Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

SYLLABUS FOR BACHELOR OF TECHNOLOGY IN ROBOTICS

(Effective from academic session 2020-21)

Semester-V

Subject Code : PC-ROB501	**Category:** Professional Core Courses
Subject Name : Design of Machine Elements	**Semester** : Fifth
L-T-P : 3-1-3	**Credit: 3**
Pre-Requisites: Strength of materials, Machine Drawing	

Course Objectives:

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice, through

1. A strong background in mechanics of materials based failure criteria underpinning the safety-critical design of machine components
2. An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations
3. An overview of codes, standards and design guidelines for different elements
4. An appreciation of parameter optimization and design iteration
5. An appreciation of the relationships between component level design and overall machine system design and performance

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Objective and scope of Mechanical Engineering Design; Design considerations; Review and selection of materials and manufacturing processes; codes and standards;	4
2	Modes of failure; Design/allowable stress; Factor of safety (FoS); Theories of failure – maximum normal stress theory, maximum shear stress theory, Distortion energy theory. Choice of Failure criteria; Design for stability: buckling analysis – Johnson and Euler columns	4
3	Fatigue in metals; S-N curve; Endurance limit and fatigue strength; Stress concentration factors – effect of discontinuity, fillets and notches; Effect of size, surface finish, stress concentration and degree of reliability on endurance limit; Design for finite and infinite life; Goodman, modified Goodman and Soderberg diagrams with respect to fatigue failure under variable stresses; Cumulative fatigue damage – Miner's equation.	5
4	Design of (i) Cotter joint; (ii) Knuckle joint and (iii) Fillet Welded joint of brackets under different types of loading.	6
5	Bolted joints: Metric thread, standard sizes, use of lock nuts and washers; Applications in structures including brackets, turn buckle; Pre-stressed bolts; Riveted joints: Unwin's formula; Brief discussion on single, double and triple row lap joints, butt joints with single or double strap / cover plate; simple strength design; joint efficiencies.	6

6	Design of : (i) Solid and hollow shafts, strength design of shafts, design based on torsional rigidity; (ii) Shaft coupling-rigid, pin-bush and geared flexible type, alignment of coupling; **(iii)** Belt drives-geometrical relations, derivation of torque and power transmission by flat and V-belt drives, selection of belt from manufacturers' catalogues, pulley (iv) Chain drives – roller chains, polygonal effect, power rating, sprocket wheel, silent chain	10
7	Design of: (i) Transmission screw, Screw jack, (ii) Helical compression spring - stress and deflection equations, stiffness, curvature effect : Wahl's factor, springs in parallel and series; (iii) Multi-leaf springs : load-stress and load-deflection equations, Nipping	8
8	Analysis and design of sliding and rolling contact bearings, Design of transmission elements: spur, helical, bevel and worm gears; Analysis of clutches and brakes	5

Course Outcomes:

Upon completion of this course, students will get an overview of the design methodologies employed for the design of various machine components.

Learning Resources:

1. J.E. Shigley and C.R. Mischke, Mechanical Engineering Design, 5th Edition, McGraw Hill International, 1989.
2. D. Deutschman, W.J. Michels and C.E. Wilson, Machine Design Theory and Practice, Macmillan, 1992.
3. R.C. Juvinal, Fundamentals of Machine Component Design, John Wiley, 1994.
4. M.F. Spottes, Design of Machine elements, Prentice-Hall India, 1994.
5. R. L. Norton, Mechanical Design– An Integrated Approach, Prentice Hall, 1998.
6. V. B. Bhandari, Design of Machine Elements by, McGraw Hill Publishing Co. Ltd., 2007.
7. P. Kannaiah, Machine Design, 2nd Edition, Scitech Publications.

