Puducherry Technological University
Puducherry – 605014

(A Technological University of Government of Puducherry)

Curriculum and Syllabi
for
B.Tech. (Mechatronics)

(Effective from Academic year 2024-25)

(Approved in the Sixth Academic Council meeting held on 17th April 2025)

Vision and Mission of the Institution

Vision:

- To foster prosperity through technology by means of education, innovation and collaborative research and emerge as a world-class technical institution.

Mission:

- To create and disseminate knowledge for the betterment of mankind in general and rural masses in particular
- To impart high quality training to students so as to provide human resource appropriate to the local and national needs.
- To establish Centers of Excellence in collaboration with industries, research laboratories and other agencies to meet the changing needs of the society.

Department Vision and Mission

Vision:

- To produce dynamic, vibrant, demand driven and quality conscious human resource through consistent and sustained development ensuring highest standards of technological ethics.

Mission:

- Strengthening the department to produce high quality engineers.
- Scaling of education, research and development.
- Evincing expertise through centers of excellence in focused areas of Mechatronics.

CURRICULUM

The Curriculum of B.Tech.. (Mechatronics) is designed to fulfill the Program Educational Objectives (PEO) and the Program Outcomes (PO) listed below.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO1	The Mechatronics programme will prepare graduates to synergistically integrate mechanical engineering with electronic and intelligent computer control in the design and manufacture of industrial products and processes (Fundamentals).
PEO2	The programme will prepare graduates with strong team skills to solve multi-disciplinary problems using Mechatronics approach (Employability).
PEO3	To encourage a majority of our graduates to pursue advanced studies in thrust areas of Mechatronics and to carry out scientific, industrial and defense research and development so as to meet/satisfy current requirements in respective sectors (Higher Studies).
PEO4	To prepare our graduates to improve their self-reliant capabilities, soft skills, leadership qualities which would help in building their own careers and make them become successful entrepreneurs to serve the nation and the society responsibly and ethically (Entrepreneurship).
PEO5	To familiarize our graduates with international and national codes and standards for good engineering practice in core and interdisciplinary fields and to help them evolve sustainable development in technological sphere with greater emphasis on mitigation of environmental impact (Professional Ethics).

PROGRAM OUTCOMES (PO)

PO1	**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	**Problem Analysis**: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid Conclusions.
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.
PO6	**The Engineer and the World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7	**Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.
PO8	**Individual and Collaborative Team Work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	**Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	**Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1	Graduates are able to analyse, design and develop mechatronics systems to solve complex engineering problems by integrating mechanical, electronic and control systems.
PSO2	Graduates are initiated to work on Innovative Ideas that will eventually motivate them to pursue Higher Studies and Research in the areas of Mechatronics and multi-disciplinary ancillary stream courses.

Distribution of credits among the subjects grouped under various categories:

Courses are grouped under various categories and the credits to be earned in each category of courses are as follows:

Sl. No.	Category	Credits	Course Category Code (CCC)
1	Basic science courses	**20**	BSC
2	Engineering science courses	**13.5**	ESC
3	Professional core courses	**86.5**	PCC
4	Professional elective courses	**12**	PEC
5	Ancillary Stream Courses	**12**	ANC
6	Ability enhancement courses	**10**	AEC
7	Skill enhancement courses	**6**	SEC
8	Value added courses	**4**	VAC
	Total	**164**	

Semester-wise Courses and Credits

CCC - Course Category Code, **SET** – Semester Exam Type, **TY** – Theory, **LB** – Laboratory, **PR** – Project

Semester I

Course Code	Course	CCC	Periods			Credits
			L	T	P	
	3 weeks compulsory Induction Program					
MAUC101	Mathematics I	BSC	3	1	-	4
MTUC101	Basics of Mechatronics	PCC	3	1	-	4
PHUC101	Physics	BSC	3	-	-	3
MEUC101	Engineering Graphics	ESC	1	-	4	3
HSUA101	English for Communication	AEC	2	-	-	2
GEUS101	Basic Engineering Skills Laboratory - I	SEC	1	-	4	3
GEUV101	NSS, Yoga and Health	VAC	-	-	2	1
PHUC102	Physics Laboratory	BSC	-	-	2	1
Total			13	2	12	
			27			21

Semester II

Course Code	Course	CCC*	Periods			Credits
			L	T	P	
MAUC102	Mathematics II	BSC	3	1	-	4
MTUC102	Basics of Sensors and Measurements	PCC	3	1	-	4
CYUC101	Chemistry	BSC	3	-	-	3
CSUC101	Programming for Problem Solving	ESC	2	-	-	2
HSUA101	Professional English	AEC	2	-	-	2
GEUS102	Basic Engineering Skills Laboratory - II	SEC	1	-	4	3
GEUV102	Essence of Indian Traditional Knowledge	VAC	1	-	-	1
CYUC102	Chemistry Laboratory	BSC	-	-	2	1
CSUC102	Computer Programming Laboratory	ESC	-	-	2	1
Total			15	2	8	
			25			21

Exit Option for the students who opt to exit after completion of first year of B. Tech Programme and have secured **a minimum of 42 credits will be awarded a *UG certificate* in a discipline** if, in addition they complete one vocational course of **4 credits during the summer vacation of the first year.**

Semester III

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MAUC104	Transforms and Partial Differential Equations	BSC	3	1	-	4
MTUC103	Manufacturing processes	PCC	3	-	-	3
MTUC104	Hydraulic and Pneumatic systems	PCC	3	-	-	3
MTUC105	Analog and Digital Electronics	PCC	3	-	-	3
HSUA103	Entrepreneurship	AEC	2	-	-	2
GEUV103	Environmental Education	VAC	1	-	-	1
MTUC106	Manufacturing processes Laboratory	PCC	-	-	3	1.5
MTUC107	Hydraulic and Pneumatic Systems Laboratory	PCC	-	-	3	1.5
MTUC108	Analog and Digital Electronics Laboratory	PCC	-	-	3	1.5
Total			15	1	9	-
			25			20.5

Semester IV

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MTUC109	Industrial Automation	PCC	4	-	-	4
MTUC110	Drone Technology and design	PCC	4	-	-	4
CSUC137	Data Structures and Object-Oriented Programming	ESC	3	-	-	3
MTUC111	Micro controller and Embedded system	PCC	3	-	-	3
HSUA104/ HSUA106	Design Thinking / Foreign Language-French	AEC	2	-	-	2
GEUV104	Universal Human Values	VAC	1	-	-	1
MTUC112	Industrial Automation Laboratory	PCC	-	-	3	1.5
MTUC113	Micro controller and Embedded system Laboratory	PCC	-	-	3	1.5
CSUC138	Data Structures and Object-Oriented Programming Laboratory	ESC	-	-	3	1.5
Total			15	2	4	**-**
			28			**21.5**

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MTUNXXX	Ancillary Stream Course –I	ANC	3	-	-	3
MTUH101	MEMS & NEMS	HNC	3	1	-	4

Exit option for the students who opt to exit after completion of II year of B. Tech Programme and have secured a **minimum of 87 credits will be awarded *UG Diploma* in a discipline, if in addition they complete one vocational course in summer vacation of the second year.**

Semester V

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MTUC114	Control System	PCC	3	-	-	3
MTUC115	Automotive Electronics	PCC	3	1	-	4
MTUEXXX	Professional Elective –I	PCC	3	1	-	4
EEUC131	Electric Motors and Power Electronics in Motion Control	ESC	3	-	-	3
MTUC116	Control System Laboratory	PEC	-	-	~~3~~	1.5
MTUC117	Automotive Electronics Laboratory	PCC	-	-	3	1.5
MTUC118	Drone Technology and Design Laboratory	PCC	-	-	3	1.5
Total			12	1	9	-
			23			**18.5**

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MTUNXXX	Ancillary Stream Course –II	ANC	3	-	-	3
MTUH102	Autonomous Vehicles & Navigation Systems	HNC	3	1	-	4

Semester VI

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MTUC119	Computer Integrated Manufacturing	PCC	3	-	-	3
MTUC120	Mechatronics System Design	PCC	3	1	-	4
MTUC121	Industrial Robotics	PCC	3	-	-	3
MTUEXXX	Professional Elective – II	PEC	3	1	-	4
HSUA105	Industrial Economics Management	AEC	2	-	-	2
MTUC122	Computer Integrated Manufacturing Laboratory	PCC	-	-	3	1.5
MTUC123	System Integration Laboratory	PCC	-	-	3	1.5
MTUC124	Industrial Robotics Laboratory	PCC	-	-	3	1.5
MTUC125	Internship	PCC	-	-	-	2
Total			14	2	9	-
			25			**22.5**

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MTUNXXX	Ancillary Stream Course –III	ANC	3	-	-	3
MTUH103	Nano Electronics & Nano Sensors	HNC	3	1	-	4

Exit option for the students who opt to exit after completion of third year of B. Tech Programme and have secured a **minimum of 132 credits** will be awarded **B.Sc. (Engg.) in a discipline, if in addition they complete one vocational course in summer vacation of the second year.**

Semester VII

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MTUC126	Machine Vision	PCC	3	-	-	3
MTUC127	Modeling and Simulation	PCC	3	-	-	3
MTUC128	Machine Learning in Mechatronics	PCC	3	-	-	3
MTUEXXX	Professional Elective – III	PEC	3	1	-	4
MTUC129	Machine Vision Laboratory	PCC	-	-	3	1.5
MTUC130	Modeling and Simulation Laboratory	PCC	-	-	3	1.5
MTUC131	Mini Project	PCC	-	-	-	2
MTUC132	Comprehensive Viva	PCC	-	-	-	1
Total			15	1	6	**-**
			22			**19**

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MTUNXXX	Ancillary Stream Course –IV	ANC	3	-	-	3
MTUH104	Deep Learning for Mechatronics Applications	HNC	3	1	-	4

Semester VIII

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MTUC133	Project Work	PCC	-	-	16	8

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MTUH105	Seminar	HNC	-	-	-	**2**

LIST OF PROFESSIONAL ELECTIVES

Professional Elective	Course Code	Course	Semester
Professional Elective - I	MTUE101	Python Programming	**V**
	MTUE102	Design Considerations in manufacturing	
	MTUE103	Mechatronics and Remote engineering	
	MTUE104	Mechatronics in Agriculture	
Professional Elective – II	MTUE105	Additive Manufacturing and 3D printing	**VI**
	MTUE106	Java Programming	
	MTUE107	Industrial Engineering and Safety	
	MTUE108	Aerospace Mechatronics	
Professional Elective - III	MTUE109	Total Quality Management	**VII**
	MTUE110	VLSI Design	
	MTUE111	Nanotechnology	
	MTUE112	Medical Mechatronics	

LIST OF ANCILLARY COURSES

Ancillary Stream Title	Course Code	Course	Semester
Artificial Intelligence in Mechatronics (For all branches except Mechatronics)	MTUN101	AI in Mechatronics	**IV, V, VI, VII**
	MTUN102	AI for Robots & Autonomous Systems	
	MTUN103	AI in Medicine	
	MTUN104	Applied AI for Manufacturing	
Internet of Things in Mechatronics (For all branches except Mechatronics)	MTUN105	Industrial Internet of Things	
	MTUN106	IoT in Mechatronics	
	MTUN107	Internet of Robotic Things	
	MTUN108	Augmented Reality and Virtual Reality	
Smart manufacturing and Industry 5.0 (Only for Mechatronics students)	MTUI101	Additive Manufacturing	
	MTUI102	Intelligent Manufacturing Systems	
	MTUI103	Digital Manufacturing and IoT	
	MTUI104	Introduction to Industry 5.0	

Courses offered under Various Categories

CCC	Course Code	Course	Semester	Credit	Total Credit
BSC	MAUC101	Mathematics I	I	4	**20**
	PHUC101	Physics	I	3	
	CYUC101	Chemistry	II	3	
	PHUC102	Physics laboratory	I	1	
	CYUC102	Chemistry Laboratory	II	1	
	MAUC102	Mathematics II	II	4	
	MAUC104	Transforms and Partial Differential equations	III	4	
ESC	MEUC101	Engineering Graphics	I	3	**13.5**
	CSUC101	Programming for Problem Solving	II	2	
	CSUC102	Computer Programming Laboratory	II	1	
	CSUC137	Data Structures and Object-Oriented Programming	IV	3	
	CSUC138	Data Structures and Object-Oriented Programming Laboratory	IV	1.5	
	EEUC131	Electric Motors and Power Electronics in Motion Control	V	3	
PCC	MTUC101	Basics of Mechatronics	I	4	**86.5**
	MTUC102	Basics of Sensors and Measurements	II	4	
	MTUC103	Manufacturing Processes	III	3	
	MTUC104	Hydraulic and Pneumatic Systems	III	3	
	MTUC105	Analog and Digital Electronics	III	3	
	MTUC106	Manufacturing Processes Laboratory	III	1.5	
	MTUC107	Hydraulic and Pneumatic Systems Laboratory	III	1.5	
	MTUC108	Analog and Digital Electronics Laboratory	III	1.5	
	MTUC109	Industrial Automation	IV	4	
	MTUC110	Drone Technology and design	IV	4	
	MTUC111	Micro controller and Embedded system	IV	3	
	MTUC112	Industrial Automation Laboratory	IV	1.5	
	MTUC113	Micro controller and Embedded system Laboratory	IV	1.5	
	MTUC114	Control System	V	3	
	MTUC115	Automotive Electronics	V	4	
	MTUC116	Control systems Laboratory	V	1.5	
	MTUC117	Automotive Electronics Laboratory	V	1.5	
	MTUC118	Drone Technology and design Laboratory	V	1.5	
	MTUC119	Computer Integrated Manufacturing	VI	3	
	MTUC120	Mechatronics System Design	VI	4	
	MTUC121	Industrial Robotics	VI	3	
	MTUC122	Computer Integrated Manufacturing Laboratory	VI	1.5	
	MTUC123	System Integration Laboratory	VI	1.5	
	MTUC124	Industrial Robotics Laboratory	VI	1.5	
	MTUC125	Internship	VI	2	
	MTUC126	Machine Vision	VII	3	
	MTUC127	Modeling and Simulation	VII	3	
	MTUC128	Machine Learning in Mechatronics	VII	3	
	MTUC129	Machine Vision Laboratory	VII	1.5	

	MTUC130	Modeling and Simulation Laboratory	VII	1.5	
	MTUC131	Mini Project	VII	2	
	MTUC132	Comprehensive Viva	VII	1	
	MTUC133	Project Work	VIII	8	
PEC	MTUE101-04	Professional Elective – I	V	4	**12**
	MTUE105-08	Professional Elective – II	VI	4	
	MTUE109-12	Professional Elective – III	VII	4	
AEC	HSUA101	English for Communication	I	2	**10**
	HSUA102	Professional English	II	2	
	HSUA103	Entrepreneurship	III	2	
	HSUA104/ HSUA106	Design Thinking / Foreign Language - French	IV	2	
	HSUA105	Industrial Economics and Management	VI	2	
SEC	GEUS101	Basic Engineering Skills Laboratory - I	I	3	**6**
	GEUS102	Basic Engineering Skills Laboratory - II	II	3	
VAC	GEUV101	NSS, Yoga and Health	I	1	**4**
	GEUV102	Essence of Indian Traditional Knowledge	II	1	
	GEUV103	Environmental Education	III	1	
	GEUV104	Universal Human Values	IV	1	
ANC	MTUN/IXXX	Ancillary Stream Elective course	**IV-VII**	12	**12**
Total					**164**

SEMESTER –III

Department: **Mechatronics**		Programme : **B.Tech. (MT)**						
Semester **: Third**		Course Category Code**: BSC**			Semester Exam type**: TY**			
Course code	Course	Periods/ week			Credit	Maximum marks		
		L	T	P	C	CA	SE	TM
MAUC104	**Transforms and Partial Differential Equations**	3	1	0	4	40	60	100
Prerequisite	Basic Integration and Probability							

Course Outcome At the end of the course, the students will be able to		
	CO1	**Apply** Laplace transforms and their properties to solve engineering problems.
	CO2	**Solve** ordinary differential equations using Laplace transform methods
	CO3	**Solve** first-order partial differential equations using standard methods
	CO4	**Apply** separation of variables to solve higher-order PDEs and boundary value problems
	CO5	**Solve** one- and two-dimensional heat flow problems using analytical techniques.

UNIT- I	**LAPLACE TRANSFORMS**	**Periods:12**	
Definition of Laplace Transform, Inverse Laplace Transform, Linearity property, Laplace transform of unit step function, Unit impulse function and some elementary functions, Change of scale and first shifting property.			**CO1**
UNIT-II	**APPLICATIONS OF LAPLACE TRANSFORMS**	**Periods:12**	
Derivatives and integrals of Laplace transform, Transform of derivatives and integrals, Application: Solution of single ordinary linear differential equation with constant coefficients-Laplace transform of Periodic functions, Initial and Final value theorem.			**CO1, CO2**
Unit-III	**PARTIAL DIFFERENTIAL EQUATIONS**	**Periods: 12**	
General and Singular solution of PDE, Complete Solution of First order Non-linear PDE, Lagrange's linear equation of first order, Solution of the simultaneous equations by the method of grouping and multipliers.			**CO3**
Unit-IV	**HIGHER ORDER PDE AND BOUNDARY VALUE PROBLEMS**	**Periods: 12**	
Homogeneous linear PDE of higher order with constant coefficients. Solution of partial differential equation by the method of separation of variables. Application of PDE: Variable separable solutions of the one-dimensional wave equation, Transverse vibration of a stretched string.			**CO4**
Unit-V	**ONE DIMENSIONAL AND TWO DIMENSIONAL HEAT FLOW EQUATION**	**Periods: 12**	
Heat Equation, Solution of one dimensional heat equation by the method of separation of variables, Temperature distribution with zero and non-zero boundary values, Two dimensional heat flow under steady state conditions (Cartesian).			**CO5**

Total Contact Hours: **48**	**Total Tutorials**: **12**	**Total Practical Classes**: **Nil**	**Total Hours**: **60**

Reference Books:

1. Veerarajan T, Engineering Mathematics II, McGraw-Hill Education (India) Private Limited, 2014
2. Veerarajan T, Transforms and Partial Differential Equations, Third Edition, McGraw-Hill Education (India) Private Limited, 2016.
3. Venkataraman M.K., Engineering Mathematics, Third Year, Part-B, The National Publishing Company, Chennai, 2008.
4. Erwin Kreyszig, Advanced Engineering Mathematics (9 th Ed), John Wiley & Sons, New Delhi, 2011.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, Eleventh Reprint, 2010.
6. Bali N. and Goyal M., Advanced Engineering Mathematics, Laxmi Publications Pvt. Ltd., New Delhi, 9th Edition, 2011.

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	-	2	-	-
CO2	3	3	-	-	2	-	-	-	-	-	2	-	-
CO3	3	3	-	-	2	-	-	-	-	-	2	-	-
CO4	3	3	2	-	2	-	-	-	-	-	2	-	-
CO5	3	3	2	-	3	1	-	-	-	-	2	-	-
Mean	**3**	**2.8**	**0.8**	**-**	**2.2**	**0.2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

Score: 3 – High   2 - Medium   1 – Low

Department: **Mechatronics**			Programme : **B.Tech. (MT)**						
Semester **: Third**			Course Category Code**: PCC**			Semester Exam type**: TY**			
Course code	Course		Periods/ week			Credit	Maximum marks		
			L	T	P	C	CA	SE	TM
MTUC103	**Manufacturing Processes**		3	0	0	3	40	60	100

Prerequisite		NIL
Course Outcome At the end of the course, the students will be able to	**CO1**	**Explain** the fundamentals of manufacturing processes and working of metal cutting machines.
	CO2	**Classify and compare** metal cutting, casting and welding processes along with defect analysis
	CO3	**Illustrate** metal forming processes and identify associated equipment and defects
	CO4	**Describe and differentiate** surface finishing and grinding processes
	CO5	**Summarize** unconventional machining processes and modern manufacturing approaches

UNIT- I	**Metal Cutting**	**Periods: 09**	
Introduction to manufacturing processes – classification – Basic mechanism of metal cutting – Cutting tools – Lathe – Types, Designation, Work holding devices – Cutting Speed, Feed and Depth of Cut, Material Removal Rate - Operations, Machining Time. Milling Machine – Types, Process, Operations, Machining Time, Material Removal Rate and Gear cutting.			**CO1, CO2**
UNIT-II	**Casting & Welding**	**Periods: 09**	
Casting process – different types of casting – pattern and core making – materials, types and allowances – moulding tools and equipment - properties of moulding sand - casting defects and remedies. Welding processes–Types –gas welding–oxyacetylene welding-Metal arc welding– types and equipment– resistance welding–types and applications-welding defects and inspections–Introduction to welding standards.			**CO1, CO2**
Unit-III	**Metal Forming**	**Periods: 09**	
Classification of metal forming processes – Rolling, Forging, Extrusion, Drawing and other Sheet metal operations: terminology used, processes, machines and defects.			**CO1, CO3**
Unit-IV	**Surface Finishing Processes**	**Periods: 09**	
Surface Finish and Surface Roughness, Honing – Lapping – Super finishing – Abrasive Belt Finishing – Mass Finishing Processes – Polishing – Buffing. Grinding: Types of grinding – Types of Grinding machines–Size and specification of Grinding machines-Work Holding Devices – Grinding Operations-Grinding Fluids – Grinding Speed, Feed and Depth of Cut.			**CO1, CO4**
Unit-V	**Unconventional Machining Process**	**Periods: 09**	
Unconventional Machining Process - Classification, Laser Beam Machining, Electron-Beam machining, Electric Discharge Machining, Electrochemical Machining, Electrochemical Grinding, Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining. Introduction to Lean, Agile and Intelligent manufacturing.			**CO1, CO5**
Total Contact Hours: **45**	**Total Tutorials**: **Nil**	**Total Practical Classes**: **Nil**	**Total Hours**: **45**

Reference Books:

1. B.S.Nagendra Parashar & R.K.Mittal – Elements of Manufacturing Processes, Prentice Hall India Pvt. Ltd., 2003.
2. J.P.Kaushish–Manufacturing Processes, Prentice Hall India Pvt.Ltd.,2008.
3. E.Paul DeGarmo, Ronald A.Kosher – Materials and Processes in Manufacturing, Prentice Hall India Pvt. Ltd.,2008.
4. Roy A.Lindberg-Processes and Materials of Manufacture, Prentice Hall India Pvt.Ltd.,2002.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	-	3	-	-	-	-	1	2	3	2
CO2	3	2	2	-	2	2	1	-	-	-	2	3	1
CO3	3	2	2	-	2	1	-	-	-	-	2	3	1
CO4	3	2	2	-	3	-	-	-	-	-	2	3	1
CO5	3	3	2	-	3	2	1	-	-	2	3	3	2
Mean	**3**	**2.2**	**2**	**-**	**2.6**	**1.7**	**0.4**	**-**	**-**	**0.6**	**2.2**	**3**	**1.4**

Score: 3 - High 2 - Medium 1 – Low

Department : **Mechatronics**		Programme : **B.Tech. (MT)**	
Semester : **Third**		Course Category Code: **PCC**	Semester Exam Type: **TY**

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUC104	**Hydraulic and Pneumatic Systems**	3	0	0	3	40	60	100

Prerequisite:	Basics of Physics	
Course Outcome At the end of the course, the students will be able to	**CO1**	**Explain** the principles, types, and construction of fluid power systems and hydraulic pumps
	CO2	**Illustrate** the working and applications of hydraulic actuators and control valves
	CO3	**Analyze and design** various industrial and electro-hydraulic circuits
	CO4	**Explain** pneumatic and electro-pneumatic components and design appropriate
	CO5	**Identify,** troubleshoot, and design fluid power systems for various industrial applications

UNIT-I	**FLUID POWER AND HYDRAULIC PUMPS**	**Periods: 09**
Introduction to Fluid Power-Global fluid power Scenario-Advantages and disadvantages-Types of fluids –Properties of fluids and selection, Pascal's Law-Principles of flow- Basic system of Hydraulics- Types, Properties & functions of hydraulic Oils, Hydraulic Symbols, Electrical Elements used in hydraulic circuits. Classification of hydraulic pumps- Construction, Working, Design, Advantages, Disadvantages.		**CO1, CO5**
UNIT-II	**HYDRAULIC ACTUATORS & CONTROL COMPONENTS**	**Periods: 09**
Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning. Hydraulic motors – Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications, Accessories: Reservoirs, Pressure Switches – Hydraulic fluid cleanliness.		**CO2, CO5**
UNIT-III	**HYDRAULIC CIRCUITS AND SYSTEMS**	**Periods: 09**
Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump,Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.		**CO3, CO5**
UNIT-IV	**PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS**	**Periods: 09**
Properties of air – Perfect Gas Laws –Basic Requirements for Pneumatic Systems- Compressor – Filters, Regulator, Lubricator (FRL Unit), Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Components – Working- Applications. Introduction to Automation in hydraulic and Pneumatic Systems.		**CO4, CO1, CO5**
UNIT-V	**TROUBLE SHOOTING AND APPLICATIONS**	**Periods: 09**
Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Semi-Automatic & Automatic Material Handling.		**CO3, CO5**

Lecture Periods: 45	**Tutorial Periods: Nil**	**Practical Periods: Nil**	**Total Periods: 45**

Reference Books:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education 2005.
2. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw- Hill, 2001.
3. James R. Daines, Martha J. Daines, "Fluid Power: Hydraulics and Pneumatics", Goodheart-Willcox Company, Incorporated, 2018.
4. Andrew Parr, "Hydraulics and Pneumatics: A Technician's and Engineer's Guide", Butterworth-Heinemann,2011.
5. Chris Stacey, Ian C. Turner," Practical Pneumatics/Engineering Applications of Pneumatics & Hydraulics", Butterworth-Heinemann,2000.

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	2	3	-
CO2	3	-	2	-	2	-	-	-	-	-		3	-
CO3	3	3	3	2	3	-	-	-	-	2	2	3	2
CO4	3		3	2	3	-	-	-	-	-	-	3	2
CO5	3	3	3	3	3	-	-	-	-	2	3	3	3
Mean	**3**	**3**	**2.8**	**-**	**2.6**	**-**	**-**	**-**	**-**	**2**	**2.4**	**3**	**2.4**

Score: 3 - High 2 - Medium 1 – Low

Department : **Mechatronics**		Programme : **B.Tech. (MT)**						
Semester : **Third**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUC105	**Analog and Digital Electronics**	3	0	0	3	40	60	100

Prerequisite:		
Course Outcome At the end of the course students will be able to	**CO1**	**Explain** the working principles of analog devices and operational amplifiers.
	CO2	**Analyze** and design analog circuits including amplifiers and oscillators.
	CO3	**Apply** Boolean algebra and logic simplification for digital logic design.
	CO4	**Design** combinational and sequential digital circuits for control logic.
	CO5	**Integrate** analog and digital components for basic interfacing in mechatronic systems.

UNIT-I	**Analog Devices and Applications**	**Periods: 09**	
Diodes: PN Junction, Zener – Characteristics and applications, Rectifiers, clippers, clampers, Voltage regulators, Bipolar Junction Transistors (BJT) – configurations, biasing and applications, Field Effect Transistors (FET) – JFET, MOSFET characteristics and applications, Operational Amplifiers: inverting, non-inverting, integrator, differentiator.			**CO1, CO2**
UNIT-II	**Feedback and Oscillator Circuits**	**Periods: 09**	
Concept of feedback: positive feedback, negative feedback, Barkhausen criterion, Principle of operation of RC phase shift Oscillator, Wien Bridge Oscillator, Colpitt's Oscillator, Hartley Oscillator, Crystal Oscillator, Power Amplifiers – Class A, B, AB, C: Characteristics and efficiencies.			**CO2, CO5**
UNIT-III	**Number Systems and Logic Gates**	**Periods: 09**	
Number systems: Binary, octal, decimal, hexadecimal conversions, Logic gates: AND, OR, NOT, NAND, NOR, XOR, XNOR, Boolean algebra, DeMorgan's theorem and logic simplification, Implementation using universal gates.			**CO3, CO4**
UNIT-IV	**Combinational Logic Circuits**	**Periods: 09**	
Adders, Subtractors, Multiplexers, Demultiplexers, Encoders, Decoders, Comparators, K-Map simplification (2,3,4 variables)			**CO3, CO4**
UNIT-V	**Sequential Logic Circuits and Applications**	**Periods: 09**	
Flip-flops – SR, JK, D, T, Master-slave, Counters – Asynchronous, Synchronous, Shift Registers – SIPO, PISO, SISO, PIPO, ADC, DAC basics, Memory types- ROM, RAM, EEPROM, Interfacing with sensors and actuators.			**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: NIL**	**Practical Periods: NIL**	**Total Periods: 45**

Reference Books:

1. **David A. Bell**, Electronic Devices and Circuits, Oxford University Press.
2. **M. Morris Mano**, Digital Logic and Computer Design, Pearson Education.
3. **Boylestad and Nashelsky**, Electronic Devices and Circuit Theory, Pearson.
4. **R. P. Jain**, Modern Digital Electronics, Tata McGraw Hill.
5. **Thomas L. Floyd**, Digital Fundamentals, Pearson Education.

