Courses of Study

B.Tech Robotics and Automation

Batch 2024 Onwards

2nd Semester

Department of Mechanical Engineering

Islamic University of Science and Technology Kashmir

Table of Contents

Detailed Course Contents for 2nd Semester

Total Credits = 20 *Total Hours Per Week = 23+1(S)*

Course Code	Course Title	L	T	P	S	Credits
MTH155C	Linear Algebra and Differential Equations	3	1	0	0	4
CSE160F	Programing for Problem Solving	3	0	2	0	4
ELE150C	Basic Electrical Engineering	3	0	2	0	4
CIV152C	Engineering Mechanics	3	0	0	0	3
ECE151C	Basic Electronic Devices	3	0	0	0	3
SS01A	Ethics and Social Responsibilities	1	0	0	0	0
MEC152C	Product Realisation through Manufacturing	0	0	2	1	2

MTH155C Linear Algebra and Differential Equations 3-1-0-0

Course Objectives: This course will enable students to understand the elementary notions of Fourier series, which is vital in practical harmonic analysis. The students will be exposed to the concept of eigenvalues and eigenvectors of matrices and the transform techniques to solve linear systems that arise in sciences and engineering. The course will also enrich the skills in solving initial and boundary value problems.

Course Outcomes: At the end of this course, a student will be able to:

1. Explain and apply the concept of vector spaces, subspaces, bases, dimension, and their properties.
2. Relate matrices and linear transformations, compute Eigenvalues and Eigenvectors of linear transformations.
3. Identify and apply the nature, formation, geometry, and solution of differential equations.
4. Apply the techniques to solve differential equations including series solution.
5. Employ the tools of Fourier series to find harmonics of periodic functions from the tabulated values.

Module I

Vector Spaces: Vector spaces over Q, R and C, subspaces, linear independence, linear span of a set of vectors, basis, and dimension of a vector space, sum and direct sum. Systems of linear (homogeneous and non-homogeneous) equations, matrices and Gauss elimination, elementary row operations, row space, column space, null space, and rank of a matrix.

Module II

Linear Mapping and Matrices: Linear transformation, rank-nullity theorem and its applications, matrix representation of a linear transformation, change of basis and similarity. Eigenvalues and eigenvectors, characteristic and minimal polynomials, Cayley-Hamilton theorem (without proof) and applications.

Module III

Ordinary Differential Equations I: Review of first order differential equations, Picard's theorem, linear dependence and Wronskian. Dimensionality of space of solutions, linear ODE with constant coefficients of second and higher order, Cauchy-Euler equations.

Module IV

Differential Equations II: Simultaneous differential equations. System of linear differential equations with constant coefficients, fundamental matrix, matrix methods.

Module V

Power Series and Fourier Analysis: Power Series and its convergence, power series method, Fourier series - Euler's formulae - Dirichlet's conditions - Change of interval - Half range series – RMS value – Parseval's identity – Computation of harmonics.

Text Books:

1. E. Kreyszig, Advanced Engineering Mathematics, 10th Edition, 2015, John Wiley, India.
2. M. D. Greenberg, Advanced Engineering Mathematics, 2nd Edition, 2006 Pearson.

Reference Books:

1. B. S. Grewal, Higher Engineering Mathematics, 43rd Edition, 2015 Khanna Publishers, India,

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Online Resources:

1. Ordinary Differential Equations and Applications by A. K. Nandakumaran, P. S. Datti & Raju K. George, (IISc Bangalore), NPTEL Course (https://www.digimat.in/nptel/courses/video/111108081/L01.html).
2. Linear Algebra by Dr. K.C. Sivakumar, Department of Mathematics (IIT Madras), NPTEL Course (https://nptel.ac.in/courses/111106051).

CSE160F Programming for Problem Solving 3-0-2-0

Course Objectives: The objective of this course is to introduce the concept of problem-solving strategies for simple problems with the fundamental syntax and semantics of the C language. The course will also enable students to use various data types and control structures in C programming.

Course Outcomes: At the end of this course, a student will be able to:

1. Design and implement algorithms and flowchart for simple problems.
2. Use syntax and semantics in C programming.
3. Define and describe C programming concepts like data types, control structures.
4. Use modular approach for problem solving using functions
5. Store and retrieve data from complex data types and files.