Subject Code : PC-EE501	**Category:** Professional Core Courses
Subject Name : Power Electronics	**Semester** : Fifth
L-T-P : **3-1-2**	**Credit: 3**
Pre-Requisites: Basic Electronics	

Objective:

1. To understand the functioning and characteristics of power switching devices.
2. To understand the principle of operation of converters.
3. To understand different triggering circuits and techniques of commutation of SCR
4. To find external performance parameter of converters.
5. To analyze methods of voltage control, improvement of power factor and reduction of harmonics of the converter

6. To solve numerical problems of converters

Unit	Content	Hrs
1	**Introduction:** Concept of power electronics, application of power electronics, uncontrolled converters,advantages and disadvantages of power electronics converters, power electronics systems,power diodes, power transistors, power MOSFETS, IGBT and GTO.	04
2	**PNPN devices:** Thyristors, brief description of members of Thyristor family with symbol, V-Icharacteristics and applications. Two transistor model of SCR, SCR turn on methods,switching characteristics, gate characteristics, ratings, SCR protection, series and paralleloperation, gate triggering circuits, different commutation techniques of SCR.	05
3	**Phase controlled converters:** Principle of operation of single phase and three phase half wave, half controlled, full controlled converters with R, R-L and RLE loads, effects of freewheeling diodes and source inductance on the performance of converters. External performance parameters of converters, techniques of power factor improvement, single phase and three phase dual converters	06
	DC-DC converters: Principle of operation, control strategies, step up choppers, types of choppers circuits based on quadrant of operation, performance parameters, multiphase choppers.	5
5	**Inverters:** Definition, classification of inverters based on nature of input source, wave shape of output voltage, method of commutation & connections. Principle of operation of single phase and three phase bridge inverter with R and R-L loads, performance parameters of inverters, methods of voltage control and harmonic reduction of inverters.	10
6	**Resonant Pulse Converters:** Introduction, Series Resonant inverter, Parallel Resonant inverter, Zero-Current Switching Resonant converters, Zero-Voltage Switching Resonant converter, Two quadrant Zero-Voltage Switching Resonant converter, Resonant DC link inverter.	05
7	**Applications:** Speed control of AC and DC motors. HVDC transmission. Static circuit breaker, UPS,static VAR controller.	05

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Subject Code : PC-ROB502	**Category:** Professional Core Courses
Subject Name : Kinematics and Theory of Machines	**Semester** : Fifth
L-T-P : 3-1-0	**Credit: 3**
Pre-Requisites: Engineering Mechanics	

Course Objectives:

1. To understand the kinematics and rigid- body dynamics of kinematically driven machine components
2. To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link
3. To be able to design some linkage mechanisms and cam systems to generate specified output motion
4. To understand the kinematics of gear trains

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains. Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms.	6
2	Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics- Coincident points- Coriolis's component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation.	7
3	Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers.	5
4	Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion	6

	gears, epicyclic and regular gear train kinematics**.**	
5	Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication, Friction clutches- Belt and Rope drives- Friction in brakes.	6
6	Vibrations– Free and forced vibration of undamped and damped Single DOF systems, Resonance, Transmissibility Ratio, Effect of damping, Vibration Isolation, Critical Speed of Shafts.	6
7	Balancing of Reciprocating and Rotating Masses- Static balancing, Unbalance of force or moment, Dynamic balancing of rotating masses- graphical and analytical methods; Swaying couple; Hammer blow.	4
8	Governors- Use and classification; Study and analysis of Porter, Proell and Wilson-Hartnell governors; Sensitiveness, stability, isochronism, hunting, effort and power of governors.	3
9	Flywheel- Inertia force and inertia torque in reciprocating engine, correction couple (torque), Turning moment diagram and flywheel design.	3
10	Gyroscope- Gyroscopic couple and precessional motion, Effect of gyroscopic couple on aeroplane and ship, Stability of two wheel and four wheel vehicles taking turn.	2

Course Outcomes:
After completing this course, the students can design various types of linkage mechanisms for obtaining specific motion and analyze them for optimal functioning

Learning Resources:

1. T. Bevan, Theory of Machines, 3rd Edition, CBS Publishers & Distributors, 2005.
2. A. Shariff, Theory of Machines, Dhanpat Rai Publication, New Delhi, 2000.
3. W.L. Cleghorn, Mechanisms of Machines, Oxford University Press, 2005.
4. R.L. Norton, Kinematics and Dynamics of Machinery, 1st Edition, McGraw Hill India, 2010.
5. A. Ghosh and A.K. Mallick, Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd., New Delhi, 1988.

