Mechanical Engineering

Semester - I						
S.No	**C. Code**	**Course**	**L**	**T**	**P**	**C**
1	MA XXX	Linear Algebra: Theory and Numerics	3	0	0	6
2	-	Introduction to Mechanical Engineering	3	0	0	6
3	CS101C	Computer Programming	3	0	3	9
4	ME201T	Engineering Mechanics	3	0	0	6
5	-	Formal and Technical Communications	0	0	2	2
6	HS101T	Design thinking and Creativity	1	0	0	1
7	ME101L	Hands on Engineering Lab	0	0	3	3
8		CCA (NSO/NSS/NCA/NCC)	0	0	2	2
	First Semester Total Credits					**35**

Mechanical Engineering

1	**Title of the course** (L-T-P-C)	**Linear Algebra: Theory and Numerics** **2-1-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**System of linear equations:** Row operations, Gauss elimination method, Rank of a matrix, Pivots, Jacobi and Gauss-Seidel methods of iteration, Determinants, Rules for determinants. **Vector Spaces:** Vectors in Rn space, Linear independence and dependence of vectors, Basis and dimension of a vector space, Vector space and subspace of a vector space, Four Fundamental subspaces for a system of linear equations. Linear transformations, Matrix of a linear transformation, Change of basis and similarity, Rank-nullity theorem, Inner product spaces, QR decomposition, Gram-Schmidt process and Householder transformation, Orthonormal bases, Projections, Least squares approximation. **Eigenvalues and Eigenvectors:** Eigenvalues and eigenvectors, Characteristic polynomials, Eigenvalues of special matrices (orthogonal, unitary, Hermitian, symmetric, skew-symmetric, normal). Algebraic and geometric multiplicity. **Numerical Linear Algebra:** Matrix and vector norms, Ill conditioned problems, Floating point representation, Round-off error, Error propagation in computer arithmetic, Big O notation, Introduction to commonly used numeric computing platform (e.g. GNU Octave, MATLAB, MATHCAD, MATHEMATICA etc.), LU and LDU factorization, Cholesky method, Eigen value and Eigen vector computation by Power methods, Diagonalization of matrices, Similarity transform **Linear Algebra Applications:** Some practical examples e.g. Markov Matrices, Spectral theorem for real symmetric matrices, Singular Value Decomposition (SVD), Pseudo inverse, etc.
4	**Texts/References**	**Textbooks:** **1.** Gilbert Strang, Linear algebra and its applications (4th Edition), Thomson (2006). **References:** **1.** E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999). **2.** H. Anton, Elementary linear algebra with applications (8th Edition), John Wiley (1995). **3.** Gilbert Strang, Differential Equations and Linear Algebra (Wellesley Cambridge Press, 2014.

1	**Title of the course** (L-T-P-C)	**Introduction to Mechanical Engineering** **2-0-2-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**Module 1 : Overview** 1. Historical Perspectives of Mechanical Engineering, Mechanics, Mechanisms, Machines, Manufacturing, and Mechatronics. 2. Overview of Fluid-Thermal engineering: The thermal and fluids engineering stream deals with processes involving transfer of energy and motion of fluids, in both coupled and uncoupled manner. Since a significant section of mechanical engineering deals with generation of power, and almost the entirety of this power is generated by means of techniques that deal with transferring energy from some form to another form, thermal and fluid engineering plays a significant role. Besides the generation of power, most systems from mechanical engineering have to deal with either absorption or dissipation of heat, and with some or other form of fluids. Hence, the principles learnt in this stream are useful throughout the entire domain of mechanical engineering. 3. Overview of Design engineering: The design stream deals with the conceptualization of the machine that needs to be produced. The process begins with a thorough assessment of the need of such a machine. Once the necessities are clearly ascertained, the design process is initiated involving various methodologies of analysis, such as stress analysis, thermal analysis, analysis of the kinematics and dynamics of the machine including the transfer of motion and power, an analysis of manufacturability, etc. The analysis is conducted on both the machine as a composite unit as well as its components. Finally, the drawings of the manufacturable design are created and passed on to the engineers specializing in the manufacturing stream. 4. Overview of Manufacturing engineering: The manufacturing stream is involved with the manufacturing of components for the machines that were designed by the engineers specializing in the design stream. The process begins with identification of the proper raw materials, moves on to the choice of the machines that would be utilized for machining the components, and finally the machining process itself with its associated controls over dimensions and tolerances. Engineers in this stream are constantly attempting to innovate methodologies that allow production of the machines and their components with the best of quality, but also with least amounts of debris and the least possible cost. **Module 2:.** Introduction to Mechanical Engineering through sharing professional experiences and knowledge in a series of lectures for 7 weeks. Dialogues with leading industry personnels with mechanical/aerospace and allied engineering background, scientists and researchers, departmental faculty members. **Module 3: Case studies** 1. Case study 1: Broadly scoped under “Design Engineering” with interdisciplinary concepts spanning across “Manufacturing and Mat.Sc.” and “Thermal Fluids Engineering” 2. Case study 2: Broadly scoped under “Manufacturing and Mat. Sc.”with interdisciplinary concepts spanning across “Design Engineering”and “Thermal Fluids Engineering”. 3. Case study 3: Broadly scoped under “Thermal-Fluids Engineering” with interdisciplinary concepts spanning across “Design Engineering” and “Manufacturing and Mat. Sc.”.