Module I

Introduction to Problem Solving: Introduction to problem solving, flowcharts, algorithms, the compilation process, features of C language, structure of C program, data types, constants and variables. arithmetic, relational and logical operators, type conversion, increment and decrement operators, bitwise operator, assignment operator and expressions, conditional expressions, precedence and associativity, I/O functions, basic C program examples.

Module II

Control Structures and Arrays: Introduction to conditional branching. iterative loops, arranging things: arrays, 2-D arrays, character arrays and strings.

Module III

Functions: Functions and parameters passing by value, recursion as a different way of solving problems, macros.

Module IV

Pointers: Idea of pointers, defining pointers, pointer and function argument (call by reference), pointer and array, pointer to functions, pointer to pointer, pointer to multi-dimensional array.

Module V

Structures and File Handling: Structures: defining structures and array of structures. unions, Storage classes: scope and extent, storage classes in a single source file: auto, extern, static & register. Use of pointers in self-referential structures, command line arguments, File handling.

List of Experiments

1. Familiarisation with the programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving conditional branching.
4. Iterative problems
5. 1D Array manipulation

6. Matrix problems,
7. String operations
8. Simple functions
9. Passing values in functions
10. Recursive functions
11. Pointers
12. Pointer and array
13. Pointer and function
14. structures
15. File operations

Text Books:

1. B. W. Kernighan and D. M. Ritchie, The C Programming Language, Prentice Hall of India.
2. B. Gottfried, Schaum's Outline of Programming with C, McGraw Hill Education India.

Reference Books:

1. A. Shaw, Learn C the hard way: Practical exercises on the computational subjects you keep avoiding (like C), Addison-Wesley Professional.
2. V. D. I. Peter, Expert C programming: deep C secrets. Prentice Hall Professional.

Online Resources:

1. Introduction to Programming in C NPTEL Course (IIT Kanpur) (https://archive.nptel.ac.in/courses/106/104/106104128/).
2. Online Compiler: (https://www.onlinegdb.com).

ELE150C Basic Electrical Engineering 3-0-2-0

Course Objectives: The objective of the course is to explain the fundamentals of AC and DC circuits and operative principle of transformer and electric machines with background of magnetic circuits. The course will also expose students to the working principle of electrical installation and protection equipment.

Course Outcomes: At the end of this course, a student will be able to:

1. Define the basic terminology/definitions of electrical engineering.
2. Solve the basic DC and AC electric circuits.
3. Apply the knowledge of theorems/laws to analyze the DC and AC electric networks.
4. Explain the working principles of magnetic circuits, transformers and electrical machines.
5. Design and implement the common electrical installation and protective equipment for a particular application.

Module I

DC Circuits analysis: Electrical circuit elements (R, L and C), voltage and current sources, Ohm's law, Kirchhoff's current and voltage laws, analysis of simple circuits with dc excitation, Mesh analysis and Nodal analysis, Superposition, Thevenin and Norton Theorems.

Module II

AC Circuit analysis and three phase circuits: Representation of sinusoidal waveforms, peak and RMS values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel). Three phase balanced circuits, voltage and current relations in star and delta connections.

Module III

Magnetism and Transformer operation: Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Module IV

Electrical Machines: Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, concept of slip, construction and working principle of a separately excited DC motor, construction and working of a synchronous generator..

Module V

Electrical Installations and types of batteries: Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries.

List of Experiments

1. Connection of Ammeters, voltmeters, Wattmeter and Multimeter in DC and AC circuits and selection of their ranges, Use of LCRQ meter.

2. Introduction to CRO, Discussion on front panel buttons and their uses.
3. To study the color coding of Resistors (4-band, 5-Band schemes), familiarization with Capacitors (Ceramic and Electrolytic, DC, AC), value calculation of ceramic caps and Inductors and their measurement using LCRQ meter.
4. Introduction to Breadboard and verify the KVL and KCL using discrete components on Breadboard.
5. To verify the Superposition theorem.
6. To measure single phase power by Wattmeter method.
7. Determination of voltage, current, power and power factor of series RLC circuit.
8. Demonstration of cut-out sections of machines: dc machine, three phase induction machine, single-phase induction machine and synchronous machine.
9. Demonstration of various commonly used electrical equipment such as fuses, MCB, Types of Wires and Types of Batteries etc.
10. Study of Light emitting diodes (common cathode/common anode), Monochromic, RGB and their Voltage current relationships.
11. Study of VI characteristics of PN junctions.
12. Study of BJT as a switch to drive a load (e.g LED, small DC Motor etc.)

