types is also included.
(RE) Prerequisite(s): 331 and Aerospace Engineering 341.

ME 500 Master's Thesis (1-15)
SEC. 001 CRN 43265 Abedi
021 CRN 43285 Balas
022 CRN 43286 Brooks
023 CRN 43287 Kreth
024 CRN 43288 Moeller
025 CRN 43289 Schmisseur
034 CRN 45579 Solies
035 CRN 45580 Vakili
036 CRN 45581 Zhang

Grading Restriction: P/NP only.
Repeatability: May be repeated.
Credit Level Restriction: Graduate credit only.
Registration Restriction(s): Minimum student level – graduate.

ME 502 Registration for Use of Facilities (1-15)
SEC. 002 CRN 45582 Moeller

Required for the student not otherwise registered during any semester when student uses university facilities and/or faculty time before degree is completed.
Grading Restriction: Satisfactory/No Credit grading only.
Repeatability: May be repeated.
Credit Restriction: May not be used toward degree requirements.
Credit Level Restriction: Graduate credit only.
Registration Restriction(s): Minimum student level – graduate.

ME 517 Finite Elements for Engineering Applications (3)
SEC. 001 CRN 49955 (Same as AE 517 001 CRN 49976)
TEXT: All required course materials with be provided. Recommended references:
Zienkiewicz, Olek C., and Robert L. Taylor. The finite element method for solid and structural mechanics. Elsevier, 2005
K. J. Bathe; *Finite Element Procedures*. Cambridge, MA: Klaus-Jurgen Bathe, 2007
ISBN: 9780979004902
T. J. R. Hughes; *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*, Dover Publications, 2000. ISBN: 978-0486411811
TIME: Monday & Wednesday 1:10 – 2:25 E-110
PROF: Dr. Reza Abedi

Modern computational theory applied to conservation principles across the engineering sciences. Weak forms, extremization, boundary conditions, discrete implementation via finite element, finite difference, finite volume methods. Asymptotic error estimates, accuracy, convergence, stability. Linear problem applications in 1, 2 and 3 dimensions, extensions to non-linearity, non-smooth data, unsteady, spectral analysis techniques, coupled equation systems. Computer projects in heat transfer, structural mechanics, mechanical vibrations, fluid mechanics, heat/mass transport.
Cross-listed: (Same as Aerospace Engineering 517.)
Comment(s): Bachelor's degree in engineering or natural science required.
Registration Permission: Consent of instructor.

ME 521 Thermodynamics I (3)
SEC. 002 CRN 45753
TEXT: *Fundamentals of Engineering Thermodynamics*; Moran, Shapiro, Boettner & Bailer; 9th Edition; John Wiley and Sons, Inc.; ISBN 978-1-119-39138-8
TIME: Monday & Wednesday 10:10 – 12:25 E-110
PROF: Dr. Milt Davis

Macroscopic thermodynamics, including First and Second Law analyses, availability, phase and chemical equilibrium criteria, combustion, gas mixtures, and property relations, determination of thermodynamic properties from molecular structure, spectroscopic data, kinetic theory, statistical mechanics, quantum physics, Schroedinger equation.
Fundamentals of engineering thermodynamics concentrating on 1st & 2nd Law with applications to vapor and gas cycles and application of ideal mixture analysis along with an introduction into combustion
Recommended Background: Undergraduate thermodynamics.

ME 529 Applications of Linear Algebra in Engineering Systems (3)
SEC. 002 CRN 46572 (Video Recorded)
TEXT: *Advanced Linear Algebra for Engineers with MATLAB*; Sohail A. Dianat and Eli S. Saber; CRC Press; Latest Edition; ISBN 978-1-4200-9523-4
TIME: Tuesday & Friday 9:30 – 10:45 E-111
PROF: Dr. Monty Smith