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	2	3	-
CO2	3	2	2	2	2	-	-	-	-	-	-	3	-
CO3	3	3	2		3	-	-	-	-	-	2	3	-
CO4	3	3	3	2	3	-	-	-	-	2	2	3	2
CO5	3	2	-	-	-	-	-	-	-	-	-	-	-
Mean	**3**	**2**	**1.4**	**0.8**	**2**	**-**	**-**	**-**	**-**	**0.4**	**1.2**	**2.4**	**0.4**

Note: 3 – High 2 – Medium 1 - Low

Department : **Humanities and Social Sciences**	Programme: **B.Tech. (Common to all branches)**	
Semester : **Third**	Course Category Code: **AEC**	Semester Exam Type: **TY**

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
HSUA103	**Entrepreneurship**	2	-	-	2	40	60	100

Prerequisite:

Course Outcome At the end of the course, the students will be able to		
	CO1	**Understand** entrepreneurial mindset, problem identification, customer segmentation, and value proposition development.
	CO2	**Develop and validate** business models, test solutions, and create a Minimum Viable Product (MVP) through iterative feedback.
	CO3	**Analyze** financial planning, revenue models, pricing strategies, and investor expectations for startup funding.
	CO4	**Apply** sales, branding, digital marketing, automation, and teamwork strategies to successfully launch and scale a venture.

UNIT-I	**Problem Identification and Customer Discovery**	**Periods: 06**
Entrepreneurial mindset – Identifying business opportunities – Effectuation principles – Design Thinking for problem-solving – Consumer segmentation and customer persona – Value Proposition Canvas (VPC) – Unique Value Proposition (UVP) – Market research techniques – Emerging trends: AI in market research.		**CO1**
UNIT-II	**Business Model and Lean Startup**	**Periods: 06**
Types of business models – Lean Canvas vs. Business Model Canvas – Competitor analysis – Blue Ocean Strategy – Building and testing Minimum Viable Product (MVP) – Build-Measure-Learn feedback loop – Digital Prototyping tools – Rapid Experimentation – Agile startup methodology.		**CO1, CO2**
UNIT-III	**Revenue Models, Costing, and Financial Planning**	**Periods: 06**
Revenue models: Subscription, Freemium, and Pay-per-use – Unit economics: Cost structures and pricing strategies – Funding sources: Bootstrapping, Crowdfunding, Venture Capital – Investor expectations and funding rounds – Pitching to investors – Financial forecasting and break-even analysis – Government startup incentives.		**CO2, CO3**
UNIT-IV	**Digital Marketing and Sales Strategies**	**Periods: 06**
Brand positioning and storytelling – Social media marketing and digital presence – SEO, SEM, and paid advertising – Data-driven marketing strategies – Sales funnels – Unique Sales Proposition (USP) – B2B vs. B2C sales – CRM tools for customer engagement – Customer retention strategies.		**CO3, CO4**
UNIT-V	**Team Building, Compliance, and Scaling**	**Periods: 06**
Building and managing startup teams – Remote collaboration tools – Business registration and legal compliance – Intellectual Property Rights (IPR) for startups – Growth hacking and automation – Scaling strategies: Expansion and franchising – Emerging trends: AI in entrepreneurship, blockchain applications – Exit strategies: Mergers, acquisitions, IPOs.		**CO5**

Lecture Periods: 30	**Tutorial Periods: NIL**	**Practical Periods: NIL**	**Total Periods: 30**

Reference Books:

1. **Eric Ries,** *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses* by Crown Business, **1st Edition (2011)**.
2. **Alexander Osterwalder & Yves Pigneur,** *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*, Wiley, **1st Edition (2010)**.
3. **Ash Maurya,** *Running Lean: Iterate from Plan A to a Plan That Works*, O'Reilly Media, **2nd Edition (2019)**.
4. **Steve Blank** and **Bob Dorf**, *The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company*, K&S Ranch, **1st Edition (2012)**.

CO-PO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	2	2	-	1	2	-	-	-	3	3	-	-
CO2	-	3	3	2	2	-	-	-	-	3	3	-	-
CO3	-	3	3	2	2	-	-	-	-	3	3	-	-
CO4	-	2	3	-	2	-	-	-	-	-	-	-	-
Mean	**-**	**2**	**2.8**	**1**	**1.8**	**0.5**	**-**	**-**	**-**	**2.3**	**2.3**	**-**	**-**

Score: 3 – High; 2 – Medium; 1 – Low

<table>
<tr><td colspan="2">Department : Humanities and Social Sciences</td><td colspan="7">Programme: B.Tech. (Common to all branches)</td></tr>
<tr><td colspan="2">Semester : Third</td><td colspan="4">Course Category Code: VAC</td><td colspan="3">Semester Exam Type: -</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>GEUV103</td><td>Environmental Education</td><td>1</td><td>-</td><td>-</td><td>1</td><td>100</td><td>-</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">-</td></tr>
<tr><td rowspan="3">Course Outcome</td><td>CO1</td><td colspan="7">Recall the concept of environment ecology and Education.</td></tr>
<tr><td>CO2</td><td colspan="7">Summarise the effect of population explosion, degradation of environment and global problem due to the anthropogenic activities.</td></tr>
<tr><td>CO3</td><td colspan="7">Justify the need of pollution control and sustainable development for future.</td></tr>
<tr><td>UNIT-I</td><td colspan="4">Introduction to Environmental Education</td><td colspan="4">Periods: 05</td></tr>
<tr><td colspan="8">Concept, scope and importance of Environmental Education - Objectives of Environmental Education - Concept of an Ecosystem: Structure and functions, Types of ecosystem (aquatic and terrestrial) - Biodiversity: Levels, values, threats and conservation - Natural resources: Renewable and Non-renewable resources.</td><td>CO1</td></tr>
<tr><td>UNIT-II</td><td colspan="4">Environmental degradation and impact</td><td colspan="4">Periods: 05</td></tr>
<tr><td colspan="8">Human population growth and its impact on environment - Deforestation: Causes and effects due to expansion of agriculture, firewood, mining and building of new habitats - Pollution: Definition, different types of Pollution - Air and water pollution: Causes and effect on environment - Climate change, Global warming, Ozone layer depletion and impacts on human communities.</td><td>CO2</td></tr>
<tr><td>UNIT-III</td><td colspan="4">Conservation of environment</td><td colspan="4">Periods: 05</td></tr>
<tr><td colspan="8">Control measures for various types of Pollution: use of renewable and alternate source of energy - Environmental laws: Environmental Protection Act (1986), Water Act (1974), Air Act (1981) - International agreements: Montreal and Kyoto Protocol, Paris Agreement - Concept of sustainable development and SDGs - Role of government, NGOs and individual in environmental conservation.</td><td>CO3</td></tr>
<tr><td colspan="2">Lecture Periods: 15</td><td colspan="2">Tutorial Periods: NIL</td><td colspan="2">Practical Periods: NIL</td><td colspan="3">Total Periods: 15</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
<tr><td colspan="9">1. Singh, J.S., Singh, S.P. and Gupta, S.R., 2014. “Ecology, Environmental Science and Conservation”, S. Chand Publishing, New Delhi.
2. Sharma, P. D., 2011. “Ecology and Environment”, Rastogi Publications.
3. Erach Bharucha, 2010. “Text Book of Environmental Studies”, University Grants Commission, Universities Press (India) Pvt.Ltd., Hyderabad.</td></tr>
</table>

CO-PO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	-	-	-	-	2	-	-	-	-	2	-	-
CO2	2	-	-	-	-	3	2	-	-	-	2	-	-
CO3	2	2	-	-	-	3	3	-	-	-	3	-	-
Mean	**2**	**0.66**	**-**	**-**	**-**	**2.67**	**1.66**	**-**	**-**	**-**	**2.33**	**-**	**-**

SCORE: 3 – High; 2 – Medium; 1 – Low

Department : **Mechatronics**		Programme : **B.Tech. (MT)**						
Semester :**Third**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUC106	**Manufacturing Processes Laboratory**	0	0	3	1.5	40	60	100

Prerequisite:	**NIL**	
Course Outcome At the end of the course, the students will be able to	**CO1**	Illustrate the working principles and components of basic manufacturing machines like lathe, milling, and grinding machines
	CO2	Perform basic machining operations such as turning, facing, threading, grooving, and taper turning using a lathe
	CO3	Execute milling and grinding operations with proper machine setup and operational parameters.
	CO4	Understand the foundry process and demonstrate pattern making using solid and split patterns

LATHE: 1. Study of Lathe 2. Plain turning and facing 3. Step turning, grooving, chamfering and knurling 4. Taper turning by swiveling the compound rest and V – thread cutting	**CO1, CO2**
MILLING MACHINE: 1. Study of Milling Machine 2. Cube milling	**CO1, CO3**
GRINDING OPERATIONS 1. Study of grinding machine 2. Surface grinding of cylindrical shafts	**CO1, CO3**
FOUNDRY: 1. Study of Foundry 2. Face Plate (Solid Pattern) 3. Pipe Flange (Split Pattern)	**CO1, CO4**

Lecture Periods: NIL	**Tutorial Periods: NIL**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books:

1. B.S.Nagendra Parashar & R.K.Mittal – Elements of Manufacturing Processes, Prentice Hall India Pvt. Ltd., 2003.
2. J.P.Kaushish – Manufacturing Processes, Prentice Hall India Pvt. Ltd., 2008.
3. E.Paul De Garmo, J.T.Black and Ronald A.Kosher – Materials and Processes in Manufacturing, Prentice Hall India Pvt. Ltd., 2008.
4. Roy A. Lindberg - Processes and Materials of Manufacture, Prentice Hall India Pvt. Ltd., 2002.

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	1	3	-
CO2	2	2	-	-	2	-	-	2	-	-	2	3	-
CO3	2	2	-	-	2	-	-	2	-	-	2	3	-
CO4	2	-	-	-	-	-	-	1	-	-	1	3	-
Mean	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1.25**	**-**	**-**	**2**	**3**	**-**

Score: 3 - High 2 - Medium 1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="5">Programme : B.Tech. (MT)</td><td colspan="3"></td></tr>
<tr><td colspan="2">Semester :Third</td><td colspan="4">Course Category Code: PCC</td><td colspan="4">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC107</td><td>Hydraulic and Pneumatic Systems Laboratory</td><td>0</td><td>0</td><td>3</td><td>1.5</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="4">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td colspan="7">Describe the working principles of hydraulic and pneumatic systems along with standard fluid power symbols and circuits</td></tr>
<tr><td>CO2</td><td colspan="7">Demonstrate the control of actuators and implement pressure and speed control in hydraulic circuits</td></tr>
<tr><td>CO3</td><td colspan="7">Design and implement pneumatic circuits using logic operations, timing, and sequencing</td></tr>
<tr><td>CO4</td><td colspan="7">Develop electro-pneumatic circuits incorporating relay logic and switching mechanisms for automation</td></tr>
</table>

<table>
<tr><td>1. Study of Fundamentals of Hydraulic and Pneumatic Systems
2. Study of ISO/GIS Fluid Power Symbols
3. Study of Electric Circuit diagram for Hydraulic and Pneumatic Systems</td><td>CO1</td></tr>
<tr><td>Hydraulic Circuits:
1. Control of single-acting cylinder
2. Control of double-acting cylinder
3. Speed control of hydraulic cylinder
4. Pressure compensation</td><td>CO1, CO2</td></tr>
<tr><td>Pneumatic Circuits:
1. Control of single acting cylinder
2. Control of double-acting cylinder using logic (AND, OR)
3. Single and double acting actuators operations using 5/3 DCV and Pilot operated DCV
4. Automatic control of double-acting cylinder
5. Application of Speed control circuits (meter-in, meter-out)
6. Application of Sequencing circuit
7. Application of Time delay circuit</td><td>CO1, CO3</td></tr>
<tr><td>Electro-Pneumatic Circuits:
1. Control of flow in double-acting cylinder
2. Application of Sequencing circuit
3. Application of Speed control circuits using relay logic
4. Application of SPST and SPDT</td><td>CO1, CO4</td></tr>
</table>

Lecture Periods: 3	**Tutorial Periods: NIL**	**Practical Periods: 42**	**Total Periods: 45**

Reference Books:

1. James R. Daines, Martha J. Daines, "Fluid Power: Hydraulics and Pneumatics", Goodheart-Willcox Company, Incorporated, 2018.
2. Andrew Parr, "Hydraulics and Pneumatics: A Technician's and Engineer's Guide", Butterworth- Heinemann,2011.
3. Chris Stacey, Ian C. Turner," Practical Pneumatics/Engineering Applications of Pneumatics & Hydraulics", Butterworth-Heinemann,2000.
4. Khurmi R.S., Hydraulic Machines, S.Chand& Co., New Delhi, 2nd ed, 2005.
5. Majumdar S.R., Oil Hydraulic systems,, Tata McGraw Hill,2001,

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	3	-
CO2	2	2	-	-	2	-	-	-	-	-	-	3	-
CO3	2	2	-	-	3	-	-	2	-	-	-	3	-
CO4	2	2	-	-	3	-	-	2	-	-	-	3	-
Mean	**2**	**1.5**	**-**	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**-**

Score: 3 - High 2 - Medium 1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="7">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Third</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC108</td><td>Analog and Digital Electronics Laboratory</td><td>0</td><td>0</td><td>3</td><td>1.5</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="4">Course Outcome
At the end of the course students will be able to</td><td>CO1</td><td colspan="7">Analyze and interpret the characteristics and applications of analog devices and circuits</td></tr>
<tr><td>CO2</td><td colspan="7">Design and evaluate oscillator and amplifier circuits using analog components</td></tr>
<tr><td>CO3</td><td colspan="7">Implement and verify combinational and sequential digital logic circuits</td></tr>
<tr><td>CO4</td><td colspan="7">Integrate digital circuits with analog components and sensors for real-time interfacing.</td></tr>
<tr><td colspan="8">1. Study and plot the V-I characteristics of PN Junction and Zener Diode.
2. Design and test a Half-Wave and Full-Wave Rectifier with and without Filter
3. Design and implementation of voltage regulator using Zener diode or IC 7805
4. Input and output characteristics of BJT in CE configuration
5. Inverting and Non-Inverting Amplifier using Op-Amp
6. Integrator and Differentiator using Op-Amp</td><td>CO1, CO2</td></tr>
<tr><td colspan="8">7. Design and analysis of RC Phase Shift Oscillator using Op-Amp or BJT
8. Design of Wien Bridge Oscillator
9. Class B and Class AB Power Amplifier using complementary transistor</td><td>CO1, CO2</td></tr>
<tr><td colspan="8">10. Verification of Logic Gates (AND, OR, NOT, NAND, NOR, XOR, XNOR
11. Implementation of Boolean expressions and DeMorgan's theorem using logic gates
12. Implementation of logic functions using only NAND/NOR gates (Universal Gates)</td><td>CO3, CO4</td></tr>
<tr><td colspan="8">13. Design and implementation of 4:1 Multiplexer and 1:4 Demultiplexer
14. Design and implementation of 3-bit Binary Adder and Subtractor using logic gates.
15. Design and verification of Encoders and Decoders</td><td>CO3, CO4</td></tr>
<tr><td colspan="8">16. Design and implementation of Flip-Flops (SR, D, JK, T) using logic gates
17. Design and testing of asynchronous and synchronous counters (up/down)
18. Interfacing digital circuits with sensors/actuators (IR sensor, temperature, LED, motor etc.)</td><td>CO3, CO4</td></tr>
<tr><td colspan="2">Lecture Periods: 03</td><td colspan="2">Tutorial Periods: NIL</td><td colspan="3">Practical Periods: 42</td><td colspan="2">Total Periods: 45</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
<tr><td colspan="9">1. David A. Bell, Electronic Devices and Circuits, Oxford University Press.
2. M. Morris Mano, Digital Logic and Computer Design, Pearson Education.
3. Boylestad and Nashelsky, Electronic Devices and Circuit Theory, Pearson.
4. R. P. Jain, Modern Digital Electronics, Tata McGraw Hill.
5. Thomas L. Floyd, Digital Fundamentals, Pearson Education.</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	3	-
CO2	2	2	2	-	2	-	-	-	-	-	-	3	-
CO3	2	2	2	-	3	-	-	-	-	-	-	3	-
CO4	2	2	3	-	3	-	-	2	-	-	-	3	2
Mean	**2**	**2**	**1.75**	**-**	**2**	**-**	**-**	**0.5**	**-**	**-**	**-**	**3**	**0.5**

Score: 3 – High 2 – Medium 1 - Low

SEMESTER –IV

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="7">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fourth</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC109</td><td>Industrial Automation</td><td>4</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">NIL</td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td colspan="7">Illustrate the concepts, evolution, and need for automation in production system</td></tr>
<tr><td>CO2</td><td colspan="7">Explain the architecture, components, and programming of Programmable Logic Controllers (PLC</td></tr>
<tr><td>CO3</td><td colspan="7">Apply PLC concepts for solving real-time industrial automation problems.</td></tr>
<tr><td>CO4</td><td colspan="7">Analyze the structure and functions of SCADA systems and their industrial applications.</td></tr>
<tr><td>CO5</td><td colspan="7">Describe Distributed Control Systems (DCS) and evaluate their configuration, interfaces, and applications.</td></tr>
<tr><td>UNIT-I</td><td colspan="3">INDUSTRIAL AUTOMATION IN PRODUCTION SYSTEMS</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Introduction to Automation - History and Evolution of Industrial Automation, Need of Industrial Automation, Benefits. Basic elements of an automated system, Levels of Automation, Types and Characteristics of Automation systems, Automated flow lines and transfer mechanisms. Applications on real time industrial automation systems- Automated Assembly Lines, Automatic Machine Handling System, Fire Detection and Alarm System.</td><td>CO1, CO3</td></tr>
<tr><td>UNIT-II</td><td colspan="3">PLC ARCHITECTURE</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Introduction-Principles of operation–PLC Architecture and specifications – PLC hardware components- Analog & digital I/O modules, CPU & memory module – Programming devices – PLC ladder diagram. PLC programming Simple instructions–Timer & Counter instructions, Data manipulating instructions, math instructions; Manually operated switches– Mechanically operated switches - Latching relays.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-III</td><td colspan="3">APPLICATIONS OF PLC</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">PLC Interface -HMI, MMI, RFID. Applications of PLC – Motor start and stop, Simple materials handling applications, Automatic water level controller, Automatic lubrication of supplier Conveyor belt, Automatic car washing machine, Automatic Bar code & Labelling, Automatic Bottle filling, Bottle label detection and process control application.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td colspan="3">SCADA SYSTEM</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Communication Network, SCADA Server, SCADA/HMI Systems. Applications of SCADA: Power Generation & Distribution, Traffic Control, Oil & Gas Industry, Water and Sewage Management.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td colspan="3">DISTRIBUTED CONTROL SYSTEM</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Introduction to DCS –Need of DCS, Features - Elements - Configuration, Applications. Types of Interfacing Systems, Operator interfaces - Low level and high-level operator interfaces – Displays interface- Engineering interfaces – Low level and high-level engineering interfaces. Factors to be considered in selecting DCS –Various Process Interfacing issues, Communication facilities -Case studies – Sugar industry, Power plant and Paper industry.</td><td>CO4, CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 45</td><td colspan="2">Tutorial Periods: 15</td><td colspan="3">Practical Periods: NIL</td><td colspan="2">Total Periods: 45</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
<tr><td colspan="9">1. Gary Dunning, “Introduction to Programmable Logic Controllers”,3rd India edition, Cengage Learning, 2007
2. John Webb, “Programmable Logic Controllers: Principles and Applications”,5th edition Prentice Hall of India, 2012.
3. Krishna Kant “Computer Based Process Control”, Prentice Hall of India, 2004.
4. Michael P. Lukas, Distributed Control Systems: Their Evaluation and Design, Van NostrandReinhold Co., 1986
5. Jose A. Romagnoli, Ahmet Palazoglu, “Introduction to Process control”, CRC Taylor and Francis group, 2005.
6. Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	2	-
CO2	2	3	-	-	2	-	-	-	-	-	-	3	-
CO3	2	2	3	-	3	-	-	-	-	-	-	3	2
CO4	2	-	-	-	2	-	-	-	-	-	-	2	3
CO5	2	-	2	-	2	-	-	-	-	-	-	2	3
Mean	**2.2**	**1.2**	**1**	**-**	**1.8**	**-**	**-**	**-**	**-**	**-**	**-**	**2.4**	**1.6**

Score: 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fourth</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC110</td><td>Drone Technology and Design</td><td>3</td><td>0</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">NIL</td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course students will be able to</td><td>CO1</td><td colspan="7">Explain the fundamentals, classifications, and societal implications of UAVs</td></tr>
<tr><td>CO2</td><td colspan="7">Apply basic principles of aerodynamics and flight stability to UAV operations.</td></tr>
<tr><td>CO3</td><td colspan="7">Analyze UAV design parameters, components, and platform types to meet application needs.</td></tr>
<tr><td>CO4</td><td colspan="7">Demonstrate mission planning, control, and autonomous operations of UAVs.</td></tr>
<tr><td>CO5</td><td colspan="7">Evaluate maintenance procedures, regulatory standards, and safety protocols for UAV systems</td></tr>
<tr><td>UNIT-I</td><td colspan="3">INTRODUCTION TO UNMANNED AERIAL VEHICLES</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Overview of Unmanned Aerial Vehicles (UAVs): Definition, components, and classification (e.g., drones, fixed-wing aircraft) - Historical development and evolution of UAVs - Contemporary applications like military, government and civil areas. - Regulatory framework and legal considerations for operating UAVs and Drones - Ethical and societal implications of UAV technology.</td><td>CO1, CO5</td></tr>
<tr><td>UNIT-II</td><td colspan="3">BASIC CONCEPTS OF FLIGHT</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Aerodynamics: lift, weight, thrust, and drag. Flight performance: climbing vs. gliding flight, range / endurance - Stability and control: flight axes, flight controls, autopilots. Emergency identification and handling - Fixed wing operations: Types of fixed wing drones, make, parts, terminology and operation.</td><td>CO2, CO5</td></tr>
<tr><td>UNIT-III</td><td colspan="3">UAV DESIGN AND CONSTRUCTION</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Design considerations for UAV: aerodynamics, propulsion systems, structure, payload integration - Components of a typical UAV: airframe, motors, propellers, flight controller, sensors, communication systems - Types of UAV platforms: fixed-wing, rotary-wing (multirotor), hybrid - Safety protocols.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td colspan="3">FLIGHT TRAINING AND AUTONOMOUS UAV OPERATIONS</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Control systems - Flight planning and mission design for UAV operations: route planning, altitude control, waypoint navigation - Flight Modes - Pre-flight checks and procedures: equipment inspection, battery management, safety protocols.
Autonomy of Drone operation - Role of sensors in enabling autonomy: GPS, IMU, altimeter, cameras, LiDAR - Autonomous Flight Control - Stability - Autonomous Mission Planning and Execution</td><td>CO3, CO4</td></tr>
<tr><td>UNIT-V</td><td colspan="3">DRONE EQUIPMENT MAINTENANCE, REGULATORIES AND REGULATIONS</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Maintenance of drone, flight control box - Maintenance of ground equipment- batteries - Scheduled servicing - Repair of equipment - Fault finding and rectification - Weather and meteorology.
Homeland regulatory: FCC, FAA and foreign regulatory. Regulations: FCC compliance, UAS registration, Federal Aircraft Regulations (FARs) - Safety considerations.</td><td>CO4, CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 60</td><td colspan="2">Tutorial Periods: NIL</td><td colspan="2">Practical Periods: NIL</td><td colspan="3">Total Periods: 60</td></tr>
<tr><td colspan="9">Reference Books:
1. "Introduction to Unmanned Aircraft Systems" – Reg Austin
2. "Unmanned Aircraft Systems: UAV Design, Development, and Deployment" – Reg Austin
3. "Small Unmanned Aircraft: Theory and Practice" – Randal W. Beard, Timothy W. McLain
4. "Unmanned Aerial Vehicles: Embedded Control" – Rogelio Lozano
5. "Drone Pilot Handbook: The Complete Guide to Drones" – Adam Juniper
6. "Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles" – Kenzo Nonami</td></tr>
</table>

CO-PO / PSO Mapping

POs/PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	-	2	3	-	-	-	-	2	-
CO2	3	2	-	-	2	-	-	-	-	-	-	3	-
CO3	3	2	2	-	3	-	-	-	-	-	-	3	2
CO4	3	-	3	-	3	-	-	-	-	-	-	3	3
CO5	2	-	-	-	2	3	3	-	-	-	-	2	3
Mean	**2.8**	**0.8**	**1**	**-**	**2**	**1**	**3.2**	**-**	**-**	**-**	**-**	**2.6**	**1.6**

Score: 3 – High 2 – Medium 1 - Low

Department : **Mechatronics**		Programme : **B.Tech. (MT)**						
Semester : **Fourth**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUC111	**Micro controller and Embedded systems**	3	0	0	3	40	60	100
Prerequisite:	NIL							

Course Outcome At the end of the course, the students will be able to		
	CO1	**Explain** the fundamental differences between microcontrollers and microprocessors, ARM architecture, and its design philosophy
	CO2	**Develop** ARM assembly programs using different instruction sets and evaluate their performance through profiling and scheduling
	CO3	**Illustrate** the embedded system design flow and identify design challenges based on application-specific requirements.
	CO4	**Apply** co-design principles, embedded firmware development, and quality attributes in embedded system implementation.
	CO5	**Demonstrate** RTOS-based embedded system design by implementing task scheduling, synchronization, and memory management.

UNIT-I	**INTRODUCTION TO MICROCONTROLLERS**	**Periods: 09**
Microprocessors v/s Micro-controllers, Processor Architecture – Harvard v/s Princeton; ARM Embedded Systems: The RISC design philosophy, The ARM Design Philosophy, Embedded System Hardware, Embedded System Software. ARM Processor Fundamentals: Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table, Core Extensions		**CO1, CO2**
UNIT-II	**ARM INSTRUCTION SET AND PROGRAMMING**	**Periods: 09**
Introduction to the ARM Instruction Set: Data Processing Instructions, Programme Instructions, Software Interrupt Instructions, Program Status Register Instructions, Coprocessor Instructions, Loading Constants ARM programming using Assembly language: Writing Assembly code, Profiling and cycle counting, instruction scheduling, Register Allocation, Conditional Execution, Looping Constructs		**CO2, CO5**
UNIT-III	**INTRODUCTION TO EMBEDDED SYSTEMS**	**Periods: 09**
Complex systems and microprocessors-embedding computers, characteristics of embedded computing applications, challenges in embedded computing system design, performance in embedded computing; The embedded system design process-requirements, specification, architecture design, designing hardware and software, components, system integration, design example.		**CO3, CO5**
UNIT-IV	**EMBEDDED SYSTEM DESIGN PRINCIPLES**	**Periods: 09**
Characteristics and Quality Attributes of Embedded Systems, Operational quality attributes, non-operational quality attributes, Embedded Systems-Application and Domain specific, Hardware Software Co-Design and Program Modelling, embedded firmware design and development		**CO4, CO5**
UNIT-V	**RTOS BASED EMBEDDED SYSTEM DESIGN**	**Periods: 09**
Introduction to basic concepts of RTOS, Task, process & threads - Task management and scheduling - Interrupt servicing - Multiprocessing and Multitasking - Inter task Communication and data exchange - Synchronization between processes: Semaphores - Memory management - Issues in real-time system design - Design of Embedded Systems.		**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: NIL**	**Practical Periods: NIL**	**Total Periods: 45**

Reference Books:

1. Andrew N Sloss, Dominic Symes and Chris Wright, ARM system developers guide, Elsevier, Morgan Kaufman publishers, 2008.
2. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education, Private Limited, 2nd Edition.
3. Raghunandan..G.H, Microcontroller (ARM) and Embedded System, Cengage learning Publication,2019
4. The Insider's Guide to the ARM7 Based Microcontrollers, Hitex Ltd.,1st edition, 2005.
5. Steve Furber, ARM System-on-Chip Architecture, Second Edition, Pearson, 2015.
6. Raj Kamal, Embedded System, Tata McGraw-Hill Publishers, 2nd Edition, 2008.

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	2	-	-	2	-	-	-	-	-	-	3	-
CO3	3	-	3	-	3	-	-	-	-	-	-	3	3
CO4	3	3	2	-	2	-	-	-	-	-	-	3	3
CO5	3	2	3	-	3	-	-	-	-	-	-	3	3
Mean	**3**	**1.4**	**1.6**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1.8**

Score : 3 – High 2 – Medium 1 – Low

Department: **Computer Science and Engineering**		Programme: **B.Tech.. (MT/ECE/EEE/EIE)**						
Semester: **Fourth**		Course Category Code: **ESC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CSUC137	**Data Structures and Object – Oriented Programming**	**3**	**-**	**-**	**3**	**40**	**60**	**100**

Prerequisite: NIL

Course Outcome: At the end of the course students will be able to		
	CO1	Analyze and implement various searching and sorting techniques.
	CO2	Choose appropriate data structures to solve real world problems data structures.
	CO3	Explain the basics Concepts of Object-Oriented Programming.
	CO4	Develop C++ programs by applying the concepts Inheritance and Polymorphism.