		Module 4: Hands on Component: Product Realization This module introduces the complete process chain of product design and realization using digital tools and rapid prototyping technologies (ex: 3D printing) Fundamentals of 3D parametric modelling to create both engineering and freeform geometries. Hands-on mini-project involving ideation, 3D modeling and fabrication using rapid prototyping technologies, culminating in a short presentation and demonstration of the final product.
4	**Texts/References**	1. An Introduction to Mechanical Engineering 4th Edition, J. Wickert, K. Lewis, Cengage Learning, 2015, ISBN: 978-1-30-563513-5. 2. A Brief History of Mechanical Engineering, 1st Edition, U.S. Dixit, M. Hazarika, J.P. Davim, Springer, 2016, ISBN: 978-3-31-942914-4. 3. Introduction to Mechanical Engineering: Part - 1, M. Clifford, CRC Press, 2009, ISBN: 978-0-34-093995-6. 4. Introduction to Mechanical Engineering: Part - 2, 2nd Edition, M. Clifford, CRC Press, 2024, ISBN: 978-1-04-002718-9.

1	**Title of the course** (L-T-P-C)	**Engineering Mechanics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**Module 1:** Introduction to Engineering Mechanics covering, Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy **Module 2:** Friction covering, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack; **Module 3:** Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines; **Module 4:** Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook; **Module 5:** Virtual Work and Energy Method- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium. **Module 6**: Particles dynamics- Kinematics of Particles: Rectilinear motion, Plane curvilinear motion - rectangular coordinates, normal and tangential coordinates, polar coordinates, Space curvilinear - cylindrical, spherical (coordinates), Relative and Constrained motion. Kinetics of Particles: Force, mass and acceleration – rectilinear and curvilinear motion, work and energy, impulse and momentum – linear and angular; Impact – Direct and Oblique. Kinetics of System of Particles: Generalized Newton's Second Law, Work-Energy, Impulse-Momentum, Conservation of Energy and Momentum **Module 7:** Introduction to Rigid body dynamics Kinematics of Planar Rigid Bodies: Equations for rotation of a rigid body about a fixed axis, General plane motion, Instantaneous Center of Rotation in Plane Motion Plane Motion of a Particle Relative to a Rotating Frame. Coriolis Acceleration Kinetics of Planar Rigid Bodies: Equations of Motion for a Rigid Body, Angular Momentum of a Rigid Body in Plane Motion, Plane Motion of a Rigid Body and D'Alembert's Principle, Systems of Rigid Bodies, Constrained Plane Motion; Energy and Work of Forces Acting on a Rigid Body, Kinetic Energy of a Rigid Body in Plane Motion, Systems of Rigid

		Bodies, Conservation of Energy, Plane Motion of a Rigid Body - Impulse and Momentum, Systems of Rigid Bodies, Conservation of Angular Momentum. **Module 8**: Mechanical Vibrations covering, Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums.
4	**Texts/References**	**Textbooks:** 1. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I – Statics, Vol II – Dynamics, 6th Ed, John Wiley, 2008. 2. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II – Dynamics, 9th Ed, Tata McGraw Hill, 2011. 3. R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press, 2006. **References:** 1. S. P. Timoshenko and D. H. Young, Engineering Mechanics. Fourth Edition. McGraw-Hill, New York, 1956. 2. I. H. Shames, Engineering Mechanics: Statics and dynamics, 4th Ed, PHI, 2002. 3. Robert W. Soutas-Little; Daniel J. Inman; Daniel Balint, Engineering Mechanics: Dynamics – Computational Edition, 1st Ed., Cengage Learning, 2007 4. Robert W. Soutas-Little; Daniel J. Inman; Daniel Balint, Engineering Mechanics: Statics-Computational Edition, 1st Ed., ,Cengage Learning, 2007