Fundamental concepts of linear algebra to problems in engineering systems: steady state and dynamic systems. Geometric and physical interpretations of relevant concepts: least square problems, LU, QR, and SVD decompositions of system matrix, eigenvalue problems, and similarity transformations in solving difference and differential equations; numerical stability aspects of various algorithms; application of linear algebra concepts in control and optimization studies; introduction to linear programming. Computer projects.
Methods of linear algebra with application to engineering problems. Systems of linear equations: matrix-vector notation, solutions to linear equations, determinants, matrix inversion, LU decomposition. Vector spaces: spanning sets, orthogonality, QR factorization, linear transformations. Eigenvalues and eigenvectors: characteristic polynomials, singular value decomposition. The Cayley-Hamilton theorem: matrix polynomials, functions of matrices. Optimization: least-squares and weighted least-squares methods.
Cross-listed: (Same as Chemical and Biomolecular Engineering 529; Civil Engineering 529, Electrical and Computer Engineering 529; Environmental Engineering 529; Industrial Engineering 529; Materials Science and Engineering 529; Nuclear Engineering 529).
Comment(s): Graduate standing or consent of instructor required.

ME 536 Continuum Mechanics (3)
SEC. 001 CRN 49184

TEXT: All required course materials will be provided.
TIME: Monday & Wednesday 11:40 – 12:55 E-110
PROF: Dr. Reza Abedi

Cartesian tensors, transformation laws, basic continuum mechanics concepts; stress, strain, deformation, constitutive equations. Conservation laws for mass, momentum, energy. Applications in solid and fluid mechanics.
Cross-listed: (Same as Aerospace Engineering 536.)
Registration Permission: Consent of instructor.

ME 576 Fuel Cell Engines (3)
SEC. 002 CRN 52361
TEXT: TBD
TIME: Tuesday & Thursday 8:40 – 9:55 E-110
PROF: Dr. Matthew Mench

Fundamental science of polymer electrolyte fuel cells. Includes fundamentals of electrochemistry, materials, manufacturing and transport in PEFCS. Laboratory testing of the performance characteristics of PEFCS.
Recommended Background: Undergraduate Thermodynamics and Fluid Mechanics.
Registration Permission: Consent of instructor.

ME 590 Selected Engineering Problems (2-6)
SEC. 001 CRN 43302 Abedi
002 CRN 43303 Balas
003 CRN 45190 Brooks
004 CRN 45583 Kreth
005 CRN 45584 Moeller
006 CRN 45585 Schmisseur
007 CRN 45586 Solies
008 CRN 45587 Vakili
009 CRN 45588 Zhang

Grading Restriction: Satisfactory/No Credit grading only.
Repeatability: May be repeated. Maximum 6 hours.
Comment(s): Enrollment limited to students in problems option.
Registration Permission: Consent of advisor.

ME 595 Mechanical Engineering Seminar (1)
SEC. 001 CRN 43304
TEXT: None
TIME: Will be announced through email
PROF: Dr. Trevor Moeller

All phases of mechanical engineering, reports on current research at the University of Tennessee, Knoxville, and the University of Tennessee Space Institute.
Grading Restriction: Satisfactory/No Credit grading only.
Repeatability: May be repeated. Maximum 20 hours.

ME 599 Special Topics in Aerospace Engineering: Data Measurement & Analysis (3)
SEC. 001 CRN 43306 (Same as AE 599 002 CRN 42626) CANCELLED

TEXT: *Random Data: Analysis and Measurement Procedures*; Julius S. Bendat and Allan G. Piersol; Wiley; 4th Edition; ISBN 978-0-470-24877-5
TIME: Tuesday & Thursday 8:40 – 9:55 E113
PROF: Dr. Phil Kreth

Tools for random data analysis (including types of random data, mean values, mean-square values, probability density and distribution functions, moments and characteristic functions, spectral and correlation analyses); bias and random error estimates in data measurements; input-output system models; measurement examples.
Repeatability: May be repeated. Maximum 6 hours.
Registration Permission: Consent of instructor.