Text Books:

1. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering, Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, Basic Electrical Engineering, McGraw Hill, 2009.
3. V. D. Toro, Electrical Engineering Fundamentals, Prentice Hall India, 1989.
4. L. Nashelsky and R Boylestad, Electronic Devices and Circuit Theory: Pearson New International Edition.

Reference Books:

1. E. Hughes, Electrical and Electronics Technology, Pearson, 2010.
2. C. K. Alexender, Mathew N. O. Sadiku, Fundamentals of Electric circuits, McGraw Hill,
3. J. E. Kemmerly William H. Hayt, Engineering Circuit Analysis,McGraw Hill, 2012.
4. L. S. Bobrow, Fundamentals of Electrical Engineering, Oxford University Press, 2011.
5. A. Chakrabarti, Circuit Theory, Dhanpat Rai Publications, 6th Edition, 2006.
6. V. N. Mittal and Arvind Mittal, Basic Electrical Engineering, McGraw Hill.

Online Resources:

1. Basic Electrical Technology by Prof. N.K. De, Prof. G. D. Roy, Prof. T. K. Bhattacharya (IIT Kharagpur), NPTEL Course (https://nptel.ac.in/courses/108105053).

CIV152C	Engineering Mechanics	3-0-0-0

Course Objectives: This course will enable students to have the knowledge of fundamental laws and basic concepts of rigid body mechanics to solve problems of bodies under rest or in motion. The students will also be able to apply conditions of static equilibrium to analyze physical systems and compute the properties of areas and bodies.

Course Outcomes: At the end of this course, a student will be able to:

1. Compute the resultant system of forces in plane and space acting on bodies.
2. Predict the support-reactions and the internal forces of the members of various trusses and Frames.
3. Apply transfer theorems to determine properties of various sections.
4. Analyse equilibrium of connected bodies virtual work method.
5. Apply the laws of dynamics to real life problems.

Module I

Statics: Fundamental concepts and laws of mechanics. Equilibrium of bodies: Free-body diagrams, conditions of equilibrium, torque due to a force, statical determinacy. Force systems: principle of moments, resultant of forces, couple systems, equilibrium of rigid bodies, Support reactions.

Module II

Properties of plane surfaces: Centroid of simple figures from first principle, centroid of composite sections; Area moment of Inertia, Moment of Inertia of plane sections from first principles, theorems of moment of inertia, moment of inertia of standard sections and composite sections.

Module III

Concept of stress and strain: Conditions of equilibrium, compatibility and stress strain relations. Stress‑strain diagrams, Modulus of elasticity, Poisson's ratio, Bulk modulus, Modulus of rigidity. Shear force and bending moment in beams; Structural analysis**:** Forces in members of a truss by method of joints and method of sections and principle of virtual work.

Module IV

Centre of Gravity and Moment of Inertia: Centre of gravity and its implications; Mass moment of inertia, Moment of inertia of Cylinder, Cone, Sphere, etc.

Module V

Fundamentals of Dynamics: Kinematics and Kinetics of particles in rectilinear and curvilinear motion; Kinematics and Kinetics of Rigid bodies, types of motion, instantaneous centre of rotation in plane motion, D'Alembert's principle and its applications in plane motion and connected bodies, Work Energy principle, Impulse-Momentum principle.

Text Books:

1. F. Beer, E. Johnston, D. Mazurek, P. Cornwell and B. Self. Vector Mechanics for Engineers: Statics and Dynamics, 10th Edition, McGraw-Companies, Inc., New York, 2013
2. Hibbeler, R.C., Engineering Mechanics: Statics and Dynamics, Prentice Hall(2012).

Reference Books:

1. R.C. Hibbeler and A. Gupta, Engineering Mechanics: Statics and Dynamics (11th Edition), Pearson Education Inc., Prentice Hall, 2010.
2. J. L. Meriam and L. G., Kraige Engineering Mechanics, Volume I - Statics, Volume II -Dynamics, 7th Edition, John Wiley & Sons, New York, 2012.