UNIT-I	**Arrays, Searching and Sorting**	**Periods: 09**
Algorithm: Characteristics – Representation – Efficiency of Algorithms – Data Structures: Characteristics – Types – Arrays: Introduction – Types – Representation – Operations – Applications: Sparse Matrix –Searching: Linear Search and Binary Search – Sorting techniques: Insertion Sort, Selection Sort, Bubble Sort, Quick Sort and Heap Sort.		**CO1**
UNIT-II	**Linear Data Structures**	**Periods: 09**
Stacks: Introduction – Operations – Applications: Evaluation of Expressions – Queues: Introduction – Operations – Circular queues – Priority queues – Double ended queues – Applications: Job Scheduling – Linked List: Introduction – Singly Linked List – Circularly Linked List and Doubly Linked List – Applications: Polynomial Addition.		**CO2**
UNIT-III	**Non-Linear Data Structures**	**Periods: 09**
Trees: Introduction – Terminology – Binary tree – Representation – Traversals– Graph: Introduction – Terminology – Representation – Traversals – Single Source and All Pairs Shortest path algorithms.		**CO2**
UNIT-IV	**Introduction to Object-Oriented Programming**	**Periods: 09**
Basics Concepts of Object-Oriented Programming – Structure of C++ – Tokens-Expressions-Control Structures – Functions in C++: Inline Functions – Recursion– Function Overloading – Classes and Objects –Constructors and Destructors – Friend Functions.		**CO3**
UNIT-V	**Concepts of Object-Oriented Programming**	**Periods:09**
Operators Overloading: Unary and Binary Operators – Type Conversions – Inheritance –Types – Polymorphism – Virtual Functions – Exception Handling: Basics and Mechanism.		**CO3, CO4**

Lecture Periods: 45	**Tutorial Periods: NIL**	**Practical Periods: NIL**	**Total Periods: 45**

Reference Books:

1. E. Balagurusamy, "Data Structures", McGraw Hill Education (India) Private Limited, 2018.
2. G. A. Vijayalakshmi Pai, *A Textbook of Data Structures and Algorithms, Volume 1: Mastering Linear Data Structures*, Wiley, August 2022.
3. Ellis Horowitz, Sartaj Sahni and Susan Anderson Freed, "Fundamentals of Data Structures in C", Second Edition, Universities Press (India) Private Limited,2018.
4. E. Balagurusamy, "Object Oriented Programming with C++", McGraw Hill Education (India) Private Limited, Seventh Edition, 2019.

CO-PO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	-	-	-	-	-
CO2	3	3	3	2	3	-	-	-	-	-	2	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	3	-	-	1	1	-	2	-	-
Mean	**3**	**2.75**	**2.5**	**1.5**	**2**	**-**	**-**	**0.25**	**0.25**	**-**	**1**	**-**	**-**

Score: 3 – High; 2 – Medium; 1 – Low

Department : Humanities and Social Sciences		Programme: B.Tech. (Common to all branches)						
Semester : Fourth		**Course Category Code: AEC**				**Semester Exam Type: TY**		
Course Code	**Course Name**	**Periods / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
HSUA104	**Design Thinking**	**2**	**-**	**-**	**2**	**40**	**60**	**100**
Prerequisite:								

Course Outcome At the end of the course students will be able to	**CO1**	Apply Design Thinking to solve engineering problems
	CO2	Produce creative solutions for real-world problems using brainstorming and other idea-generation techniques
	CO3	Build and test prototypes to validate design ideas and improve them based on user feedback.
	CO4	Collaborate work in teams and communicate ideas effectively through presentations, reports, and discussions.

UNIT-I	**Introduction to Design Thinking**	**Periods: 06**
Understanding the Need for Design Thinking in Engineering - Five-Stage Process: Empathize, Define, Ideate, Prototype, Test - Case Studies: How Engineering Innovations Used Design Thinking - Mindset Shift: From Problem-Solving to Human-Centered Design **Team Exercise:** Identify a real-world engineering problem and discuss how Design Thinking can be applied.		CO1, CO4
UNIT-II	**Empathize**	**Periods: 06**
Importance of User Research in Engineering Solutions - Techniques: Interviews, Observations, Surveys, Empathy Mapping - Engineering Constraints vs. User-Centric Needs - Role of Emotional Intelligence in Product Development **Team Exercise:** Conduct field research (interview users or observe a process) and create an Empathy Map for an engineering challenge.		CO1, CO2
UNIT-III	**Define & Ideate**	**Periods: 06**
Problem Definition Techniques: How to Frame the Right Problem - Creating Point of View (POV) Statements - Brainstorming & Idea Generation Techniques: SCAMPER, Reverse Thinking, Mind Mapping - Evaluating and Selecting Feasible Engineering Solutions **Team Exercise:** Define a problem statement and conduct a Brainstorming Workshop to generate innovative solutions.		CO2, CO4
UNIT-IV	**Prototyping**	**Periods: 06**
Importance of Rapid Prototyping in Engineering - Types of Prototypes: Paper, Digital, Physical Models, Simulation - Tools & Technologies: 3D Printing, CAD, Arduino, Low-Code Development - Iteration & Refinement – Learning from Failures **Team Exercise**: Develop a low-fidelity prototype of an engineering solution and present it to peers for feedback.		CO3, CO4
UNIT-V	**Testing, Iteration & Implementation**	**Periods: 06**
Methods of Testing: Usability Testing, A/B Testing, Stress Testing - Gathering Feedback: Stakeholder & User Insights - Iteration Strategies: Continuous Improvement & Agile Thinking - Real-World Engineering Applications of Design Thinking **Team Exercise:** Conduct a user test on the prototype, refine it based on feedback, and present the final solution in a showcase session.		CO3, CO4

Lecture Periods: 30	**Tutorial Periods: NIL**	**Practical Periods: NIL**	**Total Periods: 30**

Reference Books:

1. Michael Lewrick, Patrick Link, and Larry Leifer, The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods, Wiley, 1st Edition, 2020.
2. Teun den Dekker, Design Thinking, Noordhoff Uitgevers by International Edition, 2020
3. Angèle M. Beausoleil, Business Design Thinking and Doing, Palgrave Macmillan Imprint, Springer, 2022
4. Soni Pavan, Design your Thinking, Penguin Random House India Publishing, 2020
5. E Balagurusamy, Design Thinking, McGraw Hill; First Edition, 2024

CO-PO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	-	-	-	-	-	-	-	-	2	-
CO2	2	3	3	-	2	-	-	-	-	-	-	2	-
CO3	2	3	3	-	3	-	-	-	-	-	-	3	-
CO4	-	-	-	-	-	-	-	2	3	3	-	-	-
Mean	**1.75**	**2.25**	**2.25**	**-**	**1.25**	**-**	**-**	**0.5**	**0.75**	**0.75**	**-**	**1.75**	**-**

Score: 3 – High; 2 – Medium; 1 – Low

<table>
<tr><td colspan="2">Department : HSS</td><td colspan="7">Programme: B.Tech. (Common to all branches)</td></tr>
<tr><td colspan="2">Semester : Fourth</td><td colspan="4">Course Category Code: AEC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>HSUA106</td><td>Foreign Language - FRENCH</td><td>2</td><td>-</td><td>-</td><td>2</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
</table>

Course Outcome At the end of the course students will be able to	**CO1**	Acquire the basics of the French language
	CO2	Apply the acquired basics of the language in expressing oneself
	CO3	Develop basic conversation skills
	CO4	Communicate their student life in the University context
	CO5	Equip the students to communicate within technical contexts

UNIT-I	**INTRODUCTION TO FRENCH AND BASICS**	**Periods: 06**
French alphabets and pronunciation – Greetings and Introductions (Bonjour ça va?) – Numbers, days of the week, months, seasons – Classroom expressions and instructions – Articles (Definite and Indefinite) – Basic sentence structure (Subject – Verb Agreement)		**CO 1**
UNIT-II	**PERSONAL IDENTITY AND EXPRESSIONS**	**Periods: 06**
Introducing oneself and others (Je me présente……) – Nationalities and Professions – Describing people (Physical appearance and Personality) – Possessive adjectives (mon, ma, mes…) – Gender and number agreement of adjectives		**CO 2**
UNIT-III	**DAILY LIFE AND ROUTINES**	**Periods: 06**
Talking about daily activities and schedules (Je me lève à 7 heures…) – Telling the time and discussing time tables – Common verbs in the present tense (ER, IR, RE verbs) – Reflexive verbs (Se lever, s'habiller…)		**CO 3**
UNIT-IV	**DIRECTIONS AND UNIVERSITY LIFE**	**Periods: 06**
Asking for and giving directions (Où est….? A gauche, A droite…) – Describing locations (Près de, loin de….)- Talking about University courses and subjects (J'éudie l'ingénierie…) - Prepositions of place (sur, sous, devant….) – Using Il y a and C'est for descriptions		**CO 4**
UNIT-V	**FUTURE PLANS, BASIC TECHNICAL PRESENTATIONS AND TECHNICAL AND ENGINEERING CONTEXTS**	**Periods: 6**
Talking about future career goals (Je veux devenir ingénieur…..) Using future proche for near future plans- Vocabulary related to Engineering disciplines – Talking about machines and materials (Acier, moteur, circuit….) – Giving simple presentations on technical topics – Introduction to passive voice (La machine est réparée….)		**CO 5**

Lecture Periods: 30	**Tutorial Periods: NIL**	**Practical Periods: NIL**	**Total Periods: 30**

Reference Books:

1. Nouvelle Generations A1, Luca Giachino, Carla Baracoo, Didier FLE, 2020, Paris
2. Tech French – French for Science and Technology, Ingrid Le Gargasson, Shariva Naik et Claire Chaize, Goyal Publishers, 1 April 2011.
3. Écho – Méthode de Français, A1 , Girardet, Pecheur, CLE International,2013.
4. Écho Cahier personnel d'apprentissage, A1, Girardet, Pecheur, CLE International, 2013.

CO-PO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	-	-	3	3	-	3	-	-
CO2	-	-	-	-	-	-	-	3	3	-	3	-	-
CO3	-	-	-	-	-	-	-	3	3	-	3	-	-
CO4	-	-	-	-	-	-	-	3	3	-	3	-	-
CO5	-	-	-	-	-	-	-	3	3	-	3	-	-
Mean	-	-	-	-	-	-	-	**3**	**3**	-	**3**	-	-

Score: 3 – High; 2 – Medium; 1 – Low

<table>
<tr><td colspan="2">Department :Common to all</td><td colspan="7">Programme: B.Tech. (Common to all branches)</td></tr>
<tr><td colspan="2">Semester : Fourth</td><td colspan="4">Course Category Code: VAC</td><td colspan="3">Semester Exam Type:</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name:</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>GEUV104</td><td>Universal Human Values</td><td>1</td><td>0</td><td>0</td><td>1</td><td>100</td><td>0</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">-</td></tr>
<tr><td rowspan="4">Course Outcome
At the end of the course students will be able to</td><td>CO1</td><td colspan="7">Develop a Holistic Understanding of Value Education</td></tr>
<tr><td>CO2</td><td colspan="7">Foster Personal and Social Harmony</td></tr>
<tr><td>CO3</td><td colspan="7">Enhance Awareness of Universal Co-existence</td></tr>
<tr><td>CO4</td><td colspan="7">Apply Ethical and Humanistic Principles in Professional and Personal Life</td></tr>
<tr><td>Module--I</td><td colspan="4">Introduction to Value Education</td><td colspan="4">Periods: 03</td></tr>
<tr><td colspan="8">Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations</td><td>CO1</td></tr>
<tr><td>Module-II</td><td colspan="4">Harmony in the Human Being</td><td colspan="4">Periods: 03</td></tr>
<tr><td colspan="8">Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health</td><td>CO2</td></tr>
<tr><td>Module-III</td><td colspan="4">Harmony in the Family and Society</td><td colspan="4">Periods: 03</td></tr>
<tr><td colspan="8">Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-toHuman Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order</td><td>CO2</td></tr>
<tr><td>Module-IV</td><td colspan="4">Harmony in the Nature/Existence</td><td colspan="4">Periods: 03</td></tr>
<tr><td colspan="8">Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence</td><td>CO3</td></tr>
<tr><td>Module-V</td><td colspan="4">Implications of the Holistic Understanding</td><td colspan="4">Periods: 03</td></tr>
<tr><td colspan="8">A Look at Professional Ethics : (3 hours) Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession</td><td>CO4</td></tr>
<tr><td colspan="2">Lecture Periods: 15</td><td colspan="2">Tutorial Periods: NIL</td><td colspan="2">Practical Periods: NIL</td><td colspan="3">Total Periods: 15</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
</table>

1. Student Induction Program Handbook v2 by AICTE NCC-IP sub-committee: Dr. Rajneesh Arora, Chairman NCC-IP, Dr. Shishir Gaur, Convener NCC-IP, Dr. Ruchir Gupta, Member NCC-IP.
2. a foundation course in R R Gaur R Asthana G P Bagaria HUMAN VALUES and professional ethics , R R Gaur R Asthana G P Bagaria
3. Understanding Human Being, Nature and Existence Comprehensively By UHV Team (https://uhv.org.in/uhve)
4. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics RR Gaur, R Asthana, GP Bagaria

CO-PO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	3	3	2	2	2	3	-	-
CO2	-	-	-	-	-	3	3	3	3	2	3	-	-
CO3	-	-	-	-	-	3	3	2	2	2	3	-	-
CO4	-	-	-	-	-	3	3	2	2	3	3	-	-
Mean	-	-	-	-	-	**3**	**3**	**2.25**	**2.25**	**2.25**	**3**	-	-

Score: 3 – High; 2 – Medium; 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fourth</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC112</td><td>Industrial Automation Laboratory</td><td>0</td><td>0</td><td>3</td><td>1.5</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8">Industrial Automation Theory</td></tr>
</table>

Course Outcome		
Course Outcome At the end of the course students will be able to	**CO1**	**Explain** the architecture of Programmable Logic Controllers (PLCs) and the principles of ladder diagram programming using simulation tools like Versapro and Delta-WPL.
	CO2	**Construct** ladder logic programs using timers, counters, comparison, and arithmetic operations for basic industrial automation scenarios.
	CO3	**Implement and test** real-time control systems using PLCs for applications such as traffic light control, water level regulation, elevator automation, and bottle filling processes.
	CO4	**Design and integrate** PLC and SCADA systems to automate advanced industrial processes including water treatment, fire detection, and building management systems.

Develop PLC program using Ladder Diagram for Various Applications:
(The testing of the PLC program may be done with corresponding trainer kits and simulation software including Versapro / Delta- WPL.)

1. Study of PLC and Ladder Diagram (LD)
2. Development of LD in PLC for simple applications using timers, counters, comparison and arithmetic instructions.
3. Measure temperature characteristics using PLC.
4. One-way and two-way traffic control system.
5. Water Level Control system.
6. Material Handling system.
7. Bottle Filling process.
8. Automated Car parking process.
9. Automated Elevator Control.
10. Control of rotating stepper motor in forward and reverse direction at constant speed.

CO1, CO2,

Design real time industrial applications using PLC and SCADA.

11. Automate the different stages of Water Treatment including Filtration, Chlorination, and Distribution using PLC.
12. Implement a PLC based Fire Detection and Control System that can activate Sprinklers, Alarms, and notify authorities.
13. Implement a SCADA -based building management system that integrates lighting, HVAC, and security.
14. Develop a flexible manufacturing line that can be easily reconfigured for different products, all controlled by PLC/ SCADA.
15. Use a PLC to control a 3D printer, focusing on precision and support for various materials.

CO3, CO4

Lecture Periods: NIL	Tutorial Periods: NIL	Practical Periods: 45	Total Periods: 45

Reference Books

1. Krishna Kant – “Computer Based Industrial Control”, EEE-PHI, 2nd edition, 2010.
2. Garry Dunning-Introduction to Programmable Logic Controllers, 2nd edition, Thomson, ISBN: 981-240-625-5.
3. W.Bolton- Programmable Logic Controllers, Sixth Edition (Paperback) ISBN-13: 978- 0128029299, 2012.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	3	2
CO2	3	2	2	-	-	-	-	-	-	-	-	3	2
CO3	3	-	3	-	2	-	-	-	-	-	-	3	3
CO4	-	-	3	-	3	2	2	-	-	-	-	3	3
Mean	**2.25**	**1**	**2**	**-**	**1.25**	**0.5**	**0.5**	**-**	**-**	**-**	**-**	**3**	**2.5**

Score: 3 – High   2 – Medium   1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fourth</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC113</td><td>Micro Controller and Embedded System Laboratory</td><td>0</td><td>0</td><td>3</td><td>1.5</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8">Micro controller and Embedded system Theory</td></tr>
</table>

<table>
<tr><td rowspan="4">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td>Apply fundamental ARM assembly language instructions to develop programs for arithmetic and logical operations on the ARM7TDMI/LPC2148 microcontroller.</td></tr>
<tr><td>CO2</td><td>Analyze and implement algorithms such as array manipulation, sorting, and data counting using both Assembly and Embedded C programming.</td></tr>
<tr><td>CO3</td><td>Design and construct embedded system applications by interfacing peripherals (e.g., motors, ADC, DAC, keyboard, LCD, UART) with the ARM7 microcontroller.</td></tr>
<tr><td>CO4</td><td>Evaluate the performance and functionality of embedded applications using debugging tools in Keil uVision, and modify code to meet specified requirement.</td></tr>
</table>

<table>
<tr><td>Assembly Language Program (ALP) for ARM7TDMI/LPC2148 using an evaluation board/simulator and the required software tool.
1. Write an ALP to multiply two 16-bit binary numbers.
2. Write an ALP to find the sum of first 10 integer numbers.
3. Write an ALP to find factorial of a number.
4. Write an ALP to add an array of 16-bit numbers and store the 32-bit result in internal RAM.
5. Write an ALP to find the square of a number (1 to 10) using look-up table.
6. Write an ALP to find the largest/smallest number in an array of 32 numbers.
7. Write an ALP to arrange a series of 32-bit numbers in ascending/descending order.
8. Write an ALP to count the number of ones and zeros in two consecutive memory locations.</td><td>CO1, CO2</td></tr>
<tr><td>Conduct the following experiments on an ARM7TDMI/LPC2148 evaluation board using evaluation version of Embedded 'C' & Keil Uvision-4 tool/compiler.
9. Display “Hello World” message using Internal UART.
10. Interface and Control a DC Motor.
11. Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
12. Determine Digital output for a given Analog input using Internal ADC of ARM controller.
13. Interface a DAC and generate Triangular and Square waveforms.
14. Interface a 4x4 keyboard and display the key code on an LCD.
15. Demonstrate the use of an external interrupt to toggle an LED On/Off.
16. Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay.</td><td>CO3, CO4</td></tr>
</table>

Lecture Periods: NIL	**Tutorial Periods: NIL**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books

1. Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, “The 8051 Microcontroller and Embedded Systems", Pearson Education, Second Edition, 2014.
2. Douglas V Hall, "Microprocessors and Interfacing", McGraw Hill Education, 3rd Edition (SIE), 2017
3. Andrew N Sloss, D. Symes, C. Wright, “Arm System Developers Guide”, Morgan Kauffman/ Elsevier, 2006.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	1	-	-	-	-	-	-	1	2	1
CO2	3	2	-	1	-	-	-	-	-	-	1	2	1
CO3	3	3	3	1	1	-	-	-	-	-	1	2	1
CO4	3	3	2	1	1	1	-	-	-	-	1	2	1
Mean	**2**	**1.5**	**2.75**	**0.5**	**2.50**	**-**	**-**	**-**	**-**	**-**	**-**	**2.75**	**2.50**

Score: 3 – High 2 – Medium 1 - Low

Department: **Computer Science and Engineering**		Programme: **B.Tech. (ECE/EEE/EIE/MT)**						
Semester: **Fourth**		Course Category Code: **ESC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CSUC138	**Data Structures and Object – Oriented Programming Laboratory**	**-**	**-**	**3**	**1.5**	**40**	**60**	**100**

Prerequisite:	NIL	
Course Outcome: At the end of the course students will be able to	**CO1**	Select and implement appropriate Searching/sorting algorithms for an application.
	CO2	Implement linear/non-linear data structures using C.
	CO3	Apply OOP principles of classes, object and encapsulation to real time problems.
	CO4	Apply inheritance and polymorphism to build modular and reusable code to real time applications.

Ex. No.	**Experiment Name/Brief Description**	
Data Structures Experiments		
1. 2.	Implementation of Linear search and binary search. Implementation Insertion sort, Selection sort, Bubble sort, Quick sort and Heap Sort.	**CO1**
3. 4.	Array implementation of Stacks and Queues. Implementation of Singly and Doubly Linked List.	**CO2**
5. 6.	Implementation of Binary Tree Traversals. Implementation of Graph Traversals and shortest path Algorithms.	**CO2**
C++ Experiments		
7. 8.	Programs to implement classes and objects. Programs to implement constructors and destructors.	**CO3**
9. 10.	Programs to implement different types of inheritance. Programs to implement virtual functions to demonstrate the use of run time polymorphism.	**CO4**

Lecture Periods: NIL	**Tutorial Periods: NIL**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books:

1. Ellis Horowitz, Sartaj Sahni and Susan Anderson Freed, "Fundamentals of Data Structures in C", Second Edition, Universities Press (India) Private Limited, 2018.
2. E. Balagurusamy, "Object Oriented Programming with C++", McGraw Hill Education (India) Private Limited, 8th Edition, 2021.

CO-PO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	-	-	-	-	-
CO2	3	3	3	2	3	-	-	-	-	-	2	-	-
CO3	3	2	2	-	2	-	-	-	-	-	-	-	-
CO4	3	3	3	2	3	-	-	1	1	-	2	-	-
Mean	**3**	**2.75**	**2.75**	1.5	**2.5**	-	-	0.25	0.25	-	1	-	-

Score: 3 – High; 2 – Medium; 1 – Low

SEMESTER –V

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="6">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : FIFTH</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC114</td><td>Control System</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">NIL</td></tr>
</table>

<table>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td>Explain the basic components and structure of control systems including electrical and mechanical models</td></tr>
<tr><td>CO2</td><td>Analyze time-domain responses of first and second order systems and design PID controllers.</td></tr>
<tr><td>CO3</td><td>Interpret frequency response characteristics and design compensators using Bode plots</td></tr>
<tr><td>CO4</td><td>Evaluate system stability using Routh-Hurwitz and Nyquist criteria and construct root locus diagram</td></tr>
<tr><td>CO5</td><td>Develop and analyze state-space models for linear and digital control systems</td></tr>
</table>

<table>
<tr><td>UNIT-I</td><td>SYSTEMS COMPONENTS AND THEIR REPRESENTATION</td><td colspan="2">Periods: 09</td></tr>
<tr><td colspan="3">Control System: Terminology and Basic Structure-Feed forward and Feedback control theory Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs models-DC and AC servo Systems-Synchros -Multivariable control system.</td><td>CO1, CO5</td></tr>
<tr><td>UNIT-II</td><td>TIME REPONSE ANALYSIS</td><td colspan="2">Periods: 09</td></tr>
<tr><td colspan="3">Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number-PID control-Analytical design for PD, PI, PID control systems.</td><td>CO2, CO5</td></tr>
<tr><td>UNIT-III</td><td>FREQUENCY RESPONSE AND SYSTEM ANALYSIS</td><td colspan="2">Periods: 09</td></tr>
<tr><td colspan="3">Closed loop frequency response - Performance specification in frequency domain - Frequency response of standard second order system- Bode Plot - Polar Plot- Nyquist plots-Design of compensators using Bode plots-Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td>CONCEPTS OF STABILITY ANALYSIS</td><td colspan="2">Periods: 09</td></tr>
<tr><td colspan="3">Concept of stability-Bounded - Input Bounded - Output stability-Routh stability criterion-Relative stability-Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion.</td><td>CO3, CO4</td></tr>
<tr><td>UNIT-V</td><td>CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS</td><td colspan="2">Periods: 09</td></tr>
<tr><td colspan="3">State variable representation - Conversion of state variable models to transfer functions - Conversion of transfer functions to state variable models -Solution of state equations-Concepts of Controllability and Observability-Stability of linear systems-Equivalence between transfer function and state variable representations-State variable analysis of digital control system-Digital control design using state feedback.</td><td>CO4, CO5</td></tr>
</table>

Lecture Periods: 45	**Tutorial Periods: NIL**	**Practical Periods: NIL**	**Total Periods: 45**

Reference Books:

1. M.Gopal, “Control System – Principles and Design”, Tata McGraw Hill, 4th Edition, 2012.
2. J.Nagrath and M.Gopal, “Control System Engineering”, New Age International Publishers, 5 th Edition, 2007.
3. K. Ogata, ‘Modern Control Engineering’, 5th edition, PHI, 2012.
4. S.K.Bhattacharya, Control System Engineering, 3rd Edition, Pearson, 2013.
5. Benjamin.C.Kuo, “Automatic control systems”, Prentice Hall of India, 7th Edition,1995.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	3	2
CO2	3	3	2	2	-	-	-	-	-	-	-	3	2
CO3	3	3	3	2	-	-	-	-	-	-	-	3	3
CO4	3	3	3	2	-	-	-	-	-	-	-	3	3
CO5	3	3	3	3	2	-	-	-	-	-	-	3	3
Mean	**3**	**2.8**	**2.2**	**1.8**	**0.4**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2.6**

Score : 3 – High   2 – Medium   1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="7">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fifth</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC115</td><td>Automotive Electronics</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">NIL</td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course students will be able to</td><td>CO1</td><td colspan="7">Explain the configuration and components of various automotive systems including engines, emission norms, and charging systems</td></tr>
<tr><td>CO2</td><td colspan="7">Analyze electronic ignition and fuel injection systems used in modern vehicles</td></tr>
<tr><td>CO3</td><td colspan="7">Interpret the characteristics and functions of various automotive sensors and actuators</td></tr>
<tr><td>CO4</td><td colspan="7">Evaluate engine control subsystems and communication networks used in automotive applications</td></tr>
<tr><td>CO5</td><td colspan="7">Design and explain the working of electronic automatic and safety systems in automobile</td></tr>
<tr><td>UNIT-I</td><td colspan="3">INTRODUCTION TO AUTOMOBILES</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Evolution of Automotive Electronics, Automobile Physical Configuration - Classification of vehicles – drives - general layout. Engine - Diesel and Petrol and hybrid engines. Basics of combustion –exhaust emissions, emission limits and Introduction to Euro & Bharat Standards. Charging systems: Working and design of charging circuit diagram– Alternators – Requirements of starting system - Starter motors and starter circuits.</td><td>CO1, CO3</td></tr>
<tr><td>UNIT-II</td><td colspan="3">IGNITION AND INJECTION SYSTEMS</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition – Distribution less ignition - Direct ignition – Spark Plugs. Electronic fuel Control: Basics of combustion – Engine fueling and exhaust emissions – Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-III</td><td colspan="3">SENSORS FOR ENGINES</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, vacuum operated actuator.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td colspan="3">ENGINE CONTROL MANAGEMENT</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU’s used in the engine management – block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles.</td><td>CO3, CO4</td></tr>
<tr><td>UNIT-V</td><td colspan="3">AUTOMATIC & SAFETY SYSTEMS</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="8">Traction control system – Cruise control system – electronic control of automatic transmission – antilock braking system – electronic suspension system – working of airbag and role of MEMS in airbag systems – centralized door locking system – climate control of cars.</td><td>CO4, CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 45</td><td colspan="2">Tutorial Periods:15</td><td colspan="2">Practical Periods: Nil</td><td colspan="3">Total Periods: 60</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
<tr><td colspan="9">1. Ribbens, "Understanding Automotive Electronics", 7th Edition, Elsevier, Indian Reprint, 2013
2. Tom Denton, “Automobile Electrical and Electronics Systems”, Edward Arnold Publishers, 2000.
3. William H. Crouse & Donald L. Anglin, Automotive Mechanics, TMH, 10th Edition, 2007. ISBN: 13:978-0-07-0634350
4. Barry Hollembeak, “Automotive Electricity, Electronics & Computer Controls”, Delmar Publishers, 2001.
5. Richard K. Dupuy “Fuel System and Emission controls”, Check Chart Publication, 2000.
6. Ronald. K. Jurgon, “Automotive Electronics Handbook”, McGraw-Hill, 1999.</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	2	-	-	-	-	3	2
CO2	3	3	2	2	1	-	-	-	-	-	-	3	3
CO3	3	3	3	2	2	-	-	-	-	-	-	3	3
CO4	3	3	2	3	3	-	-	-	-	-	-	3	3
CO5	3	3	3	2	2	-	2	-	-	-	-	3	3
Mean	**3**	**2.8**	**2**	**1.8**	**1.6**	**-**	**0.8**	**-**	**-**	**-**	**-**	**3**	**2.8**

Score : 3 – High 2 – Medium 1 – Low

Department : **Electrical and Electronics Engineering**		Programme : **B.Tech. (MT)**						
Semester : **Fifth**		Course Category Code: **ESC**				Semester Exam Type **: TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC131	**Electric Motors & Power Electronics in Motion Control**	3	0	0	3	40	60	100
Prerequisite:	**Analog and Digital Electronics**							

Course Outcome At the end of the course students will be able to		
	CO1	Explain the electromechanical energy conversion and working of DC and AC motors.
	CO2	Apply the principles of semiconductor switches and also analyze the working of different electric power modulators (circuits).
	CO3	Evaluate the necessity of special electrical motors and also their working along with power electronic circuits
	CO4	Apply the mechanical characteristics of different motors and industrial process and hence suggest suitable motors and related systems.