ME 599 Special Topics in ME: Micro/Nano Electro Mechanical Systems/Sensors (3)
SEC. 008 CRN 46712 (Same as AE 599 010 CRN 51223, BME 599 005 CRN 48210)
TEXT: Liu, C. *Foundations of MEMS*, 2nd Edition, Pearson Education: New Jersey, 2010, ISBN 10: 0132497360, ISBN 13: 9780132497367.
Reference:
Marc J. Madou, *Fundamentals of Microfabrication and Nanotechnology*, 3rd Edition, CRC Press, 2011; ISBN 9780849331800.
G. Kovacs, *Micromachined Transducer Sourcebook*, McGraw-Hill, 1998.
Nadim Maluf, *An Introduction to Microelectromechanical Systems Engineering*, 2nd Edition, Artech House Publishers; 2004, ISBN 978-1-58053-590-8.
Sami Franssila; *Introduction to Microfabrication*, Wiley, 2010; ISBN 978-0-470-74983-8.
TIME: Monday & Wednesday 2:40 – 3:55 E-110
PROF: Dr. Feng-Yuan Zhang

The lectures will cover fundamentals and elements of micro/nano-scale design, fabrication, integration, and systems, including lithography, deposition, etching, thin film, surface modification, bonding, and characterization. The videos/movies will be presented to introduce the state-of-the-art fabrication process and integration. Their applications to transducers and actuators will be discussed.
Repeatability: May be repeated. Maximum 6 hours.
Registration Permission: Consent of instructor.

ME 599 Special Topics: Fundamentals of Gas Dynamics as Applied to Propulsion Systems (3)
SEC. 009 CRN 47496
TEXT: *Fundamentals of Gas Dynamics*; Robert Zucker; John Wiley and Sons, Inc.; Second Edition; ISBN #: 0-471-05967-6
TIME: Monday & Wednesday 4:00 – 5:15 E-111
PROF: Dr. Milt Davis

In this course, the student will be introduced to the fundamentals of gas dynamics. Specific topics in the course will cover varying area flow, normal and oblique shocks, expansions, duct friction and heat transfer. A wide variety of practical engineering problems can be solved with these concepts and many of these problems will be highlighted in the course. Examples of these types of problems are: off-design operation of supersonic nozzles, supersonic windtunnels, blast waves, supersonic inlets, some methods of flow measurements and choking from friction or thermal effects. The course will culminate in the study of propulsion systems since many gas dynamics issues are inherent in these types of applications.
Topics Covered
1. Isentropic flow
2. Varying area flow
3. Nozzles

4. Normal shocks
5. Oblique shocks
6. Prandtl-Meyer expansion
7. Fanno flow
8. Rayleigh flow
9. Introduction to gas turbine engines

Available only to students who have not had compressible flow course.
Repeatability: May be repeated. Maximum 6 hours.
Registration Permission: Consent of instructor.

ME 599 Special Topics in Aerospace Engineering: Astronautics (3)
SEC. 010 CRN 47594 (Same as AE 599 001 CRN 42625)
TEXT: Astrodynamics (WIKIBOOKS, 2019)
TIME: Monday & Thursday 10:00 – 11:15 E-111
PROF: Dr. Gary Flandro

Important Historical Notes, Trajectory Analysis and Design, Trajectory Optimization, Vehicle Ascent and Landing Dynamics, Orbital Maneuvers, Lunar and Interplanetary Mission Design, Flight Dynamics in Planetary Atmospheric and Gravitational Fields, Gravity Assist Maneuvers, Application of Optimal Low-Thrust Propulsion (including solar-sail and electric propulsion systems), Review of Key Analytical and Computational Tools, Demonstration of the Tools by Means of Case Studies.
Repeatability: May be repeated. Maximum 6 hours.
Registration Permission: Consent of instructor.

