AUTUMN SEMESTER 2020-21

	8:30 - 9:25	9:30 - 10:25	10:35 - 11:30	11:35 - 12:30	14:00 - 15:25	15:30 - 16:55	17:30 - 18:55	19:00 - 20:25
Monday	AE 238	AE 236	AE 240	AE 234	AE 242	AE 242	MA 214	
Tuesday	AE 234	AE 238	AE 236	AE 240				SC 618
Wednesday		CS 419					MA 214 tutorial	
Thursday	AE 240	AE 234	AE 238	AE 236	AE 242	AE 242	MA 214	
Friday		CS 419						SC 618

1 SC 618 - Analytic and Geometric Dynamics

1.1 Description

Prerequisites : An understanding of vector spaces (equivalent to SC 625 OR MA 108)
The course will consist of three modules, with the underlying thread being examining dynamics and connected engineering applications from a geometric viewpoint, in particular, the framework of Lie groups.
Dynamics on Lie groups: A quick introduction to matrix Lie groups and the associated machinery of groups actions, Lie algebras, invariant vector fields, infinitesimal generators, metrics and the Euler-Lagrange(EL) equations on a Lie group.
Discrete Mechanics : The discrete variational principle and the discrete EL and Hamiltonian equations for a mechanical system; the fiber derivatives and the discrete equations for matrix Lie groups

1.2 Applications

Attitude dynamics and control of a satellite and Formation control of mechanical systems over Lie groups

1.3 Text/References

- Geometric Mechanics and Symmetry - D .D. Holm, T. Schmah and C. Stoica, Oxford University Press, 2009.
- Introduction to Mechanics and Symmetry - J. Marsden and T. Ratiu, Springer-Verlag, 1994.

2 AE 234 - Aircraft Propulsion

2.1 Description

Introduction to various aircraft propulsive devices: Piston-prop, Turbo-prop, Turbojet, Turbofan, Turboshaft, Vectored- thrust, Lift engines. Gas Turbine Cycles and cycle based performance analysis; 1-D and 2-D analysis of flow through gas turbine components - Intake, Compressors, Turbines, Combustion Chamber, Afterburner, and Nozzle. Compressor and Turbine blade shapes; cascade theory; radial equilibrium theory; matching of compressor and Turbine. Turbine cooling. Single spool and Multi- spool engines. Powerplant performance with varying speed and altitude. Other propulsion systems: ramjets, scramjets and pulsejets.

2.2 LaTeXt/refrences

1. Saravanamuttoo, H.I.H, Rogers, G. F. C., Cohen, H., Gas Turbine Theory, ISBN 978-0138475, 5th Ed, Prentice Hall, 20. Hill, P., and Peterson, C., Mechanics and Thermodynamics of Propulsion, ISBN 978-0132465489, Pearson Education, 2009.3. Mattingly, J. D., Elements of Gas Turbine Propulsion, Tata McGraw Hill Edition, 20054. El-Sayed, A., Aircraft Propulsion and Gas Turbine Engines, ISBN 978-0849391965, 1st Ed., CRC Press, 20085. Roy, B., Aircraft Propulsion: Science of Making Thrust to Fly, 1st Ed., Elsevier India, 2011

3 AE 236 - Compressible Fluid Mechanics

3.1 Description

Review of Fundamentals. Concept of Waves in fluid, Mach waves, Compression waves, Expansion waves. Isentropic flow, Adiabatic flow, Shock waves. Stationary and Moving Normal Shocks. Oblique Shocks, Bow Shocks in 2D. Conical Shocks, Bow Shocks in 3D. Shock interactions, Shock reflection from boundaries, Shockwave Boundary Layer interaction. Prandtl-Meyer expansion fans. Shock Expansion Methods. Mach Number and Area rule, Flow through a Nozzle: Convergent Nozzle, Convergent Divergent Nozzle, Under-expanded and Over-expanded Nozzle flows. Duct flow with friction and heat addition. Shock Tubes. Supersonic and Transonic Wind tunnels. Potential flow equations. High temperature aspects of gas dynamics. Introduction to hypersonic flows

3.2 Text/ref

1. Anderson, J. D., Modern Compressible Flow: withHistorical Perspective, 3rd Ed., McGraw Hill, 2003.2. Yahya, S.M., Fundamentals of Compressible Flow, 3rd Ed., New Age International, New Delhi, 2003

4 AE 238 - Aerospace Structural Mechanics

4.1 Description

Introduction: semi-monocoque aerospace structures - Loads and Design considerations; construction concepts, layout, nomenclature and structural function of parts, strength v/s stiffness based design. Torsion of non-circular prismatic beams: importance of warping; St. Venant or Prandtl's formulation; Membrane analogy and its application to narrow rectangular cross-section. General formulation of Thin-Walled Beam (TWB) Theory: Cartesian and midline systems, CSRD & thin-wall assumptions, general expressions for dominant displacement, strain and stress fields, equilibrium equations in midline system, stress resultants and general boundary conditions. Torsion and Bending of TWBs: Torsion of single and multi cell closed sections - Bredt-Batho theory, shear flow, torsion constant, free warping calculation, and concept of center of twist, torsional equilibrium equation and boundary conditions. Torsion of open TWBs without warp restraint, primary & secondary warping, St. Venant torsion constant. Uncoupled bending of open, closed, single cell, multi-cell TWBs - axial stress, shear flow, shear centre, displacement analysis. Torsion of open section TWBs with primary warp restraint - concept and theory of torsion bending, torsion bending constant, secondary warping restraint. Unsymmetric bending and coupled bending torsion analysis. Buckling of TWBs: Concept of structural instability, flexural buckling analysis, bending of beams under combined axial and lateral loads, short column and inelastic buckling. Pure torsional buckling and coupled flexural-torsional buckling of open TWBs. Introduction to the concept of buckling of plates, local buckling of TWBs. Introduction to buckling and post-buckling of stiffened skin panels, ultimate load carrying capacity of a typical semimonocoque TW box-section. Introduction to tension-field beams