UNIT-I	**DC Motors**	**Periods: 09**
Principle of Electric Motors-Electromechanical energy conversion, Motor action; DC Motor- Construction, Torque Equation; Connection, Basic equations, Electrical and Mechanical Characteristics, Qualitative comparisons of different types of DC motors; Speed Control; Braking Methods; Losses and Energy Efficient Motors. DC Servo Motors; Motor Specifications; Types of Enclosures-Hazards; Interpretation of IS:2253.		**CO1**
UNIT-II	**AC Motors**	**Periods: 09**
Three Phase Induction Motor: Three phase Squirrel Cage Induction Motor- Construction, Establishment of rotating magnetic field; Types, Electrical and mechanical characteristics, Speed control; Braking Methods; Losses and Energy Efficient Motors; Interpretation of IS 12615:2018. **Single Phase Induction Motor:** Basic Construction; Reason for not self-starting-Alternating magnetic field Vs Rotating magnetic field, Cross-field theory; Types; Working of capacitor start induction run and Capacitor start capacitor run motors; Electrical and Mechanical Characteristics.		**CO1**
UNIT-III	**Power Electronic Circuits for Motors and Actuators**	**Periods: 09**
Power Semiconductor Switches: Signal Devices Vs Power Devices, Characteristics of an ideal switch; Power Diode, SCR and IGBT- Construction, Working, Static Characteristics, Symbol. **Single Phase Full Wave Rectifies:** Uncontrolled Vs Controlled Rectification; Power circuit, waveforms, mode diagrams and output voltage relations for continuous (with ripple) and discontinuous load currents; Full Converter with Free-Wheeling Diode; Dual Converters. **Voltage Source Inverter:** Single Phase H Bridge VSI- Square wave operation, Harmonic analysis; Voltage control and Shaping Harmonic Spectrum- Single pulse, multipluse and sinusoidal pulse width modulations. Three Phase VSI- Six step operation in 180^0 conduction modes using fundamental switching; SPWM Strategy for three phase VSI- Achieving VVVF AC.		**CO2**
UNIT-IV	**Special Electric Motors and Control**	**Periods: 09**
DC and AC Servo motors- Constructional differences and arriving servo features in speed-torque characteristics, Applications. Construction, Working, Characteristics, Power Electronic Control, and Applications of Stepper Motors, Linear Induction motor, and BLDC motor.		**CO1, CO3**
UNIT-V	**Motoring and Actuation**	**Periods: 09**
Required motion control actions in industries; Speed-torque characteristics of different industrial process; Components of load torque; Class of motor duty. Motor and PE circuit selections, Protection and control arrangements in Cutting tools, Lathe, Milling machine, Casting System, Welding Machine.		**CO4**

Lecture Periods: 45	**Tutorial Periods: NIL**	**Practical Periods: NIL**	**Total Periods: 45**

Reference Books:

1. K. Murugesh Kumar*, DC Machines & Transformers*, Vikas Publishing House Pvt Ltd, 2004.
2. K. Murugesh Kumar, *Induction & Synchronous Machines*, Vikas Publishing House Pvt Ltd, 2004.
3. Bimbra P.S. Bimbhra, *Power Electronics*, Khanna Publishers, New Delhi, 2025.
4. Ramu Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press Inc, 2009.
5. Kenneth Rexford and Peter R.Giuliani, *Electrical Control*, Vijay Nicole-Thomson Delmar Learning, 2004.
6. S.K.Pillai, *A First Course on Electrical Drives*, New Age International Pvt. Ltd., 2010.

CO-PO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	1	3	-	-	3	-	3	-	-
CO2	3	3	3	3	2	2	-	-	2	-	1	-	-
CO3	3	3	3	3	1	2	-	-	2	-	1	-	-
CO4	2	3	3	3	3	3	-	-	2	-	3	-	-
Mean	**2.75**	**2.75**	**2.75**	**2.75**	**1.75**	**2.5**	**-**	**-**	**2.25**	**-**	**2**	**-**	**-**

Score: 3 – High; 2 – Medium; 1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="7">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fifth</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC116</td><td>Control System Laboratory</td><td>0</td><td>0</td><td>3</td><td>1.5</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">Micro controller and Embedded system Theory</td></tr>
</table>

<table>
<tr><td rowspan="5">Course Outcome
At the end of the course students will be able to</td><td>CO1</td><td>Explain the basic concepts of control systems and simulate fundamental responses.</td></tr>
<tr><td>CO2</td><td>Analyze system stability using time and frequency domain methods.</td></tr>
<tr><td>CO3</td><td>Implement controller design techniques for practical applications.</td></tr>
<tr><td>CO4</td><td>Evaluate real-world case studies of control system applications.</td></tr>
<tr><td>CO5</td><td>Design and develop simulation-based control system solutions.</td></tr>
</table>

<table>
<tr><td>Basic System Analysis

1. Introduction to Scilab/Xcos and Control System Toolbox – Basics of simulation tools for control system experiments.
2. Time Response Analysis of First and Second Order Systems – Step, impulse, and ramp response analysis.
3. Effect of Damping on System Performance – Study of overdamped, critically damped, and underdamped systems.
4. Block Diagram Reduction and Signal Flow Graphs – Simplification using Mason’s Gain Formula.</td><td>CO1</td></tr>
<tr><td>Stability and Frequency Response

5. Transfer Function Determination and Stability Analysis – Poles, zeros, and system characteristics.
6. Root Locus Analysis – Stability assessment and controller tuning using root locus plots.
7. Bode Plot and Frequency Response Analysis – Gain margin, phase margin, and bandwidth estimation.
8. Nyquist Stability Criterion – Application in stability assessment of closed-loop systems.</td><td>CO2</td></tr>
<tr><td>Controller Design and Compensation

9. PID Controller Tuning and Simulation – Implementation of P, PI, and PID controllers.
10. Lead and Lag Compensator Design – Design using frequency domain methods.
11. Pole-Zero Placement for Desired System Performance – Modifying transient response characteristics.</td><td>CO3</td></tr>
<tr><td>Control System Applications

12. DC Motor Speed Control using PID Controller – Open-loop and closed-loop control of DC motors.
13. Servo Motor Position Control – Implementation of servo motor dynamics in simulation.
14. Temperature Control System using PID – Simulation of thermal system regulation.
15. Ball and Beam System Control – Stability and control using PID and other controllers.</td><td>CO4</td></tr>
<tr><td>Advanced Applications and Case Studies

16. Magnetic Levitation System Simulation – Understanding real-world unstable systems.
17. Inverted Pendulum Control System – Designing controllers for inherently unstable systems.
18. State-Space Analysis and Pole Placement – Controllability and observability verification.</td><td>CO5</td></tr>
</table>

Lecture Periods: NIL	**Tutorial Periods: NIL**	**Practical Periods: 45**	**Total Periods: 45**

Software Requirements:

- **Scilab/Xcos** – Graphical simulations and system modeling.
- **GNU Octave** – Control system analysis and frequency response plots.
- **Python (Control Systems Library, Matplotlib, SciPy)** – Numerical simulations and algorithm-based control experiments

Reference Books:

1. K. Ogata, *Modern Control Engineering*, Pearson Education, 5th Edition.
2. B.C. Kuo, *Automatic Control Systems*, Wiley India, 8th Edition.
3. Norman S. Nise, *Control Systems Engineering*, Wiley, 7th Edition.
4. Laboratory Manuals.

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	-	-	3	2
CO2	3	3	2	2	2	-	-	-	-	-	-	3	3
CO3	3	3	3	2	3	-	-	-	-	-	-	3	3
CO4	3	2	3	3	2	-	2	-	-	-	-	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	3	3
Mean	**3**	**2.60**	**2.2**	**2**	**2.40**	**-**	**0.4**	**-**	**-**	**-**	**-**	**3**	**2.80**

Score : 3 – High   2 – Medium   1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : FIFTH</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC117</td><td>Automotive Electronics Laboratory</td><td>0</td><td>0</td><td>3</td><td>1.5</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8">Basics of Sensors & Microcontroller</td></tr>
<tr><td rowspan="4">Course Outcome
At the end of the course students will be able to</td><td>CO1</td><td colspan="7">Illustrate the fundamentals of automotive electronics systems including starting and charging circuits through simulations.</td></tr>
<tr><td>CO2</td><td colspan="7">Analyze and simulate various ignition and injection systems using microcontrollers and basic sensor inputs.</td></tr>
<tr><td>CO3</td><td colspan="7">Demonstrate the working of automotive sensors and actuators and their real-time data acquisition using Arduino.</td></tr>
<tr><td>CO4</td><td colspan="7">Simulate basic ECU functionalities and interpret CAN bus communication for engine control systems.</td></tr>
<tr><td colspan="8">1. Study and Report on Emission Standards (Euro vs Bharat Norms)
2. Survey of Common Sensors in Modern Cars
3. Report on MEMS-based Safety Systems in Modern Vehicles
4. Simulation of Starter Motor Circuit using Proteus
5. Charging Circuit Simulation with Alternator Model
6. Electronic Ignition System using Arduino (Tinker cad)
7. Fuel Injection Timing using Arduino PWM Control
8. Simulation of Spark Plug Firing Sequence</td><td>CO1, CO2</td></tr>
<tr><td colspan="8">9. Throttle Position Sensor Simulation
10. Airflow Sensor Response Simulation (using LM35 + fan setup)
11. Stepper Motor Control for Actuator Simulation
12. CAN Bus Communication Simulation using CAN Hacker
13. Engine Control Unit (ECU) Block Diagram Simulation
14. Simulation of Cruise Control System using Arduino (Tinker cad)
15. MEMS-based Airbag Deployment Simulation
16. Electronic Suspension System Simulation</td><td>CO3, CO4</td></tr>
<tr><td colspan="2">Lecture Periods: NIL</td><td colspan="2">Tutorial Periods: NIL</td><td colspan="2">Practical Periods: 45</td><td colspan="3">Total Periods: 45</td></tr>
<tr><td colspan="9">Reference Books / Links</td></tr>
<tr><td colspan="9">1. Automotive Electronics Handbook by Ronald K. Jurgen, McGraw-Hill Education, ISBN: 9780070331893
2. Understanding Automotive Electronics: An Engineering Perspective by William B. Ribbens, Butterworth-Heinemann, ISBN: 9780123918603</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	3	-	-	-	-	-	-	3	2
CO2	3	3	2	2	3	-	-	-	-	-	-	3	3
CO3	3	3	3	2	3	-	-	-	-	-	-	3	3
CO4	3	2	3	3	3	-	-	-	-	-	-	-	-
Mean	3	2.50	2	1.75	3	-	-	-	-	-	-	2.25	2

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="4">Programme : B.Tech. (MT)</td><td colspan="3"></td></tr>
<tr><td colspan="2">Semester : Fifth</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC118</td><td>Drone Technology and design Laboratory</td><td>0</td><td>0</td><td>3</td><td>1.5</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8"></td></tr>
<tr><td rowspan="4">Course Outcome
At the end of the course, the student will be able to</td><td>CO1</td><td colspan="7">Design and assemble drones for simple mechanical applications.</td></tr>
<tr><td>CO2</td><td colspan="7">Implement various algorithms for Drone operation and communication</td></tr>
<tr><td>CO3</td><td colspan="7">Integrate vision system for drone</td></tr>
<tr><td>CO4</td><td colspan="7">Implement and test various algorithms for applications of drones.</td></tr>
<tr><td colspan="8">1. Basic Drone Assembly and Integration
2. Implement Proportional-Integral-Derivative (PID) control algorithms for drone stability.
3. Integrate various sensors into the drone to help with navigation and stabilization (accelerometers, gyroscopes, magnetometers, and barometers).
4. Explore wireless communication technologies like Wi-Fi, Bluetooth, and RF for controlling drones.
5. Implement RTOS to manage tasks like flight control, sensor data processing, and communication
6. Implement algorithms for autonomous navigation in a predefined environment.
7. Implement AI algorithms for real-time object detection and avoidance.
8. Implement swarm intelligence algorithms for multiple drones to work together autonomously
9. Analyse the performance of the drone in different flight conditions.
10. Implement telemetry systems to monitor the drone’s health and performance, such as altitude, speed, battery voltage, and GPS coordinates.
11. Test the drone's response to various wind conditions.
12. Integrate a camera system for aerial surveillance.
13. Design and implement algorithms to monitor and optimize battery usage, ensuring maximum efficiency and performance during flights.
14. Learn about the mathematical modelling of a drone’s dynamic system</td><td>CO1
CO2
CO3
CO4</td></tr>
<tr><td colspan="2">Lecture Periods: NIL</td><td colspan="2">Tutorial Periods: NIL</td><td colspan="2">Practical Periods: 45</td><td colspan="3">Total Periods: 45</td></tr>
<tr><td colspan="9">Reference Books</td></tr>
<tr><td colspan="9">1. "Small Unmanned Aircraft: Theory and Practice" – Randal W. Beard, Timothy W. McLain
2. "Drone Pilot Handbook: The Complete Guide to Drones" – Adam Juniper
3. Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles" – Kenzo Nonami</td></tr>
</table>

CO-PO / PSO Mapping

POs/PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	-	3	-	-	-	-	-	-	3	2
CO2	3	3	3	2	3	-	-	-	-	-	-	3	3
CO3	3	2	3	2	3	-	-	-	-	-	-	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3
Mean	**3**	**2.5**	**3**	**1.75**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2.75**

Score : 3 – High 2 – Medium 1 – Low

Semester –VI

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="7">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester :Sixth</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC119</td><td>Computer Integrated Manufacturing</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
</table>

<table>
<tr><td>Prerequisite:</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course students will be able to</td><td>CO1</td><td>Explain the evolution, architecture, and components of CIM systems, and distinguish types of production and CAD tools</td></tr>
<tr><td>CO2</td><td>Classify components using Group Technology and develop process plans using CAPP methodologies.</td></tr>
<tr><td>CO3</td><td>Describe and analyze components, layouts, and advantages of Flexible Manufacturing System</td></tr>
<tr><td>CO4</td><td>Develop CNC part programs for various machining operations using G and M codes.</td></tr>
<tr><td>CO5</td><td>Interpret and assess quality monitoring systems and CAQC integration with CIM</td></tr>
</table>

<table>
<tr><td>UNIT-I</td><td>Introduction</td><td>Periods: 09</td></tr>
<tr><td colspan="2">Introduction, evolution of CIM, components of CIM, CIM Wheel, role of management in CIM. Concepts – Computerised elements of CIM system –Types of production - Lean Production and Just-In Time Production. Product Life cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture – CAD Software packages, Computer graphics.</td><td>CO1, CO5</td></tr>
<tr><td>UNIT-II</td><td>Group Technology & CAPP</td><td>Periods: 09</td></tr>
<tr><td colspan="2">Group Technology (GT) - Introduction, part families, visual inspection, part classification and coding techniques – chain type, hierarchical structure, hybrid & Opitz coding, product flow analysis, composite part concepts. Introduction, Approaches to Computer Aided Process Planning – Variant, Generative and Hybrid method, applications and benefits.</td><td>CO2, CO1</td></tr>
<tr><td>UNIT-III</td><td>Flexible Manufacturing Systems (FMS)</td><td>Periods: 09</td></tr>
<tr><td colspan="2">Introduction & component of FMS, needs of FMS, general FMS consideration, objectives, types of flexibility, FMS layout and advantages. Automated material handling system: Types and Application, Automated Storage and Retrieval System, Automated Guided Vehicles, Automated Tool Management and supply system, Tool Monitoring System, Flexible Assembly Systems.</td><td>CO3, CO2</td></tr>
<tr><td>UNIT-IV</td><td>Fundamental Of CNC And Part Programming</td><td>Periods: 09</td></tr>
<tr><td colspan="2">Introduction to CAM - NC systems and CNC - Machine axis and Co-ordinate system- CNC machine tools-Principle of operation CNC- 2D and 3D machining on CNC- Introduction of Part Programming, types - Manual part programming (FANUC) on Lathe & Milling machines using G codes and M codes.</td><td>CO4, CO3</td></tr>
<tr><td>UNIT-V</td><td>Monitoring And Quality Control</td><td>Periods: 09</td></tr>
<tr><td colspan="2">Types of production monitoring system, - computer aided quality control - objectives of CAQC, QC and CIM, contact, non-contact inspection methods, CMM and Flexible Inspection systems. Integration of CAQC with CIM.</td><td>CO5, CO4</td></tr>
</table>

<table>
<tr><td>Lecture Periods: 45</td><td>Tutorial Periods: Nil</td><td>Practical Periods: Nil</td><td>Total Periods: 45</td></tr>
<tr><td colspan="4">Reference Books:</td></tr>
<tr><td colspan="4">1. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P Groover Pearson Education
2. Radhakrishnan P, Subramanyan S. and Raju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.
3. Kant Vajpayee. S., “Principles of Computer Integrated Manufacturing”, Prentice Hall of India, 1999.</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	2	1	-	-	-	-	1	2	3
CO2	3	3	2	2	2	-	-	-	-	-	1	2	3
CO3	2	2	2	1	2	1	-	-	-	-	1	2	3
CO4	2	2	3	2	3	-	-	-	-	-	1	2	3
CO5	2	3	2	2	2	1	-	-	-	-	1	2	3
Mean	**2.4**	**2.4**	**2.0**	**1.4**	**2.2**	**1**	**-**	**-**	**-**	**-**	**1**	**2**	**3**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="5">Programme : B.Tech. (MT)</td><td colspan="3"></td></tr>
<tr><td colspan="2">Semester : Sixth</td><td colspan="4">Course Category Code: PCC</td><td colspan="4">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC120</td><td>Mechatronics Systems Design</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">NIL</td></tr>
</table>

<table>
<tr><td rowspan="5">Course Outcome
At the end of the course students will be able to</td><td>CO1</td><td>Explain the fundamental components and design approach of Mechatronics systems</td></tr>
<tr><td>CO2</td><td>Apply software integration techniques to develop intelligent mechatronic systems</td></tr>
<tr><td>CO3</td><td>Develop real-time interfaces and perform simulation-based validation for Mechatronic systems.</td></tr>
<tr><td>CO4</td><td>Analyze the design and operation of various industrial and embedded mechatronic systems</td></tr>
<tr><td>CO5</td><td>Evaluate advanced mechatronic applications including cyber-physical systems and IoT-based designs</td></tr>
</table>

<table>
<tr><td>UNIT-I</td><td>INTRODUCTION TO MECHATRONICS AND ITS ELEMENTS</td><td>Periods: 12</td></tr>
<tr><td colspan="2">Introduction to Mechatronics system, Key elements, Mechatronics system design process, Types of design, Comparison between Traditional and Mechatronics approach, Hardware Components in Mechatronics systems, Mechanisms, Sensors, Actuators, Controllers – Power and Data transfer, signal conditioning and processing, Issues with interfacing and Troubleshooting.</td><td>CO1, CO3</td></tr>
<tr><td>UNIT-II</td><td>SOFTWARE INTEGRATION</td><td>Periods:12</td></tr>
<tr><td colspan="2">Software for Mechatronics, Needs and implementation, Control and Intelligence through Software integration for embedded controllers, Issues with software design and Troubleshooting.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-III</td><td>REAL TIME SYSTEM INTERFACING AND SIMULATION</td><td>Periods: 12</td></tr>
<tr><td colspan="2">Introduction to data acquisition- Interface and communication standards, User interfaces in automation, Real time interfacing, Human Machine Interfaces, Fundamentals of graphical programming, DAQ Interfacing and Control systems design. Modelling and Simulation, Model based Design techniques, Hardware-in-loop Simulations – Code Implementation and Automatic Code generation – Validation and Verification - Installation and testing.</td><td>CO3, CO2</td></tr>
<tr><td>UNIT-IV</td><td>CASE STUDIES- I</td><td>Periods:12</td></tr>
<tr><td colspan="2">Case studies in design and integration of components in mechatronics systems such as industrial robot, motion control systems, Embedded vehicle control system, 3D printers, micro-robot, mechatronic control in automated manufacturing, machine tool control systems, automated dispensing systems.</td><td>CO4, CO1</td></tr>
<tr><td>UNIT-V</td><td>CASE STUDIES- II</td><td>Periods: 12</td></tr>
<tr><td colspan="2">Cyber-Physical Systems- home security using IoT, ADAS systems, electronic stability control, Online surface measurement using image processing, automated testing and inspection systems, bio mechatronics, bionic arm, waste management, precision agriculture crop monitoring and analysis.</td><td>CO5, CO4</td></tr>
</table>

Lecture Periods: 45	Tutorial Periods:15	Practical Periods: NIL	Total Periods: 60

Reference Books:

1. Devadas Shetty, Richard A.Kolk, Mechatronics System Design, PWS Publishing Company, 2012.
2. W. Bolton, Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering, 7th Edition, Pearson Education, 2018.
3. Kristof Richmond, Mechatronic Systems Design, 2012, Springer.
4. Nitaigour Premchand Mahalik, Mechatronics Principles, Concepts and Applications, 2015, McGraw Hill Education, New Delhi.
5. Peter Hehenberger, David Bradley, Mechatronic Futures: Challenges and Solutions for Mechatronic Systems and their Designers, 2016, Springer International.
6. Andy Judge, Mechatronics and Dynamic System Design, 2019, 3rd Edition, Lulu.com.
7. Robert H. Bishop, The Mechatronics Handbook, 2017, CRC Press.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	-	2	1	-	-	-	-	1	3	3
CO2	3	2	2	2	3	-	-	-	-	-	1	3	3
CO3	3	2	3	2	3	-	-	-	-	-	2	3	3
CO4	2	3	2	2	2	1	-	1	-	-	2	3	3
CO5	2	2	3	2	2	2	1	1	1	1	3	3	3
Mean	**2.6**	**2.2**	**2.4**	**1.6**	**2.4**	**0.8**	**0.2**	**0.4**	**0.2**	**0.2**	**1.8**	**3**	**3**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="7">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Sixth</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td>Course Code</td><td>Course Name</td><td colspan="3">Periods/week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">MTUC121</td><td rowspan="2">INDUSTRIAL ROBOTICS</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8">NIL</td></tr>
<tr><td rowspan="5">Course Outcome

At the end of the course students will be able to</td><td>CO1</td><td colspan="7">Describe the configurations, components, and sensor-actuator mechanisms of industrial robots</td></tr>
<tr><td>CO2</td><td colspan="7">Apply kinematic and dynamic models to solve robotic motion and trajectory planning problem</td></tr>
<tr><td>CO3</td><td colspan="7">Develop basic robotic programs using VAL and VAL-II for industrial applications</td></tr>
<tr><td>CO4</td><td colspan="7">Analyze the deployment of robots in material handling, welding, and other manufacturing operation</td></tr>
<tr><td>CO5</td><td colspan="7">Analyze the deployment of robots in material handling, welding, and other manufacturing operation</td></tr>
<tr><td>UNIT-I</td><td colspan="8">Periods: 09</td></tr>
<tr><td colspan="7">INTRODUCTION TO INDUSTRIAL ROBOTICS: Types of Robots, Classification of Robots, Configurations, Robot Anatomy, functional line diagram, degrees of freedom. Components, common types of arms, joints grippers, factors to be considered in the design of grippers.
ROBOT ACTUATORS AND FEEDBACK COMPONENTS: Actuators, Pneumatic, Hydraulic actuators, Electric & Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders - velocity sensors, Tactile sensors, Proximity sensors.</td><td colspan="2">CO1,CO5</td></tr>
<tr><td>UNIT-II</td><td colspan="8">Periods: 09</td></tr>
<tr><td colspan="7">MANIPULATOR KINEMATICS: All pre-requisite topics for the study of Homogenous transformations as applicable to rotation and transition - D-H notation, Forward kinematics (3DOF) and inverse kinematics (2DOF), Simple exercise problems.
MANIPULATOR DYNAMICS: Differential transformations, Jacobians, Lagrange - Euler and Newton - Euler formations. Trajectory Planning: Trajectory Planning and avoidance of obstacles path planning, skew motion, joint integrated motion - straight line motion.</td><td colspan="2">CO2,CO3</td></tr>
<tr><td>UNIT-III</td><td colspan="8">Periods: 09</td></tr>
<tr><td colspan="7">Introduction to Robotic Programming –Types - On-line and off-line programming - Motion commands, end effectors and sensors commands - Robot Languages-Classifications, Structures-VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL.
Robot welding application using VAL program- WAIT, SIGNAL and DELAY command for communications using simple applications. VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications.</td><td colspan="2">CO3, CO2</td></tr>
<tr><td>UNIT-IV</td><td colspan="8">Periods: 09</td></tr>
<tr><td colspan="7">Industrial Applications of Robots: Material transfer, general considerations in Robotic material handling, Load handling capacity. Machine loading / unloading, welding, assembly and spray painting operations - CNC machine tool loading, Robot centered cell.</td><td colspan="2">CO4,CO1</td></tr>
<tr><td>UNIT-V</td><td colspan="8">Periods: 09</td></tr>
<tr><td colspan="7">Future scope of Robotics: Socio-Economic aspect of robotization. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics.</td><td colspan="2">CO5,CO4</td></tr>
<tr><td colspan="2">Lecture Periods: 45</td><td colspan="2">Tutorial Periods: NIL</td><td colspan="3">Practical Periods: - NIL</td><td colspan="2">Total Periods: 45</td></tr>
<tr><td colspan="9">REFERENCE BOOKS
1. S. B. Niku, Introduction to Robotics – Analysis, Contro, Applications, 3rd edition, John 8. Wiley & Sons Ltd., (2020)
2. K.S. Fu, R.C Gonzalez and C.S. Lee, “Robotics- Control, Sensing, Vision and Intelligence”, Tata McGraw-Hill Editions, 2008
3. John J.Craig, “Introduction to Robotics, Mechanics and control”, 3rd edition, Pearson education, 2005.
4. Mark W.Spong, M.Vidyasagar, “Robot dynamics and control”, Wiley India, 2009.</td></tr>
</table>

5. Yoram Koren, “Robotics for Engineers”, McGraw-Hill Book Co., 1992.
6. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, Wolfram Burgard, Lydia E. Kavraki and Sebastian Thrun, “Principles of Robot Motion – Theory, Algorithms and Implementation”, MIT Press, 2005.
7. Mikell P. Groover, Mitchell Weiss, "Industrial robotics, technology, Programming and Applications ", McGraw Hill International Editions, 1986.
8. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
9. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press 3. (2006).

CO-PO Mapping

POs/PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	-	2	2	-	-	-	-	1	3	2
CO2	3	3	3	2	3	-	-	-	-	-	2	3	3
CO3	2	2	3	2	3	-	-	-	-	-	2	3	3
CO4	2	2	2	2	2	1	-	1	1	-	2	3	3
CO5	2	2	2	2	2	2	1	1	1	1	3	3	3
Mean	**2.4**	**2.2**	**2.4**	**1.6**	**2.4**	**1.0**	**0.2**	**0.4**	**0.4**	**0.2**	**2.0**	**3.0**	**2.8**

3- High, 2-Medium, 1-Low

<table>
<tr><td colspan="2">Department: Humanities & Social Sciences</td><td colspan="7">Programme: B.Tech. (Common to all branches)</td></tr>
<tr><td colspan="2">Semester : Sixth</td><td colspan="4">Course Category Code: AEC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods/ Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>HSUA105</td><td>Industrial Economics and Management</td><td>2</td><td>-</td><td>-</td><td>2</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Pre-requisite</td><td colspan="8">Nil</td></tr>
</table>

<table>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td>Demonstrate economic theories, revenue and cost concepts and set of analytical techniques applied to a variety of economic (and non-economic) and financial management issues.</td></tr>
<tr><td>CO2</td><td>Implement various management techniques based on the needs</td></tr>
<tr><td>CO3</td><td>Apply financial planning and Interpret company's income statements and balance sheets to ascertain the financial position of a company.</td></tr>
<tr><td>CO4</td><td>Apply production planning, project scheduling and financial analysis to economic investment and project management problems.</td></tr>
<tr><td>CO5</td><td>Understand fundamental marketing concepts, apply them to real-world scenarios, and develop effective marketing strategies.</td></tr>
</table>

<table>
<tr><td>UNIT-I</td><td>Micro and Macro Economics and its Applications</td><td>Periods: 06</td></tr>
<tr><td colspan="2">Nature and Scope of Economic science – Micro Economics: Economic decisions and Technical decisions, Demand and Supply concepts, Market Equilibrium, Elasticity of Demand, Various concepts of Cost – Break Even Analysis – Market structure.
Macro Economics: Measures of National Income – Inflation – Business Cycle.</td><td>CO1</td></tr>
<tr><td>UNIT-II</td><td>Management Techniques</td><td>Periods: 06</td></tr>
<tr><td colspan="2">Introduction to Management – Functions of Management – F.W.Taylor's Scientific Management – Henry Fayol's Principles of Management. Forms of Business Organization, and Types of (Ownership) of a firm.</td><td>CO2</td></tr>
<tr><td>UNIT-III</td><td>Industrial Finance</td><td>Periods: 06</td></tr>
<tr><td colspan="2">Need for Finance –Types of finance – Sources of finance. Final Accounts - Preparation of Trading, Profit and loss Account and Balance Sheet.</td><td>CO3</td></tr>
<tr><td>UNIT-IV</td><td>Production Management</td><td>Periods: 06</td></tr>
<tr><td colspan="2">Types of Production system – Production Planning and control: Planning, Routing, Scheduling, Inspection and Dispatches. Concepts of Productivity – Measurement of Productivity.</td><td>CO4</td></tr>
<tr><td>UNIT-V</td><td>Marketing Management</td><td>Periods: 06</td></tr>
<tr><td colspan="2">Core Concepts of Marketing – Marketing Vs Selling – Channels of Distribution – Promotion Vs. Advertising – Market Research Vs Marketing Research.</td><td>CO5</td></tr>
</table>

Lecture Periods: 30	**Tutorial Periods: NIL**	**Practical Periods: NIL**	**Total Periods: 30**

Reference Books

1. Varshney Maheswari, Managerial Economics, S Chand & Co, New Delhi, 2011.
2. Dutt & Sundaram, Indian Economy, S Chand & Co, New Delhi, 2015.
3. Pandey I.M, Elements of Financial Management Wiley Eastern Ltd, New Delhi, 2015.
4. H.L. Ahuja, Macro Economics for Business and Management, S Chand & Company Ltd, 2011.
5. O.P Khanna, Industrial Engineering and Management, Dhanpat Rai and Sons, 2009.
6. Philip B Kotler, Marketing Management, Mac Millan, NewYork, 2011.