ME 600 Doctoral Research/Dissertation (3-15)
SEC. 015 CRN 43323 Abedi
016 CRN 43324 Balas
018 CRN 43326 Brooks
019 CRN 43327 Kreth
026 CRN 43334 Moeller
027 CRN 43335 Schmisseur
028 CRN 43336 Solies
029 CRN 47237 Vakili
030 CRN 47238 Zhang

Grading Restriction: P/NP only.
Repeatability: May be repeated.
Registration Restriction(s): Minimum student level – graduate.

ME 601 Doctoral Research Methodology (3)
SEC. 002 CRN 49183
TEXT: TBD
TIME: TBD
PROF: Dr. Kivanc Ekici

Methods of planning and conducting original research and proposal writing.
Registration Restriction(s): Minimum student level – doctoral student.
Registration Permission: Departmental approval.

ME 613 Advanced Radiation Heat Transfer (3)
SEC. 001 CRN 47289
TEXT: *Thermal Radiation Heat Transfer*; Robert Siegel and John R. Howell; Publisher: Taylor and Francis; Edition 3rd or 4th; ISBN #: 1-56032-839-8
Supplemental Text: Maher I. Boulos, Pierre Fauchais, and Emil Pfender, *Thermal Plasmas: Fundamentals and Applications*, Vol. 1, Plenum Press, ISBN 0-306-44607-3
TIME: Monday & Thursday 1:00 – 2:15 E-113
PROF: Dr. Trevor Moeller

Radiation heat transfer in absorbing, emitting and scattering media; interaction of thermal radiation with conduction and convection heat transfer.
(DE) Prerequisite(s): 511 and 512.
Registration Restriction(s): Minimum student level – graduate.

PHYSICS

Phys 500 Master's Thesis (1-15)
SEC. 002 CRN 41987 Davis
003 CRN 41988 Parigger

Grading Restriction: P/NP only.
Repeatability: May be repeated.
Credit Level Restriction: Graduate credit only.
Registration Restriction(s): Minimum student level – graduate.

Phys 503 Physics Colloquium (1)
SEC. 002 CRN 41950
TEXT: Classic Texts and Literature
TIME: 2nd, 4th Thursday /each month 3:00 - 4:30 H-111
PROF: Dr. Christian Parigger

Lectures and discussion on current research topics. Continuous registration required for current graduate students.
Grading Restriction: Satisfactory/No Credit grading only.
Repeatability: May be repeated. Maximum 6 hours.

Phys 600 Doctoral Research/Dissertation (3-15)
SEC. 002 CRN 41992 Davis
003 CRN 41993 Parigger

Grading Restriction: P/NP only.
Repeatability: May be repeated.
Registration Restriction(s): Minimum student level – graduate.

Phys 610 Quantum Optics (3)
SEC. 002 CRN 49115
TEXT: TBD
TIME: TBD
PROF: Dr. Lloyd Davis

Quantum theory of emission and absorption of radiation; frequency-dependent susceptibility; coherence theory; field quantization and coherent photon states; interaction of radiation with atoms; photon optics, counting and higher-order coherence; atomic scattering phenomena.
(DE) Prerequisite(s): 521.
Registration Restriction(s): Minimum student level – graduate.

Phys 642 Advanced Topics: Modern Physics: Laboratory Laser-Plasma Experiments (3)
SEC. 004 CRN 53074
TEXT: Class notes, current literature, and selected books include Ochkin: Spectroscopy of Low Temperature Plasma ISBN: 978-3-527-40778-1, Demtroeder Vol 1 and Vol 2: Laser Spectroscopy ISBN 978-3-642-53858-2 and ISBN 978-3-662-44640-9, respectively; Kunze: Introduction to Plasma Spectroscopy ISBN978-3-642-02232-6
TIME: TBD
PROF: Dr. Christian Parigger

Advanced theoretical or experimental topics not covered in other courses.
This course addresses aspects of measurements on laser-induced plasma and expansion dynamics. Student participation in ongoing experiments is planned to occur during two extensive lab meetings at UTSI, over and above regularly scheduled class meetings.
Repeatability: May be repeated with consent of department. Maximum 9 hours.
Registration Restriction(s): Minimum student level – graduate.