1	**Title of the course** (L-T-P-C)	**Hands on Engineering Lab (0-0-3-3)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**List of Experiments (Mechanical Workshop)** • To make a Square-fit from the given mid steel pieces (Fitting) • To make a V-fit from the given mid steel pieces (Fitting) • To make a rectangular tray as per required dimensions (Sheet Metal) • To build a transition piece (Sheet Metal) • To make a Butt joint using the given two M.S pieces (Arc welding) • To make a lap joint using the given two M.S pieces (Arc welding) • To build a pipe-line using fittings for given flow circuit (Plumbing) **List of Experiments (Electrical Workshop)** • To control one lamp by a one switch with provision for plug socket with switch control (Electrical wiring) • To do stair case wiring (i.e. control of one lamp by two switches fixed at two different places) (Electrical wiring) • Measurement of hot and cold resistance of filament • Improvement of Power Factor • Calibration of Energy meter • Measurement of Power using three ammeter/voltmeter method **List of Experiments (Electronics)** • Understanding breadboard, One-way traffic • Introduction to Arduino and Buzzer • Using Arduino speed measurement of motor/ glowing of LED • Control of water level using Arduino • Line follower using Arduino
4	**Texts/References**	Elements of Workshop Technology Vol. 1 (2015), S. K. Hajra Choudhary, A. K. Hajra Choudhary and Nirjhar Roy, Media Promoters and Publishers Pvt. Ltd. W. A. J. Chapman, Workshop Technology, Vol. 1 (2006), Vol 2 (2007), and (1995), CBS Publishers.

1	**Title of the course** (L-T-P-C)	**Computer Programming** **(3-0-3-9)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	This course provides an introduction to problem solving with computers using a modern language such as Java or C/C++. Topics covered will include: Utilization: Developer fundamentals such as editor, integrated programming environment, Unix shell, modules, libraries. Programming features: Machine representation, primitive types, arrays and records, objects, expressions, control statements, iteration, procedures, functions, and basic i/o. Applications: Sample problems in engineering, science, text processing, and numerical methods.
4	**Texts/References**	**1.** An Introduction to Programming through C++, 1st edition, by Abhiram G. Ranade, McGraw Hill Education, 2014. **2.** C++ Program Design: An introduction to Programming and Object-Oriented Design, 3rd Edition, by Cohoon andDavidson, Tata McGraw Hill, 2003. **Other references** **1.** Thinking in C++ 2nd Edition, by Bruce Eckel (available online). **2.** How to Solve It by Computer, by G. Dromey, Prentice-Hall, Inc., Upper Saddle River, NJ, 1982. **3.** How to Solve _It (2nd ed.), by Polya, G., Doubleday and co, 1957. **4.** Let Us C, by Yashwant Kanetkar, Allied Publishers, 1998. **5.** The Java Tutorial, Sun Microsystems, Addison-Wesley, 1999.

1	**Title of the course** (L-T-P-C)	**Design thinking and Creativity** **(1-0-0-1)**
2	**Pre-requisite courses(s)**	**Nill**
3	**Course content**	**1.** Problem Exploration- Students move around and find problems that need solutions. **2.** They analyse the problem (not solution) and evolve a problem space. The problem space is converted into a story boar and presented in a poster session. **3.** Feedback at the poster session is used to refine the problem definition(s). **4.** Solution Exploration: Creative solutions (solution space) are now explored and presented using story boards. **5.** The solutions are converted into "embodiments".
4	**Texts/References**	**1.** "Stuff Matters" Prof. Mark Miodownik, Penguin **2.** "Design and Technology" by James Garratt,Cambridge University Press. **3.** How it works in the home: Walt Disney:9780894340482- Amazon.com. **4.** How it works in the city (Walt Disney available on Amazon.com) **5.** Change by design – Tim Brown There are some additional books in this "How it Works" series.

1	**Title of the course** (L-T-P-C)	**Formal and Technical Communications** **0-0-2-2**
2	**Pre-requisite courses(s)**	--
3	**Course content**	The course will include a brief overview followed by a period of hands-on activity on the following topics: 1. The types and the need for various forms of technical communication 2. Elements of reading comprehension, effective speaking, technical writing, and ethical considerations. 3. Using technical tools effectively: a. Word processing (e.g., MS Word, Google Docs, etc.) b. Presentation tools (e.g., MS PowerPoint, Google Slides, Beamer, etc.) c. Preparing visual aids: images, graphs, drawings, and tables d. Using language model-based applications 4. Verbal and written communications a. Formal letters b. Emails c. Interviews d. Understanding technical standards 5. Communication for curricular requirements: lab reports, assignments, project reports, etc. 6. Preparing technical reports and research papers 7. Formal presentation 8. Group communication
4	**Texts/References**	1. Meenakshi Raman and Sangeeta Sharma. Technical Communication: Principles and Practice. Oxford University Press, 2015. 2. Mike Markel; Stuart A. Selber. Technical Communication. Bedford Books, 2017. 3. S. D. Sharma. A Text Book of Scientific and Technical Communication Writing for Engineers and Professionals. Sarup and Sons, 2007. References: 1. Gopen, George D., and Judith A. Swan. The Science of Scientific Writing. American Scientist, vol. 78, no. 6, 1990, pp. 550–58. 2. Leslie C. Perelman, James Paradis, and Edward Barrett, The Mayfield Handbook of Technical and Scientific Writing, McGraw-Hill Education, 1997.