CO-PO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	1	-	-	2	-	-	1	2	2	-	-
CO2	2	2	2	-	-	1	1	2	2	2	2	-	-
CO3	2	2	2	1	2	-	-	-	-	2	2	-	-
CO4	3	3	3	2	2	1	-	-	1	3	2	-	-
CO5	2	2	2	-	-	2	1	-	2	2	2	-	-
Mean	**2.2**	**2.2**	**2.0**	**0.6**	**0.8**	**1.2**	**0.4**	**0.4**	**1.2**	**2.2**	**2**	**-**	**-**

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Mechatronics**						Programme : **B.Tech. (MT)**			
Semester : **SIXTH**		Course Category Code: **PCC**				Semester Exam Type: **LB**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks			
		L	T	P	C	CA	SE	TM	
MTUC122	**Computer Integrated Manufacturing Laboratory**	-	-	3	1.5	40	60	100	
Prerequisite:									

Course Outcome At the end of the course students will be able to	**CO1**	**Apply** modeling and simulation tools for computer integrated manufacturing.
	CO2	**Implement** the part modeling knowledge for assembly of mechanical components using CAD software.
	CO3	**Develop** CNC programs turning and milling tasks and simulate manufacturing operations using CAM software
	CO4	**Design and simulate** basic flexible manufacturing systems including factory layouts, AGVs, and material handling processes using FMS simulation software.

CAD: (Use any Modeling software: SolidWorks/CREO/CATIA) 1. Surface Modeling – Line , Circle, Rectangle, Mirror, Sweep, Trim etc. 2. Solid Modeling: Extrude, Revolve, Sweep, Variational sweep and Loft. 3. Part Modeling and Assembly of Mechanical Component1. 4. Part Modeling and Assembly of Mechanical Component 2. 5. Part Modeling and Assembly of Mechanical Component 3. 6. Part Modeling and Assembly of Mechanical Component 4. 7. Part Modeling and Assembly of Mechanical Component 5.	**CO1** **CO2**
CAM: (Use any CNC Simulation Software) 8. Study of G codes and M codes. 9. CNC part program and simulate the operation for Plain Turning and Step turning. 10. CNC part program and simulate the operation for Taper Turning. 11. CNC part program and simulate the operation for Threading. 12. CNC part program and simulate the operation for Profile milling 13. CNC part program and simulate the operation for Circular and rectangular pocketing. 14. CNC part program and simulate the operation for Drilling.	**CO1** **CO3**
FMS: (Use Flexisim/OpenCIM/ProModel simulation software) 15. Factory Layout Simulation. 16. Simulation of simple material handling systems. 17. Automatic Guided Vehicle (AGV) Path planning.	**CO1** **CO4**

Lecture Periods: Nil	**Tutorial Periods: Nil**	**Practical Periods: 45**	**Total Periods:45**

Reference Books:

1.Mechatronics systems based CAD/CAM by Fusaomi Nagata, Yukihiro Kusumoto, Keigo Watanabe, Maki K. H, 2013.
2. CAD/CAM: Concepts and Applications- Alavala Chennakesava R, 2008.
3. Automation, Production Systems and Computer Integrated Manufacturing by Groover, M.P, Prentice Hall.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	1	3	-	-	-	-	-	1	2	1
CO2	3	2	3	1	2	-	-	-	-	-	1	2	1
CO3	3	3	3	2	3	-	-	-	-	-	1	3	2
CO4	3	3	3	2	3	-	-	-	-	-	1	3	2
Mean	**3**	**2.5**	**3**	**1.5**	**2.75**	**-**	**-**	**-**	**-**	**-**	**1**	**2.5**	**1.5**

Score : 3 – High 2 – Medium 1 – Low

Department : **Mechatronics**		Programme : **B.Tech. (MT)**						
Semester : **Sixth**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUC123	**System Integration Laboratory**	0	0	3	1.5	40	60	100
Prerequisite:								

Course Outcome		
Course Outcome At the end of the course students will be able to	**CO1**	**Demonstrate** modular automation systems and their role in industrial mechatronics
	CO2	**Apply** graphical data flow programming techniques for rapid prototyping in virtual lab environments.
	CO3	**Integrate** hardware and software modules to build and simulate mechatronic systems
	CO4	**Analyze and evaluate** system behavior using virtual instrumentation and automation software.

1. Design a modular conveyor system using sensors and actuators and demonstrate inter-module communication for sequential automation.
2. Simulate a closed-loop system using graphical programming in LabVIEW for understanding the data flow between components in a virtual lab.
3. Build a prototype temperature control system using Arduino, implement and test closed-loop control.
4. Design and simulate a color / size-based sorting system and implement control logic using graphical programming tools.
5. Program a robotic arm for pick-and-place operations and synchronize the robotic operation with conveyor movement.
6. Monitor data from multiple sensors and visualize data on a dashboard.
7. Implement PID control on a motor using sensor feedback, evaluate performance and tune control parameters.
8. Simulate a system model in software, test with real hardware and validate with physical performance.
9. Simulate a smart factory using IoT modules to collect and visualize sensor data on the cloud.
10. Simulate and Build an Autonomous Guided Vehicle (AGV) Control, Navigation and Obstacle Avoidance.

CO1, CO2, CO3, CO4

Lecture Periods: NIL	**Tutorial Periods: NIL**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books:

1. Krishna Kant –"Computer Based Industrial Control", EEE-PHI, 2nd edition, 2010.
2. Garry Dunning-Introduction to Programmable Logic Controllers, 2nd edition, Thomson, ISBN: 981-240-625-5.
3. W.Bolton- Programmable Logic Controllers, Sixth Edition (Paperback) ISBN-13: 978- 0128029299, 2012.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	3	-	-	-	-	-	1	3	2
CO2	3	3	3	2	3	-	-	-	-	-	1	3	3
CO3	3	3	3	2	3	-	-	-	-	-	1	3	3
CO4	3	3	2	2	3	-	-	-	-	-	1	3	2
Mean	**3**	**2.75**	**2.5**	**1.75**	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2.5**

Score : 3 – High 2 – Medium 1 – Low

Department : **Mechatronics**			Programme : **B.Tech..(MT)**						
Semester : **Sixth**			Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course		Periods / Week			Credit	Maximum Marks		
			L	**T**	**P**	**C**	**CA**	**SE**	**TM**
MTUC124	**Industrial Robotics Laboratory**		0	0	3	1.5	40	60	100
Prerequisite	**Industrial Robotics Theory**								
Course Outcome At the end of the course students will be able to	**CO1**	**Apply** Denavit-Hartenberg convention and simulate robot kinematics using RoboAnalyzer software.							
	CO2	**Analyze and simulate** forward and inverse dynamics of industrial robots including trajectory generation.							
	CO3	**Develop and implement** robot programming for basic operations using 6 DoF articulated robots.							
	CO4	**Design and simulate** task-specific robotic operations using SCARA robots.							

1. Denavit- Hartenberg parameters visualization using Robo analyzer software.
2. Creating robot joint trajectories using Robo analyzer software.
3. Simulation of Forward and Inverse Kinematics of a 3R robot using Robo Analyzer.
4. Simulation of Forward and Dynamic analysis of a 2R planar robot.
5. Determine the trajectory of end-effector to base, link to link and draw the graph respectively by applying forward kinematics method.
6. Solve direct kinematics of a PUMA 560 robotic arm for the given joint variables and simulate the robot remotely to identify the end-effector trajectory.

CO1 **CO2**

7. Program for loading and unloading operations on 6 DoF Articulated robots.
8. Program for pick and place on 6 DoF Articulated robots.
9. Program for palletizing application on 6 DoF Articulated robots.
10. Program for conveyor belt application on SCARA robot.
11. Program for deburring application on SCARA robot.
12. Program for assembly application on SCARA robot.
13. Program for Welding process on SCARA robot.
14. Robot Programming for Color identification/shape identification.
15. Programming the robot for path following operation using any robot

CO3 **CO4**

Note: Use MOTOSIM EG-VRC / RT Toolbox (Mitubishi Robots) for simulating Robotic Operations

Lecture Periods: Nil	**Tutorial Periods: Nil**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books

1. Practical and Experimental Robotics- Ferat Sahin, Pushkin Kachroo, 2008.

CO-PO / PSO Mapping

POs/PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	2	3	-	-	-	1	-	1	3	2
CO2	3	3	2	2	2	-	-	-	-	-	1	3	2
CO3	3	3	3	2	3	-	-	-	1	-	1	3	3
CO4	3	3	3	3	3	-	-	-	1	-	1	3	3
Mean	**3**	**2.75**	**2.75**	**2.25**	**2.75**	**-**	**-**	**-**	**0.75**	**-**	**1**	**3**	**2.5**

Score : 3 – High 2 – Medium 1 – Low

Department : **Mechatronics**					Programme: **B.Tech. (MT)**				
Semester : **Sixth**					Course Category Code: PCC		Semester Exam Type:		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
MTUC125	**Internship**		-	-	-	2	100	-	100
Prerequisite:									
Course Outcome At the end of the course the student will be able to	**CO1**	Understand the working environment, operations, and practices in industries or research organizations							
	CO2	Apply theoretical knowledge to solve practical problems encountered in a real-world work environment							
	CO3	Demonstrate communication, teamwork, time management, and technical documentation skills.							
	CO4	Analyze and evaluate internship experience to reflect on career interests and future learning needs.							
The student is required to undergo 'internship' in industry / research laboratory / higher learning institution for a period of at least 4 weeks in a maximum of 2 spells during vacations. Each spell of internship shall be for a period of not less than 2 weeks. The main purpose of internship is to enhance the general professional outlook and capability of the student to advance his chances of improving the career opportunities. The student should get prior approval from the Head of the Department before undertaking the internship and submit a detailed report after completion for the purpose of assessment. A departmental committee shall evaluate the performance of the students.									CO1, CO2, CO3, CO4

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2	2	1	2	2	2	3	3	2	2	1
CO2	3	3	3	3	2	2	2	2	2	2	2	3	2
CO3	2	2	2	2	2	2	2	3	3	3	3	2	2
CO4	2	2	2	3	2	2	2	2	3	3	3	2	2
Mean	**2.25**	**2.25**	**2.25**	**2.5**	**1.75**	**2**	**2**	**2.25**	**2.75**	**2.75**	**2.5**	**2.25**	**1.75**

Score : 3 – High 2 – Medium 1 – Low

SEMESTER –VII

Department: **Mechatronics**		Programme: **B.Tech. (MT)**						
Semester: **Seventh**		Course Category Code: **PCC**			Sem. Exam. Type: **TY**			
Course Code	Course Name	Periods/week			Credit	Maximum marks		
		L	T	P	C	CA	SE	TM
MTUC126	**Machine Vision**	3	0	0	3	40	60	100
Prerequisite	**Nil**							

Course Outcome At the end of the course the student will be able to		
	CO1	**Explain** the fundamentals of machine vision and various methods of image acquisition.
	CO2	**Apply** concepts of optics and illumination for effective image capture and analysis.
	CO3	**Perform** image pre-processing techniques such as filtering, contrast enhancement, and edge detection.
	CO4	**Analyze** image segmentation and feature extraction methods for object detection and classification.
	CO5	**Demonstrate** the application of machine vision systems in real-world industrial scenarios.

Unit – I	**Image Acquisition**	**Periods: 09**
Introduction to Machine Vision – Evolution, Components, Stages- Applications. Image Acquisition: Solid State Sensors – Operation of Charge Coupled Device (CCD) and Complementary Metal Oxide Semiconductor (CMOS) Sensors – Colour Sensors – Properties of Sensors. Digital cameras – control of image capture – Characteristic values – industrial operating conditions. Control of Line Scan and Area scan cameras. Image Data Transfer –Digital Camera Interfaces – Camera Link, Fire Wire, USB and Gigabit Ethernet.		**CO1, CO5**
Unit – II	**Optics and Illumination**	**Periods: 09**
Optical foundations: Focal length, Magnification, Field of view, Depth of field, F number, Distortion. Thin Lens, Imaging Equation, Typical Imaging Situations, Aberrations, Lens Selection – Mounts, Telecentric lens, Fisheye lenses and endoscopes. Light Sources - Types of Light Filters, Types of Lighting: Front lighting – Diffuse, Directed, Polarized, Ring and Structured; Back lighting – Diffuse, Directional, polarized Telecentric, Structured, Bright field, Dark Field, Incident and Transmitted Lighting.		**CO1, CO2**
Unit – III	**Image Pre-processing**	**Periods: 09**
Gray Scale Transformations: Point operation –brightness modification, Contrast enhancement, and thresholding. Image Arithmetic: Image Addition, Subtraction and Averaging, Minimum and Maximum of two images. Global operation –Histogram equalization. Neighbourhood operation – Image smoothing and image sharpening -Types of Filters: Linear Filters, Median Filter, Morphological and Non-Linear Filters.		**CO3, CO4**
Unit – IV	**Image Processing**	**Periods: 09**
Segmentation: Regions of Interests (ROIs) - Threshold Determination from Histogram, Contour Tracing: Pixel correctness, Generating Object Contours, Contour representation, Edge based Methods: Edge probing and Edge Detection, Template matching: Operation. Feature Extraction: Geometric features – Enclosing rectangle, area, perimeter and centroid. Classification: Nearest Neighbour classifier.		**CO3, CO4**
Unit – V	**Applications**	**Periods: 09**
Dimensional Checking: Simple gauging, Shape Checking, Angle Gauging, High accuracy Gauging, Calibration. Presence Verification: Simple Presence verification, Simple Gauging for assembly verification such as Pin type Verification. Decision making and actuation on visual signals - Case Studies – Currency verification – Pharmaceutical industry.		**CO5**

Lecture Periods: 45	**Tutorials Periods: Nil**	**Practical Periods: Nil**	**Total Periods: 45**

Reference books:

1. R.C.Gonzalez, Richard E.Woods, “Digital Image Processing” Second Edition, Prentice Hall India, 2005.
2. K.S.Fu,R.C.Gonzalez,C.S.G.Lee “Robotics Control, Sensing, Vision and Intelligence “Tata McGraw-Hill, 2008
3. H. Golnabi, A. Asadpour, “Design and application of industrial machine vision systems”, Robotics and Computer-Integrated Manufacturing 23 (2007) 630–637.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	3	-	-	-	1	1	-	3	2
CO2	2	2	2	2	3	-	-	-	1	1	-	3	2
CO3	3	3	2	3	3	-	-	-	2	1	-	3	3
CO4	3	3	3	3	3	-	-	-	2	1	-	3	3
CO5	2	2	2	2	2	1	-	-	2	2	2	3	3
Mean	**2.6**	**2.4**	**2.2**	**2.4**	**2.8**	**0.2**	**-**	**-**	**1.6**	**1.2**	**0.4**	3	**2.6**

Score : 3 – High 2 – Medium 1 – Low

Department : **Mechatronics**				Programme : **B.Tech. (MT)**				
Semester : **Seventh**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUC127	**Modeling and Simulation**	3	0	0	3	40	60	100

Prerequisite:	**NIL**	
Course Outcome At the end of the course, the student will be able to	**CO1**	**Explain** the fundamental concepts of systems, types of models, and simulation processes including discrete event systems.
	CO2	**Apply** appropriate statistical and queuing models for system behavior analysis using simulation.
	CO3	**Demonstrate** various simulation techniques such as Monte Carlo and continuous system models for experimental system study.
	CO4	**Develop** simulation models using software tools and **interpret** the outputs through visual and data analysis.
	CO5	**Evaluate** simulation results using post-processing techniques and **validate** the simulation models for decision-making.

UNIT-I	**Introduction**	**Periods: 09**
Definition and components of a system, continuous and discrete systems. Modelling: Concepts of system modeling, types of models, static and dynamic physical models, static and dynamic mathematical models. Simulation: Basics of simulation, Steps in simulation, Discrete event system simulation, Advantages and disadvantages of simulation, Decision making with simulation.		**CO1, CO2**
UNIT-II	**Statistical Models**	**Periods: 09**
Review of terminology and concepts, Useful statistical models, Discrete distributions, Continuous distributions, Poisson process, Empirical distributions, Random numbers, Techniques for random generation. Queuing Models: Characteristics of queuing systems; Queuing notation; Long-run measures of performance of queuing systems, Application of models.		**CO1, CO2**
UNIT-III	**System Simulation**	**Periods: 09**
Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Distributed lag models, Cobweb models Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies.		**CO2, CO3**
UNIT-IV	**Simulation software**	**Periods: 09**
Comparison of simulation packages with programming languages, classification of simulation software, Description of a general purpose simulation package, Design of scenario and modules, dialog box, database, animation, plots and output, interfacing with other software, summary of results. Examples with MATLAB/ AWESIM / ARENA.		**CO4, CO5**
UNIT-V	**Analysis after simulation**	**Periods: 09**
Importance of the variance of the sample mean, Procedure for estimating mean and variance, Subinterval method, Replication Method, Regenerative method; Variance reduction techniques, Start up policies, Stopping rules, Statistical inferences, Design of experiments. Verification and validation of simulated models, optimization via simulation. Case studies on application of modeling and simulation in mechatronics systems.		**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: NIL**	**Practical Periods: NIL**	**Total Periods: 45**

Reference Books:

1. Averill M. Shaw, "Simulation Modeling and Analysis", Tata McGraw-Hill, 2007.
2. Frank L. Severance, "System Modeling& Simulation-an Introduction", Johm Wiley & Sons, 2001
3. Geoffrey Gorden, "System Simulation", Prentice Hall of India, 2003.
4. Narsingh Deo., "System Simulation with Digital Computer", Prentice Hall of India, 2003.
5. Birta, "Modelling and Simulation: Exploring Dynamic System Behaviour", Springer, Indian Reprint, 2010
6. Allan Carrie, "Simulation of manufacturing", John Wiley & Sons, 1988

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	-	-	-	1	1	-	3	2
CO2	2	3	3	2	3	-	-	-	1	1	-	3	2
CO3	3	3	3	3	3	-	-	-	1	1	-	3	3
CO4	3	2	3	3	3	-	-	-	2	1	-	3	3
CO5	3	2	3	3	3	-	-	-	2	2	2	3	3
Mean	**2.8**	**2.6**	**2.8**	**2.6**	**3**	**-**	**-**	**-**	**1.4**	**1.2**	**0.4**	**3**	**2.6**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="8">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Seventh</td><td colspan="4">Course Category Code: PCC</td><td colspan="4">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC128</td><td>Machine Learning in Mechatronics</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the student will be able to</td><td>CO1</td><td colspan="7">Describe Machine Learning Concepts and Applications in Mechatronics.</td></tr>
<tr><td>CO2</td><td colspan="7">Apply Data Acquisition and Processing Techniques for Mechatronics Systems.</td></tr>
<tr><td>CO3</td><td colspan="7">Implement Machine Learning Algorithms for Control and Automation.</td></tr>
<tr><td>CO4</td><td colspan="7">Develop AI-based Fault Diagnosis and Predictive Maintenance Systems.</td></tr>
<tr><td>CO5</td><td colspan="7">Design and Deploy Advanced AI-Driven Mechatronics Applications.</td></tr>
<tr><td>UNIT-I</td><td colspan="2">FUNDAMENTALS OF MACHINE LEARNING IN MECHATRONICS</td><td colspan="6">Periods: 09</td></tr>
<tr><td colspan="8">Definition - Scope of Machine Learning (ML)- Importance of ML in Mechatronic Systems- Supervised Learning - Regression & Classification - Decision Trees, SVM, Neural Networks, Unsupervised Learning - Clustering and pattern detection - K-Means, DBSCAN, Reinforcement Learning - Decision-making and optimization- Role of ML in Robotics- Motion Planning and Path Optimization, Automation- AI-driven Predictive Maintenance and Fault Diagnosis, and Control Systems- Adaptive PID, Predictive Control-Tools and Libraries: Python, TensorFlow, Keras, Scikit-Learn for ML.</td><td>CO1, CO5</td></tr>
<tr><td>UNIT-II</td><td colspan="2">DATA ACQUISITION, PROCESSING, AND FEATURE ENGINEERING</td><td colspan="6">Periods: 09</td></tr>
<tr><td colspan="8">Sensors and Data Collection- IMU, LiDAR, Cameras, Pressure Sensors, Temperature Sensors- Data logging and batch vs real-time data collection, Communication protocols: UART, SPI, I2C, CAN for sensor integration - signal processing: filtering, denoising, and smoothing - Fourier Transform and Wavelet Transform for signal analysis- Feature extraction from time-series signals – Data Handling missing values, outliers, and noisy sensor data- Data normalization techniques: Min-Max Scaling, Standardization-Feature selection techniques & Extraction from sensor data- Importance of dimensionality reduction in real-time ML applications- Principal Component Analysis (PCA) - reducing redundant data- Linear Discriminant Analysis (LDA) - classification tasks - time-series data Analysis for predictive Maintenance & time dependent system</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-III</td><td colspan="2">MACHINE LEARNING FOR CONTROL AND AUTOMATION</td><td colspan="6">Periods: 09</td></tr>
<tr><td colspan="8">ML in industrial process automation - ML-driven control strategies in automation- conventional vs ML-based control systems - ML-assisted PID tuning for dynamic system control- adaptive control and fuzzy logic in automation- predictive modelling- Data-driven decision-making - process optimization - Linear and nonlinear regression techniques - optimal control parameters - reinforcement learning (RL)- Training autonomous robots using reward-based learning- Applications in motion planning and path optimization - deep learning in multi-sensor integration - Convolutional Neural Networks (CNNs)</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td colspan="2">FAULT DIAGNOSIS, PREDICTIVE MAINTENANCE, AND QUALITY CONTROL</td><td colspan="6">Periods: 09</td></tr>
<tr><td colspan="8">ML for Anomaly Detection- Types of anomalies: Point anomalies, contextual anomalies, collective anomalies - fault diagnosis in industrial automation- Clustering techniques (K-Means, DBSCAN) - Autoencoders - deep learning methods - predictive maintenance vs. traditional maintenance- Data-driven maintenance scheduling -Machine learning models for failure prediction (Random Forest, LSTMs) - Time-series forecasting techniques for industrial equipment monitoring - Supervised vs. unsupervised fault classification- K-Nearest Neighbors (KNN) and Support Vector Machines (SVM) for fault categorization - Clustering techniques for system diagnostics - AI in quality assurance and defect detection- Image processing techniques for product inspection- Deep learning models (CNNs) for defect classification - IoT and AI integration for continuous monitoring & health assessment.</td><td>CO3, CO4</td></tr>
<tr><td>UNIT-V</td><td colspan="2">ADVANCED TOPICS AND REAL-WORLD APPLICATIONS IN MECHATRONICS</td><td colspan="6">Periods: 09</td></tr>
</table>

Edge Computing- cloud computing vs. edge computing for real-time decision-making- AI-driven embedded systems: Using AI on microcontrollers (Raspberry Pi, Jetson Nano) - swarm intelligence and decentralized decision-making - search and rescue, surveillance, and logistics - Reinforcement learning - collaborative robot behaviour - AI ethics: Bias, transparency, and accountability- Case study.	**CO5**

Lecture Periods: 45	**Tutorial Periods: NIL**	**Practical Periods: NIL**	**Total Periods: 45**

Reference Books:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer,2006.
2. Francis X. Govers, **Machine Learning for Robotics and Control,** Packt Publishing, 2020.
3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.
4. Godfrey C. Onwubolu, Mechatronics: Principles and Applications, Butterworth-Heinemann (Elsevier), 2005.
5. Nikolaus Correll, Bradley Hayes, and Bradley M. Kuszmaul, Introduction to Autonomous Robots: Mechanisms, Sensors, Actuation, and Algorithms, 2nd Edition, MIT Press (Open Access), 2022.
6. Melanie Mitchell, Artificial Intelligence: A Guide for Thinking Humans, Farrar, Straus, and Giroux, 2019.
7. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", 2nd Edition, O'Reilly Media, 2019.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	-	-	-	1	2	-	3	2
CO2	3	3	3	2	3	-	-	-	1	2	-	3	3
CO3	3	3	3	3	3	-	-	-	1	2	-	3	3
CO4	3	3	3	3	3	-	-	-	2	2	2	3	3
CO5	3	3	3	3	3	-	-	-	2	3	2	3	3
Mean	**3**	**3**	**2.8**	**2.6**	**3**	**-**	**-**	**-**	**1.4**	**2.2**	**0.8**	**3**	**2.8**

Score : 3 – High 2 – Medium 1 – Low

Department: **Mechatronics**		Programme: **B.Tech. (MT)**						
Semester : **Seventh**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUC129	**Machine Vision Laboratory**	0	0	3	1.5	40	60	100
Prerequisite	-							

Course Outcome At the end of the course, the student will be able to		
	CO1	Explain the working principles of image acquisition systems and various types of sensors used in machine vision applications.
	CO2	Analyze the impact of optical parameters and illumination techniques on image quality and object visualization.
	CO3	Apply image pre-processing techniques such as filtering, enhancement, thresholding, and histogram equalization for feature extraction
	CO4	Perform segmentation, edge detection, and template matching to identify objects and extract relevant geometric features.

1. Study Report on Industrial Machine Vision Applications 2. Survey of Image Sensors: CCD vs CMOS 3. Report on Calibration and Measurement Accuracy in Vision Systems 4. Capture and Analyze Image Using Webcam with OpenCV 5. Illumination Effects on Image Quality (OpenCV)	**CO1, CO2**
6. Gray Scale and Brightness Modification 7. Edge Detection using Canny and Sobel Operators 8. Contour Detection and Object Boundary Tracing 9. Template Matching for Object Detection 10. Feature Extraction and Shape Detection	**CO3, CO4**
11. Dimensional Gauging Using OpenCV 12. Angle Gauging with Shape Analysis 13. Presence Verification using Template Matching 14. Currency Verification using Feature Matching 15. Assembly Line Simulation for Object Sorting	**CO4**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books / Links

1. Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods
2. Computer Vision: Algorithms and Applications" by Richard Szeliski

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	3	-	-	-	1	2	-	3	2
CO2	3	3	2	2	3	-	-	-	1	2	-	3	2
CO3	3	3	3	2	3	-	-	-	1	2	-	3	3
CO4	3	3	3	2	3	-	-	-	2	3	-	3	3
Mean	**3.0**	**2.75**	**2.5**	**1.8**	**3.0**	**-**	**-**	**-**	**1.25**	**2.25**	**-**	**3.0**	**2.5**

Score : 3 – High 2 – Medium 1 – Low

Department : **Mechatronics**			Programme : **B.Tech. (MT)**						
Semester : **Seventh**			Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
MTUC130	**Modeling and Simulation Laboratory**		-	-	3	1.5	40	60	100
Prerequisite:	NIL								
Course Outcome At the end of the course, the student will be able to	**CO1**	**Develop** simulation models for mechatronics systems using software tools.							
	CO2	**Demonstrate** the use of simulation techniques like Monte Carlo, system dynamics, and discrete-event simulation.							
	CO3	**Analyze** simulation results to interpret system behavior and performance under varying							
	CO4	**Validate** and **optimize** simulation models for real-world engineering applications.							

Experiments	Mapped COs
1. Introduction to MATLAB and its Components 2. Programming in MATLAB 3. Program to Display a Matrix 4. Program for Addition and Transpose of a Matrix 5. Random Number Generation and Distribution Analysis 6. Modeling and Simulation of a Queuing System using MATLAB 7. Monte Carlo Method for System Simulation 8. Implementation of Discrete Event Simulation (DES) 9. Modeling of a Dynamic System using Simulink 10. System Identification and Model Validation 11. Optimization in Simulation using Genetic Algorithms (GA) 12. Simulation of Control Systems using MATLAB 13. Simulate and control a conveyor belt system 14. Two-sample Kolmogorov-Smirnov test. 15. Simulate Mechatronics systems	**CO1, CO2, CO3, CO4**

Lecture Periods: NIL	**Tutorial Periods:NIL**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books:

Averill M. Shaw, "Simulation Modeling and Analysis", Tata McGraw-Hill, 2007.