4.2 Text/ref

1. Megson, T. H. G., Aircraft Structures for Engineering Students, Butterworth-Heinemann, 4th Ed., 2007.2. Peery, D. J., Aircraft Structures, McGraw-Hill Education, 1st Ed., 1950.3. Donaldson, B. K., Analysis of Aircraft Structures (Cambridge Aerospace Series), 2nd Ed., Cambridge University Press, 2008.4. Sun, C. T., Mechanics of Aircraft Structures, Wiley-Interscience, 1998.5. Bruhn, E. F., Analysis and Design of Flight Vehicle Structures, Jacobs Pub., 1973.6. Niu, M., Airframe Stress Analysis & Sizing, Adaso Adastra Engineering Center, 1998.7. Cutler, J. and Liber, J., Understanding Aircraft Structures, Wiley Blackwell, 4th Ed., 2006.

5 AE 240 - Spaceflight Mechanics

5.1 Description

Introduction: Space missions and role of launch vehicles and spacecraft, Historical Perspective. Ascent Mission: Ascent mission objectives, mathematical models governing ascent mission, rectilinear and gravity turn ascent trajectories, effect of aerodynamic drag and gravity on ascent mission performance. Multi-stage Launch Vehicles: Concept of multi-staging, staging solution sensitivity analysis, series and parallel staging configurations, optimal staging solutions. Launch Vehicle Attitude Motion: Short period attitude motion models, nature of attitude response to atmospheric disturbances. Basic Orbital Solution: Two-body Problem solution, Keppler's laws & equation, classical orbital elements, orbit determination from initial conditions, position and velocity prediction from orbital elements, different types of orbits, perturbation due to earth oblateness and solar radiation pressure, non-Keplerian formulation and restricted 3-body problem, sphere of activity & Roche' limit. Satellite Operations: Orbit raising manoeuvre, Hohmann and low thrust transfer manoeuvres, orbit inclination change maneuver, orbit perigee change manoeuvre, launch to orbit and docking manoeuvres, launch window concept. Spacecraft Motion: Interplanetary motion basics, departure and arrival solutions, planetary transfers, gravity assist trajectories. Descent Mission: Orbit decay solution, concept of re-entry mission, ballistic and other reentry mechanisms. Spacecraft Attitude Motion: Torque-free motion models, effect of energy dissipation on stability of rotational motion, overview of actuation mechanisms for attitude control.

5.2 LaTeXt/refrences

1. orbital mechanics for engineering students.
1. Cornelisse, J.W., Schoyer, H.F.R. and Wakker, K.F., 302221Rocket Propulsion and Spaceflight Dynamics302222, Pitman, London, 1979.2. Thompson, W. T., 302221Introduction to Space Dynamics302222, Dover Publications, New York, 1986.3. Pisacane, V.L. and Moore, R.C., 302221Fundamentals of Space Systems302222, Oxford University Press, 1994.4. Wiesel, W. E., 302221Spaceflight Dynamics302222, 2nd Ed., McGraw-Hill, 1997.5. Wie, B., 302221Space Vehicle Dynamics and Control302222, AIAA Education Series, 1998.6. Meyers, R.X., 302221Elements of Space Technology for Aerospace Engineers302222, Academic Press, 1999.

6 AE 242 - Aerospace Measurements Laboratory

7 MA 214 - Introduction to numerical methods

7.1 Description

Interpolation by polynomials, divided differences, error of the interpo-lating polynomial, piecewise linear and cubic spline interpolation.Numerical integration, composite rules, error formulae.Solution of a system of linear equations, implementation of Gaussianelimination and Gauss-seidel metho ds, partial pivoting, row echelonform, LU factorization Cholesky302222s metho d, ill-conditioning, norms.solution of a nonlinear equation, bisection and secant metho ds.Newton302222s metho d, rate of convergence, solution of a system of nonlin-ear equations, numerical solution of ordinary differential equations, Eu-ler and Runge-Kutta metho ds, multi-step metho ds, predictor-correctormetho ds, order of convergence, finite difference metho ds, numericalsolutions of elliptic, parabolic, and hyperbolic partial differential equa-tions.Eigenvalue problem, power metho d, QR metho d, Gershgorin302222s theo-rem.Exposure to software packages like IMSL subroutines, MATLAB.

7.2 LaTeXt/refrences

1. S. D. Conte and Carl de Bo or, Elementary Numerical Analysis- An Algorithmic Approach (3rd Edition), McGraw-Hill, 1980.2. C. E. Froberg, Introduction to Numerical Analysis (2nd Edition), Addison-Wesley, 1981.3. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999).

8 MA 214 - Introduction to numerical methods

8.1 Description

This course will provide a broad overview of Machine Learning with a stress on applications. Supervised learning: Decision trees, Nearest neighbor classifiers, Generative classifiers like naive Bayes, Support vector Machines Unsupervised learning: K-Means clustering, Hierarchical clustering, EM, Itemset mining Applications: image recognition, speech recognition, text and web data retrieval, bio-informatics, commercial data mining..

8.2 LaTeXt/refrences

Tom Mitchell, Machine Learning. McGraw-Hill, 1997. 302240302240302240 Pattern recognition and machine learning by Christopher Bishop, SPringer Verlag 2006 302240302240302240 Selected papers