Online Resources:

1. Engineering Mechanics by Prof. K. Rames (IIT Madras), NPTEL Course (https://archive.nptel.ac.in/courses/112/106/112106286/).

ECE151C	Basic Electronic Devices	3-0-0-0

Course Objectives: The objective of this course is to provide the student with the fundamental skills to understand the basics of semiconductor electronics and components like diode, LED, transistor, FET etc.

Course Outcomes: At the end of this course, a student will be able to:

1. Define the concepts of the depletion region and minority carrier injection.
2. Explain how a diode works and the applications of diodes.
3. Explain the operation of the Zener diode and its applications.
4. Explain the formation of several devices by joining two different Semi-Conductor materials.
5. Explain the Construction and working of unipolar electronic devices.

Module I

Fundamentals of Semiconductor : Introduction to band theory in solids, Conduction and Valence band, concept of forbidden energy, Germanium and Silicon as semiconductors, Doping in Semiconductors(S.Cs), Types of doping, Conduction in Si and Ge (Extrinsic & Intrinsic), Majority and minority charge carriers in S.Cs, Concept of Energy Levels, Excitation and de-excitation and energy release phenomenon, Luminescence. carrier transport by drift and diffusion, carrier generation and recombination, Poisson and Continuity equation.

Module II

Semiconductor Junctions: Introduction to PN semiconductor junctions, construction, Band diagrams of PN junctions, Depletion region, Barrier potential, P-N junction under zero, Forward and reverse bias, built-in potential barrier, electric field and space charge width, junction capacitance, charge flow in a P-N junction, current-voltage relationship, minority carrier distribution, junction breakdown mechanisms, application of P-N junctions.

Module III

Special Semiconductor Junctions: Zener diode constructions and VI characteristics, LEDs Voltage and current relationships in LEDS, Seven segment display, Introduction to Solar Cell, VI characteristics of solar cell. metal-semiconductor junctions, ohmic contacts, Laser diode, photodiode, PIN diode.

Module IV

Bipolar Junction Devices: Bipolar Junction transistor, Construction, principle of operation, modes of operation, C.B,C.E,C.C configurations of BJT. Static IV characteristics in active and saturation modes, minority carrier distribution, emitter efficiency, Transistor action, BJT as a switch, BJT as current controlled current source, current gain, amplification due to BJT (C.B).

Module V

Unipolar Junction Devices: UJT, Construction and principle of operation. Field effect Transistors, JFET construction and working, p-channel/n-channel FET, VI characteristics. Introduction to MOSFET construction and working, MOSFET as a switch.

Text Books:

1. D. Neamen, Semiconductor Physics And Devices: Basic Principles, McGraw Hill Education India.
2. A. P. Malvino, D. J. Bates and P. E. Hoppe, Electronic Principles, McGraw Hills, 9th Edition.

Reference Books:

1. E. D. Gates, Introduction to Electronics, Delmar, Cengage Learning 6th Edition.
2. L. Nashelsky and R. Boylestad, Electronic Devices and Circuit Theory, Pearson New International Edition.

Online Resources:

1. Basic Electronics by Prof. M. B. Patil, Department of Electrical and Electronics Engineering, (IIT Bombay), NPTEL Course (https://nptel.ac.in/Courses/108101091).

SS01A Ethics and Social Responsibilities 1-0-0-0

Course Objectives: This course aims to foster a holistic understanding of ethics by introducing students to diverse worldviews, ethical theories, and practical applications. Through philosophical and scientific perspectives, students will develop a nuanced appreciation for ethical dilemmas. They will gain proficiency in major ethical theories and learn to apply them effectively in personal, social, and professional contexts, particularly in the field of engineering. The course will also emphasise the ethical responsibilities of engineers in addressing global issues and emerging technologies, equipping students with critical analytical skills for making ethically sound decisions in an ever-evolving ethical landscape.

Course Outcomes: Upon completing this course, students will have developed a well-rounded ethical perspective by examining philosophical and scientific worldviews. They will have attained a solid grasp of major ethical theories and the ability to adeptly apply them in personal, social, and professional situations. Additionally, students will be equipped to understand and address the ethical responsibilities inherent in engineering, particularly in the context of global challenges and emerging technologies, enabling them to make sound ethical decisions in diverse, real-world scenarios.