CO-PO / PSO Mapping

POs/PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	2	-	-	-	1	2	-	3	3
CO2	3	3	3	3	3	-	-	-	1	2	-	3	3
CO3	3	3	3	3	3	-	-	-	1	2	-	3	3
CO4	3	3	3	3	3	-	-	-	2	2	-	3	3
Mean	**3.0**	**3.0**	**2.75**	**3.0**	**2.75**	**-**	**-**	**-**	**1.25**	**2.0**	**-**	**3.0**	**3.0**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Seventh</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type:</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC131</td><td>Mini Project</td><td>-</td><td>-</td><td>4</td><td>2</td><td>100</td><td>-</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="4">Course Outcome: At the end of the course the student will be able to</td><td>CO1</td><td colspan="7">Carry out literature survey, understand state of art techniques.</td></tr>
<tr><td>CO2</td><td colspan="7">Identify and apply appropriate tools to solve a problem.</td></tr>
<tr><td>CO3</td><td colspan="7">Transform knowledge into an algorithmic/experimental process.</td></tr>
<tr><td>CO4</td><td colspan="7">Prepare and present reports on the project work.</td></tr>
<tr><td colspan="8">The objective of this course is to enable the students to carry out the mini-project in a group. The topic shall be chosen in consultation with the faculty coordinators. Each group of students is expected to make a detailed review of the literature, formulate the problem, carry out the mini project and prepare a report on the work done. The mini project can be a small project work or it can be a part of the work planned for the main project. The students should present the results of the work in the review committee meetings. A departmental committee shall evaluate the performance of the students.</td><td>CO1, CO2, CO3, CO4</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	2	-	-	3	2	-	3	2
CO2	3	3	3	3	3	-	-	-	3	2	-	3	3
CO3	3	3	3	3	3	-	-	-	3	2	-	3	3
CO4	2	2	2	2	2	2	-	-	3	3	-	2	2
Mean	**2.75**	**2.75**	**2.5**	**2.5**	**2.5**	**1.0**	**-**	**-**	**3.0**	**2.25**	**-**	**2.75**	**2.5**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="8">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Seventh</td><td colspan="5">Course Category Code: PCC</td><td colspan="3">Semester Exam Type:</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="4">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td colspan="2">TM</td></tr>
<tr><td>MTUC132</td><td>Comprehensive Viva</td><td>-</td><td>-</td><td>-</td><td>1</td><td>100</td><td>-</td><td colspan="2">100</td></tr>
<tr><td>Prerequisite:</td><td colspan="9"></td></tr>
<tr><td rowspan="4">Course Outcome: At the end of the course the student will be able to</td><td>CO1</td><td colspan="8">Demonstrate a broad understanding of the subject area</td></tr>
<tr><td>CO2</td><td colspan="8">Present complex concepts in an easy-to-understand way, answering questions confidently.</td></tr>
<tr><td>CO3</td><td colspan="8">Handle unexpected and challenging questions.</td></tr>
<tr><td>CO4</td><td colspan="8">Respond thoughtfully to feedback, and participate actively in discussions.</td></tr>
<tr><td colspan="9">Comprehensive viva is an oral examination conducted to evaluate the critical thinking, analytical abilities, and how well a student can discuss and apply concepts learned throughout their studies. A committee comprising of five faculty members will conduct the comprehensive viva examination and evaluate the students. Experts from the industry may also be included in this committee. The Head of the Department shall constitute this committee</td><td>CO1, CO2, CO3, CO4</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	3	2	-	-	-	2	3	-	2	2
CO2	2	2	2	2	-	-	-	-	3	3	-	2	2
CO3	3	3	2	2	-	-	-	-	2	3	-	2	2
CO4	2	2	2	2	-	-	-	-	3	3	-	2	2
Mean	**2.5**	**2.25**	**2.0**	**2.25**	**0.5**	**-**	**-**	**-**	**2.5**	**3.0**	**-**	**2.0**	**2.0**

Score : 3 – High 2 – Medium 1 – Low

SEMESTER –VIII

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Eighth</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type:</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUC133</td><td>Project Work</td><td>-</td><td>-</td><td>16</td><td>8</td><td>60</td><td>40</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="4">Course Outcome
At the end of the course the student will be able to</td><td>CO1</td><td colspan="7">Carry out literature survey, understand state of art techniques.</td></tr>
<tr><td>CO2</td><td colspan="7">Identify and apply appropriate tools to solve a problem.</td></tr>
<tr><td>CO3</td><td colspan="7">Transform knowledge into an algorithmic/experimental process.</td></tr>
<tr><td>CO4</td><td colspan="7">Prepare and present reports on the project work.</td></tr>
<tr><td colspan="8">In this project work, the team would solve the problem taken up for study. Simulation studies and/or hardware development would be completed. Necessary inferences have to be drawn from the studies carried out and the same should be presented before the committee members. If the project involves intensive analytical procedure, the analysis has to be completed and suitable comparison to existing methodologies reported in literature should be done to validate the correctness as well as effectiveness of the work.
Rigorous review by the committee will be carried out in the process to ascertain whether the work qualifies as a suitable project at the graduate level. Each team is expected to present their work at National/International conferences or at the students' technical symposiums. Team that has come out with novel contribution will be encouraged to publish their work in any referred journals.</td><td>CO1, CO2, CO3, CO4</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	-	-	-	2	2	2	3	2
CO2	3	3	3	2	3	-	-	-	2	2	2	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	3	3
CO4	2	2	2	2	2	-	-	-	3	3	2	2	2
Mean	**2.75**	**2.5**	**2.5**	**2.25**	**2.5**	**-**	**-**	**-**	**2.25**	**2.25**	**2**	**2.75**	**2.5**

Score : 3 – High 2 – Medium 1 – Low

PROFESSIONAL ELECTIVE COURSES

LIST OF PROFESSIONAL ELECTIVES

Professional Elective	Course Code	Course	Semester
Professional Elective - I	MTUE101	Python Programming	V
	MTUE102	Design Considerations in manufacturing	
	MTUE103	Mechatronics and Remote engineering	
	MTUE104	Mechatronics in Agriculture	

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fifth</td><td colspan="4">Course Category Code: PEC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUE101</td><td>Python Programming</td><td>3</td><td>1</td><td>-</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8">Nil</td></tr>
</table>

<table>
<tr><td rowspan="5">Course Outcome
At the end of the course the student will be able to</td><td>CO1</td><td>Apply basic Python programming constructs such as data types, control flow, and functions to solve computational problems.</td></tr>
<tr><td>CO2</td><td>Implement data structures and object-oriented features to develop modular Python applications</td></tr>
<tr><td>CO3</td><td>Utilize system-level modules in Python to perform file system traversal, threading, and automation tasks</td></tr>
<tr><td>CO4</td><td>Design and implement client-server applications and scripts for web interactions using socket and web programming in Python.</td></tr>
<tr><td>CO5</td><td>Develop network and web applications using sockets and CGI scripts</td></tr>
</table>

<table>
<tr><td>UNIT-I</td><td>Core Python: Basics</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Introduction to Python, Python Interpreter and its working, Syntax and Semantics, Data Types, operators, loops, Assignments and Expressions, Control Flow Statements. Illustrative problems: exchange the values of two variables, circulate the values of n variables, distance between two points, Guess an integer number in a range, Towers of Hanoi.</td><td>CO1</td></tr>
<tr><td>UNIT-II</td><td>Core Python: Advanced Features</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing. Functions and lambda expressions. Iterations and Comprehensions, Handling text files Modules, reading and writing files, Classes and OOP Exception Handling, Strings and Regular Expression. Packages. Illustrative programs: square root, gcd, exponentiation, sum of array values, linear search, binary search, selection sort, insertion sort, merge sort, histogram, word count, copy file.</td><td>CO1, CO2, CO5</td></tr>
<tr><td>UNIT-III</td><td>System Programming</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">System tools: OS and System modules, Directory Traversal tools, Parallel System tools threading and queue, Program Exits.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td>Network and Web Programming</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Socket Programming: Handling Multiple Connections, Client Server Programming, Client Side Scripting, urlib, Server Side Scripting: CGI Scripts with User Interaction, Passing Parameters. Sending Mail: SMTP protocol – Sending Email using Python.</td><td>CO3, CO4</td></tr>
<tr><td>UNIT-V</td><td>GUI Programming and Database Connectivity</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Introduction to tkinter, Top Level Windows, Dialogs, Message and Entry Event Handling, Menus, Listboxes and Scrollbars, Text. Database – SQLDB – Database connection – Python code for Insert, Update, Delete operations, Database Transactions.</td><td>CO4, CO5</td></tr>
</table>

Lecture Periods: 45	Tutorial Periods: 15	Practical Periods: Nil	Total Periods: 60

Reference Books

1. Mark Lutz, Learning Python, O Reily, Fifth Edition, 2013.
2. Eric Matthes, Python Crash Course, Second Edition, No Starch Press, 2016.
3. Tim Hall and J-P Stacey, Python 3 for Absolute Beginners, 2009.
4. Magnus Lie Hetland, Beginning Python: From Novice to Professional", Second Edition, 2009.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	-	-	-	2	2	2	3	2
CO2	3	3	3	2	3	-	-	-	2	2	2	3	3
CO3	3	3	3	3	3	-	-	-	2	2	2	3	3
CO4	2	2	2	2	2	-	-	-	3	3	2	2	2
CO5	3	2	3	2	3	-	-	-	3	3	2	3	2
Mean	**2.8**	**2.4**	**2.6**	**2.2**	**2.6**	**-**	**-**	**-**	**2.4**	**2.4**	**2**	**2.8**	**2.4**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="7">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fifth</td><td colspan="4">Course Category Code: PCC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUE102</td><td>Design Considerations in Manufacturing</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
</table>

<table>
<tr><td>Prerequisite:</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course the student will be able to</td><td>CO1</td><td>Analyze the effect of tolerance stack-up and interpret tolerance-cost relationships.</td></tr>
<tr><td>CO2</td><td>Apply geometric dimensioning and tolerancing (GD&T) concepts as per ASME Y14.5 standards</td></tr>
<tr><td>CO3</td><td>Redesign cast, welded, and sheet metal components considering form design principles to enhance manufacturability.</td></tr>
<tr><td>CO4</td><td>Construct tolerance charts and evaluate manufacturing processes using process drawings and centrality analysis.</td></tr>
<tr><td>CO5</td><td>Integrate environmental considerations into product design using DfE principles to meet sustainability goals.</td></tr>
</table>

<table>
<tr><td>UNIT-I</td><td>TOLERANCE ANALYSIS</td><td>Periods: 12</td></tr>
<tr><td colspan="2">Introduction to Tolerances, Cumulative effect of tolerances -Worst case method, root sum square method, Monte Carlo simulation. Tolerance synthesis, nonlinear tolerance analysis, tolerance cost relationships. Process capability, mean, variance, Cp, Cpk, cost aspects, feature tolerances, geometric tolerances - ISO standards - surface finish, review of relationship between attainable tolerance grades and different machining and sheet metal processes</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td>GEOMETRIC DIMENSIONING AND TOLERANCING</td><td>Periods: 12</td></tr>
<tr><td colspan="2">Introduction to GD&T, ASME Y-14.5 standard - Examples for application of geometric tolerance True Position Theory -Comparison between co- ordinate and convention method of feature location, tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, zero true position tolerance, functional gauges, paper layout gauging.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-III</td><td>FORM DESIGN OF CASTINGS AND WELDMENTS</td><td>Periods: 12</td></tr>
<tr><td colspan="2">Redesign of castings based on parting line considerations, minimizing core requirements, redesigning cast members using weldments, form design aspects of sheet metal components.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td>TOLERANCE CHARTING</td><td>Periods: 12</td></tr>
<tr><td colspan="2">Operation sequence for typical shaft type of components. Preparation of process drawings for different operations, tolerance worksheets and centrality analysis</td><td>CO4</td></tr>
<tr><td>UNIT-V</td><td>DESIGN FOR THE ENVIRONMENT</td><td>Periods: 12</td></tr>
<tr><td colspan="2">Environmental objectives - Global issues - Regional and local issues - Basic DFE methods – Design guide lines - Example application. Introduction</td><td>CO5</td></tr>
</table>

<table>
<tr><td>Lecture Periods: 45</td><td>Tutorial Periods:15</td><td>Practical Periods: Nil</td><td>Total Periods: 60</td></tr>
<tr><td colspan="4">Reference Books:</td></tr>
<tr><td colspan="4">1. Basem said EI-Haik, “Axiomatic Quality”, John Wiley and Sons, 2005.
2. Micheal Wader, “Lean Tools: A Pocket Guide to Implementing Lean Practices”, Productivity and Quality Publishing Private Limited, 2002</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	2	-	-	2	-	2	3	2
CO2	3	3	2	2	3	2	-	-	2	-	2	3	2
CO3	3	2	3	2	3	3	-	-	2	-	2	3	2
CO4	3	2	3	3	3	2	-	-	3	-	2	3	2
CO5	2	2	2	2	2	3	2	-	2	-	2	2	2
Mean	**2.8**	**2.4**	**2.4**	**2.2**	**2.8**	**2.4**	**0.4**	**-**	**2.2**	**-**	**2.0**	**2.8**	**2.0**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="7">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fifth</td><td colspan="4">Course Category Code: PEC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUE103</td><td>Mechatronics and Remote Engineering</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
</table>

Prerequisite:		
Course Outcome At the end of the course, the students will be able to	**CO1**	**Explain** the architecture and components of mechatronic systems
	CO2	**Model** and **simulate** mechatronic systems using software tools for analysis and design.
	CO3	**Develop** remote monitoring and control systems using communication protocols
	CO4	**Analyze** the performance and reliability of mechatronic systems integrated with remote engineering solutions.
	CO5	**Evaluate** the challenges and ethical considerations in implementing remote engineering in medical applications.

UNIT-I	**Periods: 12**
Introduction to mechatronics system – key element -- Mechatronics Design process – Types of Design -- Design Parameter– Traditional and Mechatronics designs – Advanced approaches in Mechatronics -- Industrial design and ergonomics, safety - Mechatronics Approach.	**CO1, CO5**
UNIT-II	**Periods: 12**
Introduction - Input isolation, DC amplifier, power amplifier, and differential amplifier – feedback, Op-Amp electrometer amplifier, carrier Amplifier – instrument power supply. Oscillographic – galvanometric - X-Y, magnetic recorder, storage oscilloscopes – electron microscope – PMMC writing systems – Telemetry Principles – Bio telemetry. Electrocardiograph measurements – blood pressure measurement: by ultrasonic method – plethysonography.	**CO1, CO2**
UNIT-III	**Periods: 12**
Introduction-selection of interface cards-DAQ card-single channel-multichannal-RS232/422/485 communication- IEEE 488 standard interface-GUI card-GPIB-Ethernet switch -Man machine interface. Introduction –Fuzzy based Washing machine – pH control system – Autofocus Camera, exposure control– Motion control using D.C.Motor & Solenoids Micro actuation – Micro robot – Micro pump – Applications of micro mechatronics components.	**CO2, CO3**
UNIT-IV	**Periods: 12**
Introduction-model categories-fields of application-model development-model verification-model validation model simulation-design of mixed systems-electro mechanics design-model transformation-domain-independent description forms-simulator coupling.	**CO4, CO5**
UNIT-V	**Periods: 12**
Blood flow measurement by electromagnetic flow meter cardiac output measurement by dilution method – phonocardiography – vector cardiography. Heart lung machine – artificial ventilator – Anesthetic machine – Basic ideas of CT scanner – MRI and ultrasonic scanner – Bio-telemetry –laser equipment and application – cardiac pacemaker – DC – defibrillator patient safety - electrical shock hazards. Centralized patent monitoring system.	**CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: Nil**	**Total Periods: 60**

References:

1. George plez, Mechatronics Systems: Modelling and simulation with HDL's, john Wiley and sons Ltd, 2003.
2. Devdas Shetty, Richard A. kolk, " Mechatronics System Design", Thomson Learning Publishing Company, Vikas publishing house, 2001.
3. Bolton, Mechatronics – Electronic control systems in mechanical and electrical Engineering- 2nd Edition, Addison Wesley Longman Ltd, 1999.
4. Arumugam M., "Bio Medical Instrumentation", Anuradha agencies pub., 2002.

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	2	-	-	2	-	2	3	2
CO2	3	3	2	2	3	2	-	-	2	-	2	3	2
CO3	3	2	3	2	3	3	-	-	2	-	2	3	2
CO4	3	2	3	3	3	2	-	-	3	-	2	3	2
CO5	2	2	2	2	2	3	2	-	2	-	2	2	2
Mean	**2.8**	**2.4**	**2.4**	**2.2**	**2.8**	**2.4**	**0.4**	**-**	**2.2**	**-**	**2.0**	**2.8**	**2.0**

Score : 3 – High   2 – Medium   1 – Low

<table>
<tr><td colspan="3">Department : Mechatronics</td><td colspan="8">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="3">Semester : Fifth</td><td colspan="4">Course Category Code: PEC</td><td colspan="4">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="4">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td colspan="3">TM</td></tr>
<tr><td>MTUE104</td><td colspan="2">Mechatronics in Agriculture</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td colspan="2">100</td></tr>
<tr><td>Prerequisite:</td><td colspan="10"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td colspan="9">Describe the application of automation in agricultural practices</td></tr>
<tr><td>CO2</td><td colspan="9">Demonstrate proficiency in utilizing IoT devices and sensor technologies for data collection, transmission, and analysis in agricultural settings.</td></tr>
<tr><td>CO3</td><td colspan="9">Apply principles of remote sensing techniques to monitor crop health, predict yield, and optimize resource allocation.</td></tr>
<tr><td>CO4</td><td colspan="9">Design and implement robotic solutions for various farm operations, including planting, spraying, harvesting, and monitoring tasks</td></tr>
<tr><td>CO5</td><td colspan="9">Develop and implement smart irrigation systems, integrating sensor data and automation to efficiently manage water resources and minimize wastage</td></tr>
</table>

<table>
<tr><td>UNIT-I</td><td>INTRODUCTION</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Overview of agriculture automation and smart farming - Importance and benefits of automation in agriculture - Historical background and evolution of smart farming practices, Key technologies and components involved (IoT, sensors, drones, robotics, AI, etc.) - Case studies showcasing successful implementation.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td>SENSORS AND MEASUREMENT IN AGRICULTURE</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Sensors for monitoring soil moisture and humidity - Temperature sensors - soil minerals and composition detection - Colorimetry based detection - Weather sensors - Air flow sensors - Thermal camera - Visual Measurements and Image processing</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-III</td><td>TELEMETRY AND IOT TECHNOLOGIES AND REMOTE SENSING IN AGRICULTURE</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Wireless communication modules: Zig-bee, Bluetooth - IoT (Internet of Things) and its usage in agriculture - Wireless sensor networks and communication protocols - Data collection, transmission, and analysis techniques - Sensor deployment and data acquisition system.
Role of remote sensing technologies (satellite imagery, aerial drones) in agriculture - Applications of GIS (Geographic Information Systems) in precision farming - Monitoring and managing crop health, yield prediction, and resource allocation</td><td>CO3, CO4</td></tr>
<tr><td>UNIT-IV</td><td>ROBOTICS AND AUTOMATION IN FARM OPERATIONS</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Introduction to agricultural robotics - Types of agricultural robots (autonomous tractors, harvesters, drones, etc.) - Automation of planting, spraying, harvesting, and other farm operations - Integration of robotics with IoT and AI for decision-making – Case Studies.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td>SMART IRRIGATION AND CHALLENGES, OPPORTUNITIES, AND FUTURE TRENDS IN AGRICULTURE</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Importance of efficient water management in agriculture - Smart irrigation systems and technologies (drip irrigation, soil moisture sensors, etc.) - Real-time monitoring and control of water usage - Water conservation strategies and sustainable practices.
Current challenges facing agriculture and how automation can address them - Emerging trends and innovations in smart farming - Economic, social, and environmental implications of agriculture automation - Opportunities for entrepreneurship and career paths in the field</td><td>CO4, CO5</td></tr>
<tr><td>Lecture Periods: 45</td><td>Tutorial Periods: 15</td><td>Practical Periods: NIL</td><td>Total Periods: 60</td></tr>
</table>

References:

1. Ramesh C. Poonia, Xiao-Zhi Gao, Linesh Raja, Sugam Sharma and Sonali Vyas, Smart Farming Technologies for Sustainable Agricultural Development, IGI Global, 2018.
2. Pradeep Tomar and Gurjit Kaur, Artificial Intelligence and IoT-Based Technologies for Sustainable Farming and Smart Agriculture, IGI Global, 2021.
3. Annamaria Castrignano, Gabriele Buttafuoco, Raj Khosla, Abdul Mouazen, Dimitrios Moshou and Olivier Naud, Agricultural internet of things and decision support for precision smart farming, Elsevier, 2020.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	2	-	-	2	-	2	3	2
CO2	3	3	2	2	3	2	-	-	2	-	2	3	2
CO3	3	2	3	2	3	3	-	-	2	-	2	3	2
CO4	3	2	3	3	3	2	-	-	3	-	2	3	2
CO5	2	2	2	2	2	3	2	-	2	-	2	2	2
Mean	**2.8**	**2.4**	**2.4**	**2.2**	**2.8**	**2.4**	**0.4**	**-**	**2.2**	**-**	**2.0**	**2.8**	**2.0**

Score : 3 – High 2 – Medium 1 – Low

LIST OF PROFESSIONAL ELECTIVES

Professional Elective	Course Code	Course	Semester
Professional Elective – II	MTUE105	Additive Manufacturing and 3D printing	**VI**
	MTUE106	Java Programming	
	MTUE107	Industrial Engineering and Safety	
	MTUE108	Aerospace Mechatronics	

Department : **Mechatronics**		Programme : **B.Tech. (MT)**						
Semester : **SIXTH**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUE105	**Additive Manufacturing and 3D Printing**	3	1	-	4	40	60	100
Prerequisite:								

Course Outcome At the end of the course, the students will be able to	**CO1**	**Explain** the evolution, principles, and classification of additive manufacturing systems and rapid prototyping.
	CO2	**Compare** various liquid, solid, and powder-based RP processes with respect to principles, materials, and parameters.
	CO3	**Apply** CAD tools for 3D modeling and generate STL files for additive manufacturing.
	CO4	**Evaluate** different rapid tooling techniques and their suitability for industrial and biomedical applications.
	CO5	**Develop** additive manufacturing solutions using reverse engineering for customized product development.

UNIT-I	**Introduction to Additive Manufacturing**	**Periods: 12**
Evolution, fundamental fabrication processes, CAD for RPT, product design and rapid product development - Need for time compression in product development - Conceptual design - Detail design, Prototype fundamentals - Fundamentals of RP systems – RP process chain - 3D modelling -3D solid modeling software and their role in RPT - Data format - STL files- History of RP systems - Classification of RP systems - Benefits of RPT.		**CO1, CO2**
UNIT-II	**Liquid based RP systems**	**Periods: 12**
Stereo Lithography Apparatus (SLA): Principle, Photo polymers, Post processes, Process parameters, Machine details, Advantages. Solid Ground Curing (SGC): Principle, Process parameters, Process details, Machine details, Limitations. Solid Creation System (SCS): Principle, Process parameters, Process details, Machine details, Applications.		**CO1, CO2**
UNIT-III	**Solid based RP systems**	**Periods: 12**
Fusion Deposition Modeling (FDM): Principle, Raw materials, BASS, Water soluble support system, Process parameters, Machine details, Advantages and limitations. Laminated Object Manufacturing (LOM): Principle, Process parameters, Process details, Advantages and limitations. Solid Deposition Manufacturing (SDM): Principle, Process parameters, Process details, Machine details, Applications.		**CO1, CO3**
UNIT-IV	**Powder based RP systems**	**Periods: 12**
Selective Laser Sintering (SLS): Principle, Process parameters, Process details, Machine details, Advantages and applications. 3-Dimensional Printers (3DP): Principle, Process parameters, Process details, Machine details, Advantages and limitations. Laser Engineered Net Shaping (LENS): Principle, Process details, Advantages and applications.		**CO4, CO5**
UNIT-V	**Rapid Tooling and Applications of RP:**	**Periods: 12**
Direct Rapid Tooling, Indirect Rapid Tooling: Soft tooling and Hard tooling. Applications of RP in Product design, Automotive industry, and Medical field – Conversion of CT/MRI scan data - Customized implant - Case studies -Reverse engineering.		**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods:15**	**Practical Periods: Nil**	**Total Periods:60**

Reference Books:

1. Chua C.K.,Leong K..& Lim C.S., "Rapid prototyping: Principles and Applications", 3rd Edition, World scientific, Newjersy, 2010.
2. Pham D.T. & Dimov S.S., "Rapid Manufacturing", Springer -Verlag, London, 2011.
3. Amitabha Ghosh, "Rapid Manufacturing a Brief Introduction", Affiliated East West Press, New Delhi, 2011.

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	1	-	-	1	-	2	3	2
CO2	3	3	2	2	2	2	-	-	1	-	2	3	2
CO3	2	2	2	2	3	-	-	-	2	-	2	3	2
CO4	2	3	3	2	2	2	1	-	2	-	2	3	2
CO5	2	2	3	2	3	2	1	-	2	-	3	2	3
Mean	**2.4**	**2.4**	**2.4**	**2**	**2.4**	**1.4**	**0.4**	**-**	**1.6**	**-**	**2.2**	**3**	**2.2**

Score : 3 – High 2 – Medium 1 – Low

Department : **Mechatronics**		Programme : **B.Tech. (MT)**						
Semester: **Sixth**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUE106	**Java Programming**	3	0	1	4	40	60	100
Prerequisite:	**Nil**							

Course Outcome At the end of the course the students will be able to		
	CO1	**Illustrate** the basic syntax, object-oriented principles, and control structures in Java programming.
	CO2	**Apply** object-oriented programming concepts such as classes, inheritance, polymorphism, and interfaces.
	CO3	**Develop** Java applications using exception handling, file I/O, and multithreading techniques.
	CO4	**Implement** GUI-based applications and event-driven programming using Java Swing
	CO5	**Evaluate and debug** Java programs to ensure functionality, performance, and robustness.

UNIT-I	**Periods: 12**
Java features – Java Platform – Java Fundamentals – Expressions, Operators, and Control Structures – Classes and Objects, Constructors – Destructors.	**CO1**
UNIT-II	**Periods: 12**
Packages and Interfaces – Overloading – Inheritance – Enumerations – Internationalization - Inner Classes - Polymorphism — Exception Handling – Garbage Collection – Containers.	**CO2, CO3**
UNIT-III	**Periods: 12**
GUI Components – Layouts – Event Driven Programming – AWT package – Applet Applications – Swing Classes and fundamentals.	**CO2, CO4**
UNIT-IV	**Periods: 12**
Strings – I/O Streams – Collections –Date and Time – Java Database Connectivity: Manipulating database with JDBC – prepares statements – stored procedures – Transaction processing.	**CO3, CO5**
UNIT-V	**Periods: 12**
Networking Basics - Java and the Net – Inet Address – TCP/IP Client Sockets – URL – URL Connection – TCP/IP Server - Sockets - A Caching Proxy HTTP Server – Datagrams – Remote Method Invocation.	**CO5**

Lecture Periods: 45	**Tutorial Periods: NIL**	**Practical Periods: 15**	**Total Periods: 60**

Reference Books:

1. Herbert Schildt, Java - The Complete Reference, Eleventh Edition, Tata McGraw Hill, 2018.
2. Paul Deitel and Harvey Deitel, Java: How to Program, Eleventh Edition, Pearson, 2017.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	-	-	-	1	-	2	2	1
CO2	3	3	3	2	3	-	-	-	1	-	2	3	2
CO3	3	2	3	2	3	-	-	-	1	-	2	3	2
CO4	2	2	3	2	3	-	-	-	2	-	2	3	2
CO5	2	2	3	2	3	-	-	-	2	-	2	2	2
Mean	**2.6**	**2.2**	**2.8**	**2**	**2.8**	**-**	**-**	**-**	**1.4**	**-**	**2**	**2.8**	**1.8**

Score : 3 – High 2 – Medium 1 – Low

Department : **Mechatronics**		Programme : **B.Tech. (MT)**						
Semester : **SIXTH**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods/week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUE107	**Industrial Engineering and Safety**	4	-	-	4	40	60	100
Prerequisite	-							

Course Outcome At the end of the course students will be able to	CO1	**Describe** the principles of plant location and layout design for efficient operations.
	CO2	**Apply** modern work study and material handling techniques to optimize productio processes.
	CO3	**Analyze and implement** advanced production management strategies.
	CO4	**Demonstrate** financial management capabilities and cost control.
	CO5	**Evaluate** and manage modern marketing and human resources strategies for performance-driven management.