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN ROBOTICS

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Subject Code : HM-HU501	**Category:** Humanities and Social Sciences
Subject Name: Humanities I (Effective Technical Communication)	**Semester** : Fifth
L-T-P : 3-0-0	**Credit: 2**
Pre-Requisites: Basic English	

Course Objectives:

The course aims to teach students the principles of technical communication for their academic and professional needs, focusing on essential written and oral skills for presenting technical information effectively.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Information Design and Development- Different kinds of technical documents, Information development life cycle, Organization structures, factors affecting information and document design, Strategies for organization, Information design and writing for print and for online media.	7
2	Technical Writing, Grammar and Editing- Technical writing process, forms of discourse, writing drafts and revising, Collaborative writing, creating indexes, technical writing style and language. Basics of grammar, study of advanced grammar, editing strategies to achieve appropriate technical style. Introduction to advanced technical communication, Usability, Hunan factors, Managing technical communication projects, time estimation, Single sourcing, Localization.	8
3	Self-Development and Assessment- Self assessment, Awareness, Perception and Attitudes, Values and belief, Personal goal setting, career planning, Self-esteem. Managing Time; Personal memory, Rapid reading, Taking notes; Complex problem solving; Creativity	6
4	Communication and Technical Writing- Public speaking, Group discussion, Oral; presentation, Interviews, Graphic presentation, Presentation aids, Personality Development. Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, memos, progress reports, minutes of meetings, event report.	8
5	Ethics- Business ethics, Etiquettes in social and office settings, Email etiquettes, Telephone Etiquettes, Engineering ethics, Managing time, Role and responsibility of engineer, Work culture in jobs, Personal memory, Rapid reading, Taking notes, Complex problem solving, Creativity.	7

Course Outcomes:

After completing this course, the students will be able to

1. Understand the dynamics of Verbal and Non Verbal aspects of technical communication
2. Practice multi-step writing process to plan, draft, and revise reports, correspondence, and presentations.
3. Illustrate and examine the knowledge of ethical aspects of engineering
4. Demonstrate and explain social and professional etiquettes
5. Plan self-development and practice self-assessment to function on multi-disciplinary teams.

Learning Resources:

1. D.F. Beer and D. McMurrey, Guide to Writing as an Engineer, John Willey, New York, 2004
2. D. Hacker, Pocket Style Manual, Bedford Publication, New York, 2003.
3. S. Khera, You Can Win, Macmillan Books, New York, 2003.
4. R. Sharma, Technical Communications, Oxford Publication, London, 2004.
5. D. Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004.
6. R. Sharma and K. Mohan, Business Correspondence and Report Writing, 5th Edition, McGraw Hill Education, 2017.
7. Xebec, Presentation Book, McGraw Hill Education India, New Delhi, 2000.

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Subject Code : MC501	**Category:** Mandatory Courses
Subject Name : Essence of Indian Knowledge Tradition	**Semester** : Fifth
L-T-P : 0-2-0	**Credit: 0**
Pre-Requisites: Nil	

Course Objectives:

To facilitate students with the concepts of Indian traditional knowledge and to make them understand the importance of the root of knowledge system.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge	5
2	Protection of traditional knowledge (TK): the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.	4
3	Legal frame work and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); B: The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003.	5
4	Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.	5

5	Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.	5

Course Outcomes:
After completion of the course, students will be able to:
1. Understand the concept of Traditional knowledge and its importance
2. Know the need and importance of protecting traditional knowledge.
3. Know the various enactments related to the protection of traditional knowledge.
4. Understand the concepts of Intellectual property to protect the traditional knowledge.

Learning Resources:
1. A. Jha, Traditional Knowledge System in India, 2009.
2. B.K. Mohanta and V.K. Singh, Traditional Knowledge System and Technology in India, Pratibha Prakashan, 2012.
3. K. Kapoor and M. Danino, Knowledge Traditions and Practices of India, Central Board of Secondary Education, 2012.
4. E-Resources: http://nptel.ac.in/courses/121106003/

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Subject Code : PC-ECE501	**Category:** Professional Core Courses
Subject Name : Microprocessor & Microcontroller	**Semester** : Fifth
L-T-P : 3-1-3	**Credit: 3**
Pre-Requisites: Nil	

Course Objective: •

1. To introduce students with the architecture and operation of typical microprocessors and microcontrollers.
2. To familiarize the students with the programming and interfacing of microprocessors and microcontrollers.
3. To provide strong foundation for designing real world applications using microprocessors and microcontrollers.