Module I
Worldview: An Introduction, Philosophical Perspective, Scientific Perspective, Science and Scientism

Module-II
Applied Ethics, Meaning and Introduction of Ethics, Overview of Key Ethical Theories (Utilitarianism, Deontology, Virtue Ethics, etc.), Personal & Social Ethics, Professional Ethics

Module-III
Ethical Considerations in Engineering, The Role of Engineers in Society, Environmental Ethics and Sustainable Engineering, Engineering and Global Issues (e.g., Climate Change, Resource Depletion), Ethical Considerations in Emerging Technologies (e.g., AI, Biotechnology)

Evaluation: Presentation cum Viva Voce

Suggested Readings:

1. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
2. India Wins Freedom - Maulana Abdul Kalam Azad.
3. Wings of Fire: Autobiography, A. P. J. Abdul Kalam.
4. Theology, and Ethics, Ted Peters, Science, London: Taylor and Francis, 2017.
5. The Alchemy of Happiness, Al-Ghazali. Translated by Claud Field.

MEC152C Product Realisation through Manufacturing 0-0-2-1

Course Objectives: The objective of the course is to expose students to the role of manufacturing processes in product realisation by endeavouring hands-on activities by undertaking manufacturing exercises and assembly activity in teams.

Course Outcomes: At the end of this course, a student will be able to:

1. Explain and select manufacturing processes for a particular product realisation task
2. Safely use various tools, instruments and machines for a particular product realisation task
3. Practise various trades including fitting, carpentry, machining and welding.
4. Apply skills acquired from C01, C02, and C03 in order to fabricate a prototype with societal applications.

Module I

Overview of Manufacturing Methods and Tools:

Manufacturing as a backbone of a developed economy, Subtractive manufacturing, conventional, CNC, additive manufacturing, forging and forging tools, metal casting, plastic moulding, glass cutting.

Module II

Introduction to workshop practices: Safety precautions, introduction of various shops trades used in engineering and technology viz., machining trade, sheet metal and spray-painting section, fitting and bench work section, welding section, smithy and forging section, carpentry and pattern making section, automobile section, electrical and electronics section, plastic moulding section etc.

Module III

Practicals in machine shop:

1. Demonstration of basic operations on the lathe machine, such as drilling, facing, turning, taper turning, step turning, knurling, chamfering etc.
2. Demonstration of basic measuring instruments.
3. To manufacture a job on the centre lathe as per given drawing
4. To perform additional operations such as grooving, drilling, knurling.
5. To manufacture a job on the CNC lathe and CNC milling trainers as per the given drawing

Module IV

Practicals in fitting shop and carpentry shop:

1. Demonstration of all basic hand tools/ measuring tools and equipment.
2. Demonstration of simple operations such as marking, punching, filing, sawing, scrapping, and drilling.
3. Demonstration and practice of different carpentry operations like planning, sawing and chiselling and joints.
4. Demonstration of pattern making tools and materials
5. To prepare a half lap cross joint.

Module V

Practicals in welding shop:

1. Demonstration of all basic tools and personal protective equipment.
2. To make a single-V butt joint of mild steel 80×50×8 mm.
3. To make a lap joint of mild steel 85×35×6 mm.

Social Component Module:

Fabrication of a prototype: This module includes fabrication of a prototype using the skills, knowledge and the tools and machines available in the workshop. The prototype should be developed by a team of students which has relevance to some societal problems. The developed prototype shall be submitted by the students at the end of the semester for evaluation.

Text Books:

1. S. K. H Choudhury, Elements of Workshop Technology, Media promoters and publishers private limited, Mumbai.
2. P. N. Rao, Manufacturing Technology, Vol. I and Vol. II, Tata McGraw Hill House, 2017.

Reference Books:

1. S. Kalpakjian and S. S. Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
2. P. Gowri, Hariharan and A. S. Babu, Manufacturing Technology – I, Pearson Education, 2008.
3. R. A. Lindberg, Processes and Materials of Manufacture, 4th edition, Prentice Hall India, 1998.

Online Resources: NA