UNIT-I	**Plant Location and Layout**	**Periods: 12**
Plant location- center of gravity method, load-distance model, and break-even analysis**.** The plant layout -classification of production systems and principles of layout, lean layout design principles **and** Industry 4.0 applications for smart plant layouts**.** Safety in plant layout design -ergonomic principles, emergency evacuation routes, fire safety measures, hazard identification, risk assessment, safety signage placement, and compliance with occupational health and safety standards.		CO1, CO5
UNIT-II	**Work Study and Material Handling**	**Periods: 12**
Digital process mapping and value stream mapping (VSM)**,** time-driven activity-based costing (TDABC**)**. Line balancing-heuristic methods, Rank Positional Weight Method, and assembly line optimization**.** Work measurement-time-driven activities, automation, AGVs (Automated Guided Vehicles), and IoT-enabled systems, current industrial practices		CO2, CO3
UNIT-III	**Safety**	**Periods: 12**
Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.		CO3, CO4
UNIT-IV	**Industrial Safety**	**Periods: 12**
Machinery Safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas 5 welding and Arc Welding. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries.		CO4, CO5
UNIT-V	**Work System Design**	**Periods: 12**
Scope of Industrial Engineering, Evolution of Industrial Engineering approach. Nature of work, Physical work systems, Work systems as a field of professional practice, Type of Occupation, Productivity concepts, Manual Work Systems, Worker-Machine Systems, Automated Work systems, Cycle time analysis of Manual work and in Worker machine systems (including numerical), Service operations , Office work, Work study.		CO5, CO1

Lecture Periods: 45	**Tutorial Periods:12**	**Practical Periods: Nil**	**Total Periods: 60**

Reference Books:

1. S.N. Chary, Production and Operations Management.
2. Khanna, Industrial Engineering and Management.
3. I.M. Pandey, Financial Management

CO-PO / PSO Mapping

POs/PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	2	-	-	1	-	2	2	1
CO2	3	3	3	2	3	2	-	-	1	-	2	3	2
CO3	2	3	3	2	2	2	1	-	1	-	2	3	2
CO4	2	2	2	2	2	1	1	-	2	2	2	2	2
CO5	2	2	2	1	2	1	1	2	2	2	2	2	2
Mean	**2.4**	**2.4**	**2.4**	**1.6**	**2.2**	**1.6**	**0.6**	**0.4**	**1.4**	**0.8**	**2**	**2.4**	**1.8**

Score : 3 – High   2 – Medium   1 – Low

Department : **Mechatronics**					Programme : **B.Tech. (MT)**				
Semester **: Sixth**					Course Category Code: **PEC**			Semester Exam Type: **TY**	
Course Code	Course Name	Periods / Week			Credit	Maximum Marks			
		L	T	P	C	CA	SE	TM	
MTUE108	**Aerospace Mechatronics**	3	1	-	4	40	60	100	
Prerequisite:									

Course Outcome At the end of the course students will be able to	**CO1**	**Describe** the basics in aerodynamics, aircraft propulsion, materials and controls
	CO2	**Explain** about the various concepts used in aerodynamics
	CO3	**Apply** the techniques to develop the aero system
	CO4	**Design** the aircraft with the use of concepts in aerodynamics, propulsion, materials and controls
	CO5	**Apply** this aircraft system in various applications

UNIT-I	**INTRODUCTION TO AERODYNAMICS**	**Periods: 12**	
Nomenclature used in Aerodynamics, different parts of airplane- Wing as lifting surface, Types of wing plan forms, Aerodynamic features like Aerofoil pressure distribution- Aerodynamic forces and moments Lift and Drag- Drag polar, L/D ratio, high lift devices, Airplane performance like Thrust/Power available, climb and glide - maximum range and endurance, take off and landings.			**CO1, CO2**
UNIT-II	**PROPULSION**	**Periods: 12**	
Requirement of power- various means of producing power - Brief description of thermo dynamics of engines - Piston engines, Jet engines - Airplane Structure, Materials and Production - Structural arrangement of earlier airplane- developments leading to all metal aircraft - Strength to weight ratio choice of aircraft materials for different parts.			**CO1, CO2**
UNIT-III	**AIRCRAFT MATERIALS**	**Periods: 12**	
Detailed description of wing - tail and fuselage joints - Stress-Strain diagrams, Plane and Space, Mechanical properties of materials - Materials for different components - use of composites - Aircraft production methods and equipment.			**CO3, CO4**
UNIT-IV	**PRIMARY FLIGHT CONTROLS**	**Periods: 12**	
Ailerons - Aileron Control System of a Commercial Aircraft - Elevators - Elevator control system of a commercial aircraft – Rudders- Rudder Control System.			**CO4, CO5**
UNIT-V	**APPLICATIONS OF MECHATRONICS IN AVIATION**	**Periods:12**	
Aileron-Flaps and Actuator drive unit-Pilot Static system-Fly by wire control system-Yaw damper-Primary flight control system-Internal navigation system-Under carriage-Measurement of motor rpm-Measurement of air flow velocity-Altitude measurement sensor-Air speed.			**CO4, CO5**
Lecture Periods: 45	**Tutorial Periods:15**	**Practical Periods: Nil**	**Total Periods:60**

Reference Books:

1. Fundamentals of Flight; By Dr. O. P. Sharma and Lalit Gupta.2006.
2. Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004 .
3. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
4. Pallet. E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011.
5. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993.
6. Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	2	-	-	1	-	2	3	1
CO2	3	3	2	2	3	2	-	-	2	-	3	3	2
CO3	3	2	3	3	3	2	-	-	2	-	3	3	2
CO4	3	3	3	3	3	2	1	-	2	-	3	3	3
CO5	2	2	3	3	3	3	1	2	3	-	3	3	3
Mean	**2.8**	**2.4**	**2.6**	**2.4**	**2.8**	**2.2**	**0.4**	**0.4**	**2**	**-**	**2.8**	**3**	**2.2**

Score : 3 – High 2 – Medium 1 – Low

LIST OF PROFESSIONAL ELECTIVES

Professional Elective	Course Code	Course	Semester
Professional Elective - III	MTUE109	Total Quality Management	**VII**
	MTUE110	VLSI Design	
	MTUE111	Nanotechnology	
	MTUE112	Medical Mechatronics	

<table>
<tr><td colspan="2">Department : Mechatronics</td><td colspan="9">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester :Seventh</td><td colspan="4">Course Category Code: PEC</td><td colspan="5">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUE109</td><td colspan="2">Total Quality Management</td><td>4</td><td>0</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="10"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td colspan="9">Explain the basic concepts and principles of Total Quality Management.</td></tr>
<tr><td>CO2</td><td colspan="9">Apply quality tools and techniques for continuous improvement in manufacturing/service.</td></tr>
<tr><td>CO3</td><td colspan="9">Analyze the role of quality management systems such as ISO 9001 and Six Sigma.</td></tr>
<tr><td>CO4</td><td colspan="9">Evaluate the impact of TQM practices on organizational performance and customer focus.</td></tr>
<tr><td>CO5</td><td colspan="9">Design a quality improvement plan using statistical process control and benchmarking.</td></tr>
<tr><td>UNIT-I</td><td colspan="4">INTRODUCTION</td><td colspan="6">Periods: 12</td></tr>
<tr><td colspan="10">Introduction to TQM, Concept of quality, Need for quality, Evolution of quality, Dimensions of manufacturing and service quality, Basic concepts of TQM, Definition of TQM, TQM Framework, Barriers to TQM, quality control and quality management</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td colspan="4">TQM PRINCIPLES</td><td colspan="6">Periods: 12</td></tr>
<tr><td colspan="10">TQM Principles, Leadership, Strategic quality planning, Quality statements, Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention, Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal, Continuous process improvement, PDSA cycle, 5s, Kaizen - Supplier partnership, Partnering, Supplier selection, Supplier Rating</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-III</td><td colspan="4">TQM MANAGEMENT</td><td colspan="6">Periods: 12</td></tr>
<tr><td colspan="10">Science of quality, human resources and quality, Quality organization and management, Quality manual, quality cost, quality related tasks. Quality information system: Planning, hardware-software.</td><td>CO3, CO4</td></tr>
<tr><td>UNIT-IV</td><td colspan="4">TQM TOOLS</td><td colspan="6">Periods: 12</td></tr>
<tr><td colspan="10">The seven traditional tools of quality, New management tools, Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT, Bench marking, Reason to bench mark, Bench marking process, FMEA – Stages, Types, Quality circles, Quality Function Deployment (QFD), Taguchi quality loss</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td colspan="4">QUALITY SYSTEMS AND TECHNIQUES</td><td colspan="6">Periods: 12</td></tr>
<tr><td colspan="10">Statistical process control and quality deployment techniques, controlling quality through measurement and through counting, Quality system and I.S.O.9000series, Quality assurance. Reports on quality, quality audit, quality training, newer quality management approaches, Quality tools.</td><td>CO3, CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 60</td><td>Tutorial Periods: Nil</td><td colspan="4">Practical Periods: Nil</td><td colspan="4">Total Periods: 60</td></tr>
<tr><td colspan="11">Reference Books:</td></tr>
</table>

1. Dale H. Besterfield, Carol BesterfieldMichna, Mary BesterfieldSacre, Glen H. Bester field, Total Quality Management 3rd Edition, Pearson,2010.
2. Mukherjee, P.N., “Total Quality Management”, Prentice Hall of India Ltd., New Delhi, 2006.
3. R. Ashley Rawlins, Total Quality Management (TQM), Autherhouse,2008
4. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 6th Edition, South- Western (Thomson Learning), 2005.
5. James I Bossert, “Quality Function Deployment”, ASQC Quality press, Wisconsin, 1994.
6. KanishkaBedi, “Total Quality Management”, Oxford University Press 8th Impression, 2011.

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	1	2	3	-	-	2	-	2	3	1
CO2	3	3	3	2	3	3	-	-	2	-	3	3	2
CO3	3	3	2	3	3	3	2	-	2	-	3	3	2
CO4	3	3	3	3	2	3	2	-	2	-	2	3	3
CO5	2	3	3	3	3	3	2	2	3	-	3	3	3
Mean	**2.8**	**3**	**2.6**	**2.4**	**2.8**	**3**	**1.2**	**0.4**	**2**	**-**	**2.8**	**3**	**2.2**

Score : 3 – High 2 – Medium 1 – Low

Department : **Mechatronics**		Programme : **B.Tech. (MT)**						
Semester : **Seventh**		Course Category Code**: PCC**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods/week			Credit	Maximum Marks		
MTUE110	**VLSI Design**	L	T	P	C	CA	SE	TM
		3	1	-	4	40	60	100
Prerequisite	-							

Course Outcome At the end of the course students will be able to	**CO1**	Explain the principles of CMOS fabrication processes and device characteristics.
	CO2	Analyze the behavior of CMOS logic gates in terms of performance, delay, and power
	CO3	Design combinational and sequential circuits using CMOS logic styles.
	CO4	Interpret layout design rules and construct stick diagrams and physical layouts.
	CO5	Model and simulate digital circuits using HDL and compare various VLSI design methodologies.

UNIT-I	**Basics of VLSI and CMOS Fabrication.**	**Periods:09**
Evolution of IC and VLSI technology, Moore's Law and scaling, MOSFET operation and threshold voltage, CMOS fabrication steps and process types, Latch-up and mitigation techniques.		CO1
UNIT-II	**CMOS Inverter and Layout Design.**	**Periods: 09**
CMOS inverter static and dynamic behavior, Propagation delay and power trade-offs, Sizing, and logical effort basics, Stick diagrams and layout rules, Use of layout tools and DRC basics		CO2, CO4
UNIT-III	**CMOS Combinational and Sequential circuits**	**Periods: 09**
Logic styles: static CMOS, dynamic logic, Design of multiplexers, decoders, Sequential elements: flip-flops, registers, Timing: setup/hold, skew, metastability, Low power considerations		CO3
UNIT-IV	**Subsystems and Design Methodology**	**Periods: 09**
Arithmetic building blocks: adders, multipliers, Modular and hierarchical design, ASIC vs FPGA architectures and workflows, Floorplanning, placement, and routing		CO4, CO5
UNIT-V	**HDL Modelling and Simulation**	**Periods:09**
Verilog modelling: Dataflow, Behavioral, Structural, Writing testbenches, Simulation vs synthesis, RTL design flow with tool overview.		CO5

Lecture Periods: 45	**Tutorial Periods:15**	**Practical Periods: Nil**	**Total Periods: 60**

Reference Books:

1. Neil H.E. Weste and David Harris, CMOS VLSI Design: A Circuits and Systems Perspective, Pearson.
2. Douglas A. Pucknell and Kamran Eshraghian, Basic VLSI Design, PHI.
3. Jan M. Rabaey, Digital Integrated Circuits: A Design Perspective, Pearson.
4. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Pearson.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	1	2	3	-	-	2	-	3	3	2
CO2	3	3	3	2	3	3	-	-	2	-	3	3	3
CO3	3	2	2	3	3	3	-	-	2	-	3	3	3
CO4	3	2	3	3	2	3	-	-	2	-	3	3	2
CO5	3	3	3	3	3	3	-	-	3	-	3	3	3
Mean	**3**	**2.6**	**2.6**	**2.4**	**2.8**	**3**	-	-	**2**	-	**3**	**3**	**2.8**

Note : 3 – High 2 – Medium 1 – Low

Department : **Mechatronics**		Programme : **B.Tech. (MT)**							
Semester **: Seventh**		Course Category Code: **PEC**				Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks			
		L	T	P	C	CA	SE	TM	
MTUE111	**Nanotechnology**	3	1	-	4	40	60	100	
Prerequisite:									

Course Outcome At the end of the course, the students will be able to		
	CO1	**Describe** the structure and function of human biological systems relevant to bionics and medical mechatronics.
	CO2	**Illustrate** the use of sensors and actuators in biological signal measurement and medical diagnostics.
	CO3	**Apply** signal processing techniques to develop and evaluate sensory assist devices for biomedical applications.
	CO4	**Analyze** various patient monitoring systems and prosthetic technologies in medical mechatronics.
	CO5	**Evaluate** wearable bionic devices and robotic interventions through case studies in surgical and rehabilitation fields.

UNIT-I	**INTRODUCTION TO BIO-MECHATRONICS**	**Periods: 12**
Introduction to Bionics and Medical Mechatronics, Overview of human functional system Fundamentals of Biological systems and Mechanisms - Cardiovascular, Musculoskeletal and orthopedic systems, human ergonomic, Rehabilitation.		**CO1, CO5**
UNIT-II	**SENSORS AND MEDICAL MEASUREMENTS**	**Periods: 12**
Gas analyzers: pH of blood, Smart actuators for biological applications - Heart rate - Heart sound - Pulmonary function measurements -spirometer -finger-tip oximeter, ESR, GSR measurements		**CO2, CO3**
UNIT-III	**SIGNAL PROCESSING & SENSORY ASSIST DEVICES**	**Periods: 12**
Bio-medical signals, Signal acquisition and signal processing-Isolation barriers, bionic Eyes, hearing aids and Cochlear Implants, Visual Neuroprostheses, Assisting Devices – Sonar based systems, Respiratory aids, Tactile devices for visually challenged		**CO2, CO3**
UNIT-IV	**MEDICAL SUPPORT EQUIPMENT, PATIENT MONITORING AND PROSTHETICS**	**Periods: 12**
Ventilators, Nerve and muscle stimulators, Heart Lung machine, Dialyzers, Nebulizer, Anesthesia machine - Defibrillator – Pacemakers, Different types of biotelemetry systems and patient monitoring. Introduction to prosthetics, Passive Prosthetics – walking dynamics, Knee and foot prosthesis, Active prosthesis - Control of Prosthetic Arms and Hands, Leg Mechanisms, Ankle–Foot Mechanisms, Prosthesis Suspension.		**CO4, CO5**
UNIT-V	**WEARABLE BIONIC DEVICES AND CASE STUDIES**	**Periods: 12**
Wearable Artificial Kidney, Wireless capsule endoscope, Wearable Exoskeletal rehabilitation system, Wearable hand rehabilitation. Case studies on Robotic surgery- Orthopedic Surgery, Urologic Surgery, Cardiac Surgery, Neurosurgery, endoscopic trans-nasal skull base surgery, Therapeutic Exercise and rehabilitation Robots		**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods:15**	**Practical Periods: Nil**	**Total Periods: 60**

Reference Books:

1. Graham M. Brooker, Introduction to Biomechatronics, 2012, SciTech Publishing.
2. Xie Song, Shane Xie, Wei Meng, Biomechatronics in Medical Rehabilitation, 2017, Springer.
3. Hu Xiaoling, Intelligent Biomechatronics in Neurorehabilitation, 2019, Academic Press.
4. Ahmad Azar, Control Systems Design of Bio-Robotics and Bio- Mechatronics with Advanced Applications, 2019, Academic Press.
5. Raymond Tong Kaiyu, Bio-mechatronics in Medicine and Healthcare, 2011, Pan Stanford Publishing, CRC Press.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	2	1	-	-	-	2	2	2
CO2	3	2	-	-	2	-	-	-	-	-	2	2	2
CO3	3	2	2	-	2	-	-	-	-	-	2	3	3
CO4	2	-	3	-	-	2	2	1	-	2	2	3	3
CO5	2	1	3	-	-	2	2	2	1	3	3	3	3
Mean	**2.6**	**1.4**	**1.8**	-	**0.8**	**1.2**	1	**0.2**	**0.2**	1	**2.2**	**2.6**	**2.6**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="3">Department : Mechatronics</td><td colspan="5">Programme : B.Tech. (MT)</td></tr>
<tr><td colspan="3">Semester : Seventh</td><td colspan="4">Course Category Code: PEC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUE112</td><td colspan="2">Medical Mechatronics</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="9">NIL</td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the student will be able to</td><td>CO1</td><td colspan="8">Explain the principles of bionics and the structure and function of human physiological systems relevant to bio-mechatronics.</td></tr>
<tr><td>CO2</td><td colspan="8">Describe and analyze various biomedical sensors and smart actuators used for medical measurements and diagnostics.</td></tr>
<tr><td>CO3</td><td colspan="8">Apply signal acquisition and processing techniques in the development of sensory assistive devices for healthcare applications.</td></tr>
<tr><td>CO4</td><td colspan="8">Evaluate the design and functioning of medical support equipment, patient monitoring systems, and prosthetic devices.</td></tr>
<tr><td>CO5</td><td colspan="8">Design and assess wearable bionic systems and interpret real-world case studies in robotic-assisted surgeries and rehabilitation technologies.</td></tr>
<tr><td>UNIT-I</td><td colspan="4">INTRODUCTION TO BIO-MECHATRONICS</td><td colspan="5">Periods:12</td></tr>
<tr><td colspan="9">Introduction to Bionics and Medical Mechatronics, Overview of human functional system Fundamentals of Biological systems and Mechanisms - Cardiovascular, Musculoskeletal and orthopedic systems, human ergonomic, Rehabilitation.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td colspan="4">SENSORS AND MEDICAL MEASUREMENTS</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="9">Gas analyzers: pH of blood, Smart actuators for biological applications - Heart rate - Heart sound -Pulmonary function measurements -spirometer -finger-tip oximeter, ESR, GSR measurements.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-III</td><td colspan="4">SIGNAL PROCESSING & SENSORY ASSIST DEVICES</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="9">Bio-medical signals, Signal acquisition and signal processing-Isolation barriers, bionic Eyes, hearing aids and Cochlear Implants, Visual Neuroprostheses, Assisting Devices – Sonar based systems, Respiratory aids, Tactile devices for visually challenged.</td><td>CO3</td></tr>
<tr><td>UNIT-IV</td><td colspan="4">MEDICAL SUPPORT EQUIPMENT, PATIENT MONITORING AND PROSTHETICS</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="9">Ventilators, Nerve and muscle stimulators, Heart Lung machine, Dialyzers, Nebulizer, Anesthesia machine - Defibrillator – Pacemakers, Different types of biotelemetry systems and patient monitoring. Introduction to prosthetics, Passive Prosthetics – walking dynamics, Knee and foot prosthesis, Active prosthesis - Control of Prosthetic Arms and Hands, Leg Mechanisms, Ankle–Foot Mechanisms, Prosthesis Suspension.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td colspan="4">WEARABLE BIONIC DEVICES AND CASE STUDIES</td><td colspan="5">Periods: 12</td></tr>
<tr><td colspan="9">Wearable Artificial Kidney, Wireless capsule endoscope, Wearable Exoskeletal rehabilitation system, Wearable hand rehabilitation.
Case studies on Robotic surgery- Orthopedic Surgery, Urologic Surgery, Cardiac Surgery, Neurosurgery, endoscopic trans-nasal skull base surgery, Therapeutic Exercise and rehabilitation Robots.</td><td>CO4, CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 45</td><td>Tutorial Periods: 15</td><td colspan="4">Practical Periods: NIL</td><td colspan="3">Total Periods: 60</td></tr>
<tr><td colspan="10">Reference Books:</td></tr>
</table>

1. Graham M. Brooker, Introduction to Biomechatronics, 2012, SciTech Publishing.
2. Xie Song, Shane Xie, Wei Meng, Biomechatronics in Medical Rehabilitation, 2017, Springer.
3. Hu Xiaoling, Intelligent Biomechatronics in Neurorehabilitation, 2019, Academic Press.
4. Ahmad Azar, Control Systems Design of Bio-Robotics and Bio- Mechatronics with Advanced Applications, 2019, Academic Press.
5. Raymond Tong Kaiyu, Bio-mechatronics in Medicine and Healthcare, 2011,Pan Stanford Publishing, CRC Press.

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	2	1	-	-	-	1	2	2
CO2	3	3	2	-	2	-	-	-	-	-	2	2	2
CO3	2	3	3	-	3	-	-	-	-	-	2	3	3
CO4	3	3	3	-	2	2	2	2	2	2	2	3	3
CO5	3	2	3	-	3	2	3	2	2	2	3	3	3
Mean	**2.8**	**2.6**	**2.2**	**-**	**2**	**1.2**	**1.2**	**0.8**	**0.8**	**0.8**	**2**	**2.6**	**2.6**

Score : 3 – High 2 – Medium 1 – Low

ANCILLARY STREAM COURSES

LIST OF ANCILLARY STREAM COURSES

Ancillary Stream Title	Course Code	Course	Semester
Artificial Intelligence (For all branches except Mechatronics)	MTUN101	AI in Mechatronics	**IV, V, VI, VII**
	MTUN102	AI for Robots & Autonomous Systems	
	MTUN103	AI in Medicine	
	MTUN104	Applied AI for Manufacturing	
Internet of Things (For all branches except Mechatronics)	MTUN105	Industrial Internet of Things	
	MTUN106	IoT in Mechatronics	
	MTUN107	Internet of Robotic Things	
	MTUN108	Augmented Reality and Virtual Reality	
Smart manufacturing and Industry 5.0 (Only for Mechatronics students)	MTUI101	Additive Manufacturing	
	MTUI102	Intelligent Manufacturing Systems	
	MTUI103	Digital Manufacturing & IoT	
	MTUI104	Introduction to Industry 5.0	

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="5">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester: Fourth</td><td colspan="4">Course Category Code: ANC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUN101</td><td>AI in Mechatronics</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">Basic understanding of mechatronics and its components</td></tr>
</table>

Course Outcome		
Course Outcome At the end of the course, the students will be able to	**CO1**	**Explain** the role and scope of artificial intelligence and machine learning in mechatronic systems.
	CO2	**Apply** AI Algorithms for mechatronics systems
	CO3	**Demonstrate** sensor fusion, computer vision, and AI techniques in smart automation and robotics.
	CO4	**Develop** AI-based optimization solutions for manufacturing and process automation.
	CO5	**Implement** mapping in mechatronics systems

UNIT-I	**INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND MECHATRONICS**	**Periods: 09**

Overview of artificial intelligence and its applications in mechatronics, Understanding the role of machine learning, computational intelligence, and neural networks in AI for mechatronics, exploring various learning methods: supervised, unsupervised, reinforcement, and semi supervised learning, Introduction to generative networks, deep neural networks, and convolutional neural networks, Case studies showcasing AI applications in mechatronics. **CO1, CO4**

UNIT-II	**COMPUTATIONAL INTELLIGENCE ALGORITHMS**	**Periods: 09**

Understanding computational intelligence algorithms: fuzzy systems and evolutionary algorithms, Exploring the concept of optimization in mechatronics, Applying AI approaches effectively in mechatronic systems, Introduction to stochastic dynamic programming and its relationship with AI, Case studies on optimization using AI in mechatronics. **CO2, CO3**

UNIT-III	**COMPUTER VISION AND SENSOR FUSION IN AUTOMATION**	**Periods: 09**

Basics of computer vision: Image processing, object detection, and tracking, AI-powered quality inspection and defect detection, Sensor fusion techniques using AI, Practical applications in industrial robots and smart factories. Case study: The Intelligent Robotic Car. **CO2, CO3**

UNIT-IV	**OPTIMIZATION AND DECISION-MAKING IN AUTOMATION**	**Periods: 09**

AI-driven optimization techniques (Genetic Algorithms, Particle Swarm Optimization), AI in scheduling and process optimization, AI for supply chain and logistics automation, Implementation using AI frameworks. IoT-based predictive maintenance using AI - Case study: AI in predictive maintenance of industrial equipment. **CO4, CO5**

UNIT-V	**LOCALIZATION, MAPPING, AND CONTROL WITH AI**	**Periods: 09**

Introduction to localization and mapping in mechatronics - AI techniques for localization and mapping: SLAM (Simultaneous Localization and Mapping, Implementing SLAM algorithms using AI techniques - Understanding tracking and control in mechatronics, AI-based control algorithms for mechatronic systems, Case studies showcasing AI-enabled tracking and control in mechatronics. **CO2, CO5**

Lecture Periods: 45	**Tutorial Periods: Nil**	**Practical Periods: Nil**	**Total Periods: 45**

Reference Books:

1. S. Russell and P. Norvig, *Artificial Intelligence: A Indu Approach*, Pearson.
2. Zhang, Dan and Wei, Bin, *Artificial Intelligence in Mechatronics and Robotics*, Springer
3. Godfrey C. Onwubolu, *Mechatronics: Principles and Applications*, Elsevier

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	2	3	2	2	-	-	-	3	3	2
CO2	3	3	2	3	3	-	3	-	-	-	3	3	2
CO3	3	2	3	3	3	-	3	-	-	-	3	3	3
CO4	3	3	3	3	3	2	3	2	-	-	3	3	3
CO5	3	3	3	3	3	2	3	2	-	-	3	3	3
Mean	**3**	**2.8**	**2.2**	**2.8**	**3**	**1.2**	**2.8**	**0.8**	**-**	**-**	**3**	**3**	**2.6**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fifth</td><td colspan="4">Course Category Code: ANC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUN102</td><td>AI for Robots & Autonomous Systems</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td colspan="7">Understand AI fundamentals in robotics, including locomotion, perception, planning, control, and learning</td></tr>
<tr><td>CO2</td><td colspan="7">Apply computer vision techniques like object detection, depth estimation, and deep learning in robotics.</td></tr>
<tr><td>CO3</td><td colspan="7">Apply computer vision techniques like object detection, depth estimation, and deep learning in robotics.</td></tr>
<tr><td>CO4</td><td colspan="7">Analyze AI-based decision-making in autonomous systems, including motion planning and multi-agent coordination.</td></tr>
<tr><td>CO5</td><td colspan="7">Evaluate safety standards, risk management, and accident prevention techniques in robotics.</td></tr>
<tr><td>UNIT-I</td><td colspan="3">Introduction to AI in Robotics</td><td colspan="5">Periods: 09</td></tr>
<tr><td colspan="8">Introduction to the fundamentals of mobile robotics, basic principles of locomotion, Kinematics and Mobility, Classification of mobile robots, Overview of AI applications in robotics and autonomous systems, Traditional vs AI-driven robotics, Key components: Perception, Planning, Control, and Learning, Applications of AI in Robotics and autonomous systems.</td><td>CO1, CO4</td></tr>
<tr><td>UNIT-II</td><td colspan="3">Computer Vision for Robotics</td><td colspan="5">Periods: 09</td></tr>
<tr><td colspan="8">Image processing techniques for robots, Object detection and tracking (CNN, YOLO, SSD), Depth estimation and stereo vision, AI-powered vision applications in robotic grasping and navigation, Implementing OpenCV and deep learning models in Python.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-III</td><td colspan="3">AI-powered Human-Robot Interaction</td><td colspan="5">Periods: 09</td></tr>
<tr><td colspan="8">Path planning algorithms (A*, Dijkstra, RRT), Deep Q Networks (DQN) and Policy Gradient methods, RL applications in robot control and adaptive learning, AI-based motion planning and manipulation. AI-driven speech and gesture recognition, Natural Language Processing (NLP) for robotic communication, Emotion recognition and social robots, Implementing AI-based human-robot interaction in a simulation.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td colspan="3">AI for Decision-Making in Autonomous Systems</td><td colspan="5">Periods: 09</td></tr>
<tr><td colspan="8">Autonomous Mobile Robots – need and applications, sensing, localisation, mapping, navigation and control. The Basics of Autonomy (Motion, Vision and PID), Programming Complex Behaviors (reactive, deliberative, FSM). Behaviour trees and decision-making algorithms, AI-based motion planning in self-driving vehicles, AI for multi-agent coordination in robotics. Case studies: AI in autonomous drones, AGVs, and humanoid robots.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td colspan="3">Safety Standards for Robots</td><td colspan="5">Periods:09</td></tr>
<tr><td colspan="8">BIS and ISO safety standards for Robots, Safety management system, Hazard identification, Risk analysis and Evaluation, Audit Programme, Preventive Maintenance of Robots, Accident Prevention Techniques, Ergonomics of robots handling, Safety management and management principles, Major accident control, Safety Training, Robotics Safety Requirements.</td><td>CO4, CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 45</td><td colspan="2">Tutorial Periods: Nil</td><td colspan="3">Practical Periods: Nil</td><td colspan="2">Total Periods: 45</td></tr>
<tr><td colspan="9">Reference Book:</td></tr>
<tr><td colspan="9">1. Francis X. Govers, Artificial Intelligence for Robotics, Packt Publishing
2. Murphy, Robin R., Introduction to AI Robotics, MIT Press
3. El-Sayed, Hashem H., AI in Manufacturing and Robotics, Springer</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	2	-	-	-	-	3	3	2
CO2	3	3	3	3	3	-	-	-	-	-	3	3	2
CO3	3	2	3	3	3	-	-	-	-	-	3	3	3
CO4	3	3	2	3	3	2	-	-	-	-	3	3	3
CO5	3	3	3	3	3	2	3	2	-	-	3	3	3
Mean	**3**	**2.8**	**2.6**	**2.8**	**3**	**1.2**	**0.6**	**0.4**	**-**	**-**	**3**	**3**	**2.6**

Score : 3 – High 2 – Medium 1 – Low

Department: **Mechatronics**		Programme: **B.Tech. (MT)**						
Semester **: Sixth**		Course Category Code: **ANC**				Semester Exam Type: **TY**		
Course Code	Course name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUN103	**AI in Medicine**	3	0	0	3	40	60	100
Prerequisite:								

Course Outcome At the end of the course, the students will be able to		
	CO1	**Describe** the fundamentals of artificial intelligence and its role in medical applications.
	CO2	**Apply** machine learning algorithms for diagnosis, prediction, and classification in healthcare.
	CO3	**Analyze** medical datasets using AI tools to derive insights for decision-making.
	CO4	**Evaluate** AI-based systems for image analysis, drug discovery, and patient monitoring.
	CO5	**Design and develop** AI solutions for medical applications using ethical and regulatory frameworks.