Module No.	Description of Topic	Contact Hrs.
1	Microprocessors 8085 and 8086- Pin description, memory, data structure/ access. Overview of microcomputer systems and their building blocks, memory interfacing, concepts of interrupts and Direct Memory Access (DMA), instruction sets of microprocessors (with examples of 8086 and 8088	10
2	Interfacing with peripherals- timer, serial I / O, parallel I / O, A/D and D/A converters; Arithmetic coprocessors, System level interfacing design.	8
3	Concepts of virtual memory, Cache memory; Advanced coprocessor architectures- 286, 486, Pentium; Microcontrollers 8051 systems- pin and port description.	6
4	Introduction to RISC processors; ARM microcontrollers interface design	6

Text/Reference Books:

1. R. S. Gaonkar, Microprocessor Architecture: Programming and Applications with the 8085/8080A, Penram International Publishing, 1996
2. D A Patterson and J H Hennessy, "Computer Organization and Design The hardware and software interface. Morgan Kaufman Publishers.
3. Douglas Hall, Microprocessors Interfacing, Tata McGraw Hill, 1991.
4. Kenneth J. Ayala, The 8051 Microcontroller, Penram International Publishing, 1996.
5. Keneth Ayala, keneth. J. Ayala- The 8086 Microprocessor: Programming and interfacing the PCWest Pub.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Do assembly language programming
2. Do interfacing design of peripherals like, I/O, A/D, D/A, timer etc.
3. Develop systems using different microcontrollers
4. Understand RSIC processors and design ARM microcontroller based systems

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Subject Code : PC-ROB591	**Category:** Professional Core courses
Subject Name : Robotics Laboratory III- Practice of Manufacturing Processes and Systems Laboratory	**Semester** : Fifth
L-T-P : **0-0-3**	**Credit:1.5**
Pre-Requisites: No prerequisite	

List of Experiments:

It should include about 12 experiments as outlined below:

1. Measurement of surface roughness
2. Measurement of tapered objects using Sine Bar and using balls and rollers, etc.
3. Measurement of threads using three wire method
4. Measurement of gears
5. Measurement of bore diameter using micrometer and gauges
6. Measurement of angles using bevel Vernier protractor
7. Practicing different gauges to assess angles, thread, internal and external radius, etc.
8. Determination of velocity ratios of simple, compound, epicyclic and differential gear trains
9. Studying kinematics of four bar, slider crank, crank rocker, double crank, double rocker and oscillating cylinder mechanisms
10. Studying kinematics of typical mechanisms like pantograph, some straight line motion mechanisms, wiper, drafter, etc.
11. Motion studies of different cams & followers
12. Single degree of freedom Spring-mass-damper system: determination of natural frequency and damping coefficient
13. Determination of torsional natural frequency of single and double rotor systems- undamped and damped natural frequencies
14. Studying machine vibration using sensor
15. Solving simple balancing problems experimentally

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Subject Code: PC-ROB592	**Category:** Professional Core Courses
Subject Name: Machine Drawing II	**Semester**: Fifth
L-T-P: **0-0-3**	**Credit: 1.5**
Pre-Requisites: Engineering Drawing	

Course Objectives:

Student will get methodically and well thought out presentation that covers fundamental issues common to almost all areas of machine drawing.

1. Students have an ability to apply knowledge of Modeling, science & engineering.
2. Student can model this drawing even in CAD/CAM software by applying the basic knowledge of machine drawing.
3. Students will able to demonstrate an ability to design and conduct experiments, analyze and interpret data and assembly and disassembly drawings knowledge will be provided.

The contents should include about 10 assignments with the focus given as outlined below:

UNIT - I Projection and Isometric Drawing of Machine components

Fasteners: Drawings of various views of Screw threads, metric and BSW threads, Square thread and multi start threads. Nut bolts, Washers, Setscrew, Locknuts and foundation bolts. Riveted joints: Forms and proportions of river heads, Different views of different types of riveted Lap and Butt joints.

Drawings of various views of Shaft joints: Cotter joint and Knuckle joint. Keys & Shaft coupling: Muff, Flanged, Flexible, Universal and Oldham's coupling.

UNIT - II Assignments using graphic software

Assembly and detailed drawings: Tool head of a shaping machine; Engine parts: Eccentric, Piston, Cross head and Connecting rod; Valves: Steam stop valve, Anyone of safety, relief and non-return valves; Solid modeling of Plummer block

Course Outcomes:

1. Understand and apply the knowledge of machine drawing as a system of Communication in which ideas are expressed clearly and all information fully conveyed.
2. To understand the design a system, component or process to meet desired needs within, realistic constraints such as manufacturability, economic, environmental, safety & sustainability etc., to represent a part drawing and assembly drawings.
3. To identify, formulates, analyzes and solve Engineering Problems in Optimum time.

Learning Resources:

1. N.D.Bhatt, Machine Drawing, 46th Edition, Charotar Publishing House, India, 2011.
2. P.S. Gill, Machine Drawing, 18th Edition, S.K. Kataria & Sons, Delhi, 2013.
3. T. Jones, Machine Drawing, John Heywood Ltd, Manchester, UK, 2012.

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Subject Code : PC-ROB593	**Category:** Professional Core Courses
Subject Name : Microprocessor & Microcontroller Lab	**Semester** : Fifth
L-T-P : 0-0-3	**Credit: 1**
Pre-Requisites: Nil	

List of Experiments:

1. Familiarization with 8085 & 8051simulator on PC.
2. Study of prewritten programs using basic instruction set (data transfer, Load/Store, Arithmetic, Logical) on the KIT. Assignments based on above
3. **Programming using kit and simulator for:**
   i) Table look up
   ii) Copying a block of memory
   iii) Shifting a block of memory
   iv) Packing and unpacking of BCD numbers
   v) Addition of BCD numbers
   vi) Binary to ASCII conversion
   vii) String Matching, Multiplication using shift and add method and Booth's Algorithm
4. Program using subroutine calls and IN/OUT instructions using 8255 PPI on the trainer kit e.g. subroutine for delay, reading switch state and glowing LEDs accordingly.
5. Study of timing diagram of an instruction on oscilloscope.
6. Interfacing of 8255: Keyboard and Multi-Digit Display with multiplexing using 8255
7. Study of 8051 Micro controller kit and writing programs as mentioned in S/L3. Write programs to interface of Keyboard, DAC and ADC using the kit.
8. Serial communication between two trainer kits

Subject Code : PC-EE591	**Category:** Professional Core Courses
Subject Name : Power Electronics Lab	**Semester** : Fifth
L-T-P : 0-0-2	**Credit: 1**
Pre-Requisites: Nil	

Laboratory Experiments:

1. Study of the characteristics of an SCR.
2. Study of the characteristics of a Triac
3. Study of different triggering circuits of an SCR
4. Study of firing circuits suitable for triggering SCR in a single phase full controlled bridge.
5. Study of the operation of a single phase full controlled bridge converter with R and R-L load.
6. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converters.
7. Study of performance of step down chopper with R and R-L load.
8. Study of performance of single phase controlled converter with and without source inductance (simulation)

9. Study of performance of step up and step down chopper with MOSFET, IGBT and GTO as switch (simulation)
10. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converter.(simulation)
11. Study of performance of three phase controlled converter with R & R-L load. (simulation)
12. Study of performance of PWM bridge inverter using MOSFET as switch with R and R-L load.
13. Study of Zero Voltage Switching Resonant converter and Zero Current Switching Resonant Converter and to plot its output waveforms.
14. Study the speed control of universal motor to plot speed v/s α

Reference book:

1. Power Electronics Laboratory: Theory, Practice and Organization, O.P.Arora, Om Prakash Arora, Alpha science International.

Course outcome: After completion of this course, the learners will be able to

1. Identify appropriate equipment and instruments for the experiment.
2. Test the instrument for application to the experiment.
3. Construct circuits with appropriate instruments and safety precautions. Validate characteristics of scr, triac, and performance of phase controlled converter, dc-dc converter, inverters and resonant pulse converters.
4. Demonstrate the relation between the speed and firing angle of universal motor. work effectively in a team

Subject Code : PW-ROB581	**Category:** Project (Summer internship)
Subject Name : Project-I	**Semester** : Fifth
L-T-P : 0-0-2	**Credit: 1**
Pre-Requisites: Nil	

Course Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Course Outcomes:

Students will be able to gather some exposure on some projects, may be designing some innovative ideas, fabricating and/or demonstrating an innovative machine or product, etc.