UNIT-I	**Introduction to Clinical Data Set**	**Periods: 09**
Clinical Data Sets: Data sources and types (structured, unstructured); Standards in data acquisition and management; Opportunities and challenges in data handling. The Role of Smart and Intelligent Systems in Clinical Workflow: Computer systems in clinical workflow; traditional systems vs. intelligent systems in medicine & healthcare; concepts of intelligence and smartness. Recent Inroads / Trends of AI in Healthcare: Landmark applications in medicine & healthcare.		**CO1, CO5**
UNIT-II	**AI & Deep Learning in Medicine**	**Periods: 09**
Introduction to Artificial Intelligence in Medicine, Definition and scope of AI in healthcare, Historical perspective and milestones in AI research, Applications of AI in clinical practice and biomedical research. Deep Learning Architectures, Neural networks, convolutional neural networks (CNNs), and recurrent neural networks (RNNs), Deep learning frameworks (e.g., TensorFlow, PyTorch), Transfer learning and pre-trained models.		**CO1, CO2**
UNIT-III	**AI in Imaging & Diagnosis**	**Periods: 09**
AI in Medical Imaging, Image classification, segmentation, and registration, Radiomics and quantitative imaging biomarkers, Applications of AI in radiology, pathology, and ophthalmology. AI in Diagnostics and Disease Prediction, Predictive modelling for disease risk assessment, Diagnostic decision support systems, Early detection of diseases using AI algorithms.		**CO3, CO4**
UNIT-IV	**NLP in healthcare**	**Periods: 09**
Natural Language Processing (NLP) in Healthcare, Text mining and information extraction from clinical Scores, Clinical language understanding and medical coding, Applications of NLP in electronic health records (EHR) analysis and clinical documentation. AI in Personalized Medicine and Treatment Planning, Pharmacogenomics and precision medicine, Treatment recommendation systems, Drug discovery and repurposing using AI approaches.		**CO3, CO4**
UNIT-V	**Ethics & Case studies**	**Periods: 09**
Integration challenges of AI in healthcare, Ethical considerations, patient autonomy. Legal, and Social Implications (ELSI) of AI in Medicine, Bias and fairness in AI algorithms, Privacy and security of healthcare data, Regulation and policy considerations for AI in healthcare. Case Studies on Screening, Diagnosis, Patient Management & Hospital Management.		**CO5**

Lecture Periods: 45	**Tutorial Periods: Nil**	**Practical Periods: Nil**	**Total Periods: 45**

Reference Books:

1. Mesko, B., 2017. A guide to artificial intelligence in healthcare. Budapest, Hungary: The Medical Futurist. leanpub. com.
2. Edward H. Shortliffe; Leslie E. Perreault, Medical Informatics – Computer Applications in Healthcare and Biomedicine, Springer-Verlag New York Inc.Publishers, 2014.
3. Lei Xing and James K. Min, *Artificial Intelligence in Medicine: Technical Basis and Clinical Applications*, Elsevier
4. S. Kevin Zhou, Hayit Greenspan, and Dinggang, *Deep Learning for Medical Image Analysis*, Elsevier

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	2	-	-	-	-	3	3	2
CO2	3	3	3	3	3	-	-	-	-	-	3	3	2
CO3	3	2	3	3	3	-	-	-	-	-	3	3	3
CO4	3	3	2	3	3	2	-	-	-	-	3	3	3
CO5	3	3	3	3	3	2	3	2	-	-	3	3	3
Mean	**3**	**2.8**	**2.6**	**2.8**	**3**	**1.2**	**0.6**	**0.4**	**-**	**-**	**3**	**3**	**2.6**

Score : 3 – High 2 – Medium 1 – Low

Department: **Mechatronics**					Programme: **B.Tech. (MT)**				
Semester **: Seventh**					Course Category Code: **ANC**		Semester Exam Type: **TY**		
Course Code	Course name	Periods / Week			Credit	Maximum Marks			
		L	T	P	C	CA	SE	TM	
MTUN104	**Applied AI for Manufacturing**	3	0	0	3	40	60	100	

Prerequisite:	NIL	
Course Outcome At the end of the course, the students will be able to	**CO1**	**Explain** the concepts of AI with relevance to their components, scope, and applications in manufacturing.
	CO2	**Apply** machine learning techniques for data preprocessing, model development, and evaluation in manufacturing use cases.
	CO3	**Analyze** the role of explainable AI methods in improving transparency and trust in manufacturing applications.
	CO4	**Evaluate** the integration of digital twins and AI in real-time monitoring, simulation, and optimization of manufacturing processes.
	CO5	**Design** AI-driven solutions for manufacturing problems by leveraging expert systems, ML models, and digital twin technologies.

UNIT-I	**Introduction to AI in Manufacturing**	**Periods: 09**
Definitions of intelligence and artificial intelligence - Human mental capabilities: association, stereotyping, reasoning and vision - Artificial intelligence: components, scope and application areas in manufacturing, Challenges and opportunities of AI adoption in manufacturing, Case studies highlighting AI use cases in different manufacturing sectors.		**CO1, CO2**
UNIT-II	**Expert Systems Tools and Applications**	**Periods: 09**
Overview of Knowledge-based or expert systems – Structure, Sources. Expert system languages - Expert system shells: typical examples of shells - CLIPS programming - Expert system software for manufacturing applications in CAD, CAPP, MRP, adaptive control, robotics, process control, fault diagnosis, failure analysis, process selection, group technology, etc.		**CO1, CO2**
UNIT-III	**Explainable AI Techniques**	**Periods: 09**
Interpretable models (e.g., Decision Trees, linear models), Post-hoc explanations - Shapley Additive explanations (SHAP), Local Interpretable Model-agnostic Explanations (LIME), Rule-based systems, Model distillation, and simplification techniques. Applications of XAI in Manufacturing: Predictive maintenance and fault detection, Quality control and defect detection, Process optimization and scheduling, and Supply chain management. Integration of XAI with autonomous systems and robotics.		**CO2, CO3**
UNIT-IV	**ML for Manufacturing**	**Periods: 09**
Machine Learning (ML), difference between AI and ML, types of ML, applications of ML, types of data in ML, exploring structure of data, data preprocessing , model evaluation metrics. Challenges of Black-Box AI Models: Lack of transparency and interpretability, Risks associated with black-box models in manufacturing, Regulatory requirements, and ethical considerations.		**CO2, CO4, CO5**
UNIT-V	**Digital Twin in Manufacturing**	**Periods: 09**
Introduction to Digital Twins-How AI Enhances Digital Twin Models, Real-Time Monitoring and Simulation of Manufacturing Processes. Case studies of typical applications in tool selection, process selection, part classification, inventory control, process planning, etc. Ethical considerations and responsible AI practices in manufacturing.		**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: Nil**	**Practical Periods: Nil**	**Total Periods: 45**

Reference Books:

1. Uday Kamath, and John Liu, "Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning", Springer, 2021, ISBN 9783030833558
2. Leonida Gianfagna and Antonio Di Cecco, "Explainable AI with Python", Springer International Publishing, First Edition, 2021
3. Fazel Famili (Editor), Dana S. Nau (Editor), Steven H. Kim (Editor); Artificial Intelligence Applications in Manufacturing, AAAI Press.
4. El-Sayed, Hashem H., *AI in Manufacturing and Robotics*, Springer

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	2	-	-	-	-	3	3	2
CO2	3	3	3	3	3	-	-	-	-	-	3	3	2
CO3	3	2	3	3	3	-	-	-	-	-	3	3	3
CO4	3	3	2	3	3	2	-	-	-	-	3	3	3
CO5	3	3	3	3	3	2	3	2	-	-	3	3	3
Mean	**3**	**2.8**	**2.6**	**2.8**	**3**	**1.2**	**0.6**	**0.4**	**-**	**-**	**3**	**3**	**2.6**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="5">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester: Fourth</td><td colspan="4">Course Category Code: ANC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUN105</td><td>Industrial Internet of Things</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td colspan="7">Describe the architecture, components, and communication protocols of Industrial Internet of Things systems.</td></tr>
<tr><td>CO2</td><td colspan="7">Explain the architecture of Industrial IoT (IIoT), its components, advantages, challenges, and industry implementations.</td></tr>
<tr><td>CO3</td><td colspan="7">Analyze and Apply appropriate sensors, actuators, and their interfacing protocols in IIoT applications.</td></tr>
<tr><td>CO4</td><td colspan="7">Evaluate the performance, reliability, and security of IIoT systems used in smart manufacturing and industrial operations.</td></tr>
<tr><td>CO5</td><td colspan="7">Design IIoT-based solutions for specific industrial use cases integrating edge computing, cloud platforms, and analytics tools.</td></tr>
<tr><td>UNIT-I</td><td colspan="3">INTRODUCTION TO IoT</td><td colspan="5">Periods: 09</td></tr>
<tr><td colspan="8">Fundamentals of IoT: Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, Role of IoT in manufacturing industries- Real time scenario.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td colspan="3">ARCHITECTURE OF IIoT</td><td colspan="5">Periods: 09</td></tr>
<tr><td colspan="8">Introduction to Industrial Internet of Things (IIoT), IOTvs.IIOT, History of IIOT, fundamental terms in IIOT, Components of IIOT, Various Architectures of IIOT- Advantages and disadvantages. Basic Technologies, Challenges & Benefits in implementing IIOT, Industry environments and scenarios covered by IIoT.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-III</td><td colspan="3">SENSORS AND INTERFACING IN IIoT</td><td colspan="5">Periods: 09</td></tr>
<tr><td colspan="8">Introduction to sensors, Transducers, Classification, Roles of sensors in IIOT, Various types of sensors, Design of sensors, sensor architecture, special requirements for IIOT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACNet etc.</td><td>CO3</td></tr>
<tr><td>UNIT-IV</td><td colspan="3">TECHNICAL AND BUSINESS INNOVATORS OF INDUSTRIAL INTERNET</td><td colspan="5">Periods: 09</td></tr>
<tr><td colspan="8">Miniaturization – Cyber Physical Systems – Wireless technology – IP Mobility – Network Functionality Virtualization – Cloud and Fog - Big Data and Analytics – M2M Learning and Artificial Intelligence.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td colspan="3">IIoT BASED INDUSTRIAL AUTOMATION</td><td colspan="5">Periods: 09</td></tr>
<tr><td colspan="8">IoT based gas leakage monitoring system, Temperature and liquid level monitoring in boilers, Fire detection system, wireless video surveillance robot, Automatic Solar Tracker, Plant Automation, Case studies.</td><td>CO4, CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 45</td><td colspan="2">Tutorial Periods: Nil</td><td colspan="3">Practical Periods: Nil</td><td colspan="2">Total Periods: 45</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
<tr><td colspan="9">1. Veneri, Giacomo, and Antonio Capasso- Hands-on Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0, 1stEd., Packt Publishing Ltd, 2018.
2. Alasdair Gilchrist- Industry 4.0: The Industrial Internet of Things, 1st Ed., Apress, 2017.
3. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	2	2	3	-
CO2	2	2	3	-	-	-	-	-	-	-	2	3	2
CO3	2	3	2	3	3	-	-	-	-	-	2	3	2
CO4	2	3	2	2	3	2	2	1	2	-	3	2	2
CO5	2	2	3	2	3	-	-	-	3	3	3	3	3
Mean	**2.2**	**2**	**2**	**1.4**	**2.2**	**0.4**	**0.4**	**0.2**	**1**	**1**	**2.4**	**2.8**	**1.8**

Score : 3 – High   2 – Medium   1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fifth</td><td colspan="4">Course Category Code: ANC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUN106</td><td>IoT in Mechatronics</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">Basics of Mechatronics</td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td colspan="7">Describe the mechanical, electrical, and electromechanical components in mechatronics systems</td></tr>
<tr><td>CO2</td><td colspan="7">Apply IoT devices and programming techniques for sensor and actuator interfacing in mechatronics systems.</td></tr>
<tr><td>CO3</td><td colspan="7">Analyze IoT architectures, communication models, and connectivity methods for mechatronics applications.</td></tr>
<tr><td>CO4</td><td colspan="7">Evaluate cloud storage models, communication APIs, and cloud platforms for IoT-based mechatronics solutions.</td></tr>
<tr><td>CO5</td><td colspan="7">Implement real-world mechatronics and IoT applications through case studies in automation and monitoring.</td></tr>
<tr><td>UNIT-I</td><td colspan="4">Basic Mechatronics Systems</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="8">Introduction – Mechanical system building blocks- Translational and Rotational system building up a mechanical system model, Electrical system building blocks- building up model, Electro – mechanical systems – system components and function – comparison of mechanical, electrical & electro-mechanical systems, advantages & disadvantages, Applications of mechatronics systems.</td><td>CO1, CO5</td></tr>
<tr><td>UNIT-II</td><td colspan="4">Fundamentals of IoT in Mechatronics Systems</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="8">Introduction to IoT Simulation Environment and Devices (Raspberry Pi, Espressif Processors, Arduino), Architecture, Setup, IDE, Installation, Interfaces (serial, SPI, I2C), Programming with focus on interfacing for reading input from pins, connecting external gadgets/sensors/actuators, Controlling and Displaying Output, Libraries, Basics of Embedded C programming.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-III</td><td colspan="4">Interfacing</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="8">IoT Architecture: Building architecture and Open-source architecture (OIC), Main design principles and needed capabilities, An IoT architecture outline, Standards Considerations. Overview and Working of Controlled Systems, Connectivity models - TCP/IP Vs OSI model, IoT Communication Models, IoT Communication APIs, Serial Vs Parallel Communication, Wires Vs Wireless Communication, their Technologies and Hardware.</td><td>CO3, CO4</td></tr>
<tr><td>UNIT-IV</td><td colspan="4">Communication for IoT Applications</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="8">Introduction to Cloud Storage models and Communication APIs Webserver, API Virtualization concepts and Cloud Architecture, Advantages and limitations of Cloud computing, IoT Cloud platforms, Cloud services.</td><td>CO4</td></tr>
<tr><td>UNIT-V</td><td colspan="4">Mechatronics and IoT Case Studies</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="8">Mechatronics systems: Drone actuation and Control -Autonomous Robot with Vision System, IoT case studies: Remote Monitoring Systems- Remotely Operated Autonomous Systems – Centralized Water Management System – IoT Enabled Robotic Camera Dolly – Portable, Wireless, Interactive IoT Sensors for Agriculture – IoT Vehicle Management System with Network Selection.</td><td>CO1, CO3, CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 45</td><td colspan="2">Tutorial Periods: Nil</td><td colspan="2">Practical Periods: Nil</td><td colspan="3">Total Periods: 45</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
<tr><td colspan="9">1. Mechatronics-Integrated Mechanical Electronic systems, Wiley – India, New Delhi First Edition, 2008
2. John Billingsley, “Essentials of Mechatronics”, Wiley, 2006
3. Raj, P. and Raman, A. C., (2017), “The Internet of Things: Enabling Technologies, Platforms, and Use Cases,” Auerbach Publications/CRC Press,</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	2	3	1
CO2	2	2	3	-	2	3	-	-	-	-	2	3	2
CO3	2	3	2	2	3	3	-	-	-	-	2	3	2
CO4	2	2	2	3	3	3	1	-	-	-	3	3	2
CO5	2	2	3	2	2	3	-	-	-	2	3	3	3
Mean	**2.2**	**1.8**	**2**	**1.4**	**2.4**	**2.4**	**0.2**	**-**	**-**	**0.4**	**2.4**	**3**	**2**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="4">Programme: B.Tech. (MT)</td><td colspan="3"></td></tr>
<tr><td colspan="2">Semester : Sixth</td><td colspan="4">Course Category Code: ANC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUN107</td><td>Internet of Robotic Things (IoRT)</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
</table>

Prerequisite:	Knowledge of IoT	
Course Outcome At the end of the course, the students will be able to	**CO1**	**Describe** the architecture, components, and emerging trends in the integration of IoT and robotic systems.
	CO2	**Compare** various communication protocols used in robotic systems for reliable data transfer and coordination
	CO3	**Analyze** advanced protocols in multi-robot and industrial robotic communication for real-time applications.
	CO4	**Develop** simple IoRT systems using cloud platforms, embedded hardware, and mobile-controlled interfaces.
	CO5	**Evaluate** real world IoT- based robotic applications and ethical issues.

UNIT-I	**Introduction to IoRT**	**Periods: 09**	
Introduction to stationary and mobile robots, Brief introduction to localization, mapping, planning, and control of robotic systems. Concept of IoRT: Architecture – Elements, Components in IoRT- Hardware, Software. Emerging Technologies of IoRT - Advantages, Disadvantages, IoT-enabled Robotics Applications, Challenges and Opportunities in Robotics and IoT Integration -Future Trends in Robotics and IoT.			**CO1, CO5**
UNIT-II	**Communication Protocols for Robots**	**Periods: 09**	
Communication Protocol Structure – EtherNet/IP, Control Net, CAN, LIN, Devicenet, Satellite systems, Wireless LANs , WiFi, VPAN, IEEE 802.15.4-Zigbee, Bluetooth GPRS and – their comparison, limitations and characteristics, , HF RFID ,– their relevance to industrial applications			**CO2, CO3**
UNIT-III	**Advanced Protocols for Industrial Robots**	**Periods: 09**	
Interaction Protocols for Multi-Robot Systems - Queue Telemetry Transport (MQTT), Constrained Application Protocol (CoAP) –- EtherCAT - ,OPC UA , Ethernet TSN - Automotive industry- FlexRay and MOST Automotive Protocols - 6G communication protocol – Defense communication protocol – Real time applications & case studies.			**CO2, CO3**
UNIT-IV	**Development of IoRT**	**Periods: 09**	
Line Follower Robot, Wifi Controlled Robot in local network, Connecting Robot to Internet & Cloud, Internet Controlled Robot through Cloud (IoT Robot), Android App Based Controlled Robot over Internet. Ethical Issues in Robotics and IoT : Privacy and Security Concerns, Impact on Society and the Environment , Responsible Design and Development.			**CO4, CO5**
UNIT-V	**Applications of IoT in Robotics**	**Periods: 09**	
Drones for surveillance, Soft low-power robotics, Tracking sensors for underwater robotics, Disaster response, Medical services, Smart restaurant. Analysis of IoT applications and Sensors: Space robotics for science and space exploration, Satellite based Internetworking, Space component systems like rover mobility, locomotion and guidance.			**CO4, CO5**
Lecture Periods: 45	**Tutorial Periods: Nil**	**Practical Periods: Nil**	**Total Periods: 45**

Reference Books:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", First Edition, Cisco Press, 2017
3. Deon Reynders, Steve Mackay,Edwin Wright, "Practical Industrial Data Communications",1st edition Elsevier, 2005.

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	2	-	-	-	1	2	3	2
CO2	3	3	2	2	2	2	-	-	-	2	2	3	2
CO3	3	3	2	3	3	2	-	-	-	2	2	3	3
CO4	3	3	3	2	2	2	-	-	-	2	2	2	3
CO5	3	2	3	3	2	2	-	2	-	2	3	3	2
Mean	**3**	**2.6**	**2.4**	**2.4**	**2.2**	**2**	**-**	**0.4**	**-**	**1.8**	**2.2**	**2.8**	**2.4**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="6">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Seventh</td><td colspan="4">Course Category Code: ANC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUN108</td><td>Augmented Reality and Virtual Reality</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
</table>

<table>
<tr><td>Prerequisite:</td><td colspan="2">Basics of Sensors and Robotics</td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td>Explain the fundamental concepts of Augmented Reality (AR) and Virtual Reality (VR), including their differences, components, and applications.</td></tr>
<tr><td>CO2</td><td>Demonstrate and apply the necessary sensor and processors needed for AR application</td></tr>
<tr><td>CO3</td><td>Analyze the key technologies behind AR and VR systems, such as computer vision, sensors, display devices, and tracking systems.</td></tr>
<tr><td>CO4</td><td>Design interactive AR/VR systems for real-world applications such as education, entertainment, and industrial training.</td></tr>
<tr><td>CO5</td><td>Evaluate the impact of AR and VR technologies in real time applications</td></tr>
</table>

<table>
<tr><td>UNIT-I</td><td>Introduction to Augmented Reality</td><td>Periods: 09</td></tr>
<tr><td colspan="2">Defining augmented reality, history of augmented reality, The Relationship Between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum Between Real and Virtual Worlds, applications of augmented reality, Working, Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td>Augmented Reality Architecture</td><td>Periods: 09</td></tr>
<tr><td colspan="2">Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-III</td><td>AR Techniques</td><td>Periods: 09</td></tr>
<tr><td colspan="2">Marker-based approach- Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication Marker types- Template markers, 2D barcode markers, imperceptible markers. Marker-less approach- Localization based augmentation, real world examples Tracking methods- Visual tracking, feature based tracking, hybrid tracking, and initialisation and recovery.</td><td>CO3, CO5</td></tr>
<tr><td>UNIT-IV</td><td>Introduction to Virtual Reality</td><td>Periods: 09</td></tr>
<tr><td colspan="2">Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality in health care- Robotics-Manufacturing. Human Eye, eye movements & implications for VR.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td>Virtual World Motion tracking</td><td>Periods: 09</td></tr>
<tr><td colspan="2">Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR, Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies.</td><td>CO3, CO4, CO5</td></tr>
</table>

Lecture Periods: 45	**Tutorial Periods: Nil**	**Practical Periods: Nil**	**Total Periods: 45**

Reference Books:

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016 2. Dieter Schmalstieg and Tobias Höllerer, Augmented Reality: Principles & Practice, Pearson Education India, 2016 3.
3. Norman K (Ed), Wiley Handbook of Human Computer Interaction, Wiley 2017

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	2	-	-	-	1	2	3	2
CO2	3	3	2	2	3	-	-	-	-	2	2	3	2
CO3	3	3	3	3	3	-	-	-	-	2	2	3	3
CO4	3	3	3	3	3	2	-	-	-	2	2	2	3
CO5	2	2	2	2	2	-	-	-	-	2	3	3	2
Mean	**2.8**	**2.6**	**2.4**	**2.4**	**2.6**	**0.5**	**-**	**-**	**-**	**1.8**	**2.2**	**2.8**	**2.4**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fourth</td><td colspan="4">Course Category Code: ANC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUI101</td><td>Additive Manufacturing</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
</table>

<table>
<tr><td>Prerequisite:</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td>Describe the principles, classifications, and process parameters of various additive manufacturing techniques.</td></tr>
<tr><td>CO2</td><td>Compare additive manufacturing with conventional manufacturing methods in terms of materials, precision, and applications.</td></tr>
<tr><td>CO3</td><td>Analyze material selection, process parameters, and software issues in AM, including CAD modeling.</td></tr>
<tr><td>CO4</td><td>Select and justify suitable additive manufacturing techniques and materials for specific engineering applications.</td></tr>
<tr><td>CO5</td><td>Design simple 3D printable parts using CAD tools and simulate process performance.</td></tr>
</table>

<table>
<tr><td>UNIT-I</td><td>INTRODUCTION</td><td colspan="2">Periods: 09</td></tr>
<tr><td colspan="3">Additive Manufacturing (3D printing) - Distinction Between AM and Conventional Manufacturing Processes - Benefits of AM - Generic AM Process - Eight Steps in AM - Classification of AM Processes - Liquid Polymer Systems - Discrete Particle Systems - Solid Sheet Systems. Design for AM - Part Orientation - Removal of Supports - Hollowing Out Parts - Inclusion of Undercuts - Interlocking Features - Reduction of Part Count - Identification Markings/Numbers.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td>DEVELOPMENT OF ADDITIVE MANUFACTURING</td><td colspan="2">Periods: 09</td></tr>
<tr><td colspan="3">Stereo lithography Apparatus (SLA): process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning. Solid Ground Curing (SGC): process, working principle. Powder Bed Fusion – Materials - Powder Fusion Mechanisms - Selective laser sintering (SLS): process, working principle, Sheet Lamination - Laminated object manufacturing (LOM) (Applications, advantages and disadvantages for all processes)</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-III</td><td>DESIGN & SOFTWARE ISSUES</td><td colspan="2">Periods: 09</td></tr>
<tr><td colspan="3">Material Jetting - Materials for Material Jetting - Technical Challenges of MJT - Droplet Formation Technologies - Process Parameters in Material Jetting - Process Benefits and Drawbacks. and Resulting Perspectives, AM based New Strategies, Material Design and Quality Aspects for Additive Manufacturing; Material for AM, Engineering Design Rules for AM. Software Issue for Additive Manufacturing; Introduction, Preparation of CAD Models: The STL file, Problem with STL file, STL files Manipulation, Beyond the STL file, Additional Software to Assist AM.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td>RAPID TOOLING</td><td colspan="2">Periods: 09</td></tr>
<tr><td colspan="3">Introduction to rapid tooling (RT), conventional tooling Vs RT, Need for RT. RT classification: Indirect rapid tooling methods: spray metal deposition, RTV epoxy tools, Ceramic tools, investment casting, spin casting, die casting, sand casting, 3D Keltool process. Direct rapid tooling: LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td>RAPID PROTOTYPING</td><td colspan="2">Periods: 09</td></tr>
<tr><td colspan="3">Secondary Rapid Prototyping processes, Intellectual Property, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing, Business Opportunities. RP Applications: Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewellery, Toys, Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others.</td><td>CO4, CO5</td></tr>
</table>

Lecture Periods: 45	**Tutorial Periods: Nil**	**Practical Periods: Nil**	**Total Periods: 45**

Reference Books:

1. Ian Gibson, David Rosen, Brent Stucker Mahyar Khorasani, “Additive Manufacturing Technologies”, Springer
2. Chua C.K.,Leong K..& Lim C.S., "Rapid prototyping: Principles and Applications", 3rd Edition, World scientific, Newjersy, 2010.
3. Pham D.T. & Dimov S.S., "Rapid Manufacturing", Springer -Verlag, London, 2011.
4. Amitabha Ghosh, "Rapid Manufacturing a Brief Introduction", Affiliated East West Press, New Delhi, 2011.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	2	1	-	-	-	-	2	3	2
CO2	2	3	-	2	2	1	-	-	-	-	2	3	2
CO3	3	3	2	3	3	-	-	-	-	-	2	3	3
CO4	2	2	3	2	3	2	-	-	-	1	2	3	2
CO5	2	2	3	2	3	2	2	1	2	2	3	3	3
Mean	**2.4**	**2.4**	**1.6**	**1.8**	**2.6**	**1.2**	**0.4**	**0.2**	**0.4**	**0.6**	**2.2**	**3**	**2.4**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="5">Programme: B.Tech. (MT)</td><td colspan="3"></td></tr>
<tr><td colspan="2">Semester : Fifth</td><td colspan="5">Course Category Code: ANC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUI102</td><td colspan="2">Intelligent Manufacturing Systems</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="9"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td colspan="8">Describe the evolution, architecture, and key technologies of intelligent manufacturing systems.</td></tr>
<tr><td>CO2</td><td colspan="8">Analyze the integration of IoT, and AI in manufacturing environments.</td></tr>
<tr><td>CO3</td><td colspan="8">Evaluate the performance intelligent scheduling and human machine collaboration.</td></tr>
<tr><td>CO4</td><td colspan="8">Design flexible and adaptive manufacturing systems using digital twins, cloud platforms, and control strategies.</td></tr>
<tr><td>CO5</td><td colspan="8">Apply intelligent manufacturing concepts to optimize resource utilization, energy efficiency, and real-time decision-making.</td></tr>
<tr><td>UNIT-I</td><td colspan="5">INTRODUCTION</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="9">Introduction to Smart Manufacturing, Smart Sensors and Smart Tooling, Smart machines and intelligent machining, digital and smart factories, implementing smart manufacturing across an industrial organization. Smart vs Intelligent Manufacturing. Concept and Characteristics of Intelligent manufacturing: IoT enabled manufacturing, cloud manufacturing. Intelligent decision-making, Application of Artificial Intelligence and Machine learning in developing intelligent manufacturing systems.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td colspan="5">FRAMEWORK FOR INTELLIGENT MANUFACTURING</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="9">Component of Intelligent Manufacturing Technologies, Development of Intelligent systems for Design, Process planning, Controls, Scheduling, Quality Management, Maintenance and Diagnostics. Supporting technologies for IMS: Industry Internet of Things, Cyber Physical Systems, Cloud computing, RFID Technologies, Data Analytics, other Information and Communications Technology.</td><td>CO2, CO4</td></tr>
<tr><td>UNIT-III</td><td colspan="5">DEVELOPMENT OF INTELLIGENT MANUFACTURING</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="9">Intelligent design, Intelligent machines, Intelligent control, Intelligent scheduling, Human-Machine collaboration, collaborative robots and other enabling technologies such as AR and VR, Data-driven intelligent manufacturing models, Autonomous intelligent manufacturing units.</td><td>CO1, CO3</td></tr>
<tr><td>UNIT-IV</td><td colspan="5">AGILE INTELLIGENT MANUFACTURING</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="9">The Fundamental Structure of Agile Manufacturing Paradigm- Agile Manufacturing through Management Driver, Technology Driver, Strategy Driver, Competitive Driver. Introduction to Agile Intelligent Manufacturing, Implementation of Manufacturing Next – Intelligent, Agile, Automated and Cloud enabled. Business 4.0, Connected Cars 4.0, Workforce 4.0.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td colspan="5">APPLICATIONS OF INTELLIGENT MANUFACTURING SYSTEMS</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="9">Applications and case studies in intelligent manufacturing systems implementation, limitation of technologies and other real time issues in implementations of IMS.</td><td>CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 45</td><td colspan="2">Tutorial Periods: Nil</td><td colspan="3">Practical Periods: Nil</td><td colspan="3">Total Periods:45</td></tr>
<tr><td colspan="10">Reference Books:</td></tr>
<tr><td colspan="10">1. Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, Smart Manufacturing -Concept and Methods, Elsevier Publications Ist Edition, August 4, 2020.
2. Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, Smart Manufacturing: Applications and Case Studies, Elsevier Publications, 1st Edition, August 4, 2020.</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	1	1	-	-	-	-	1	3	2
CO2	3	2	-	2	1	1	-	-	-	-	1	3	3
CO3	3	2	3	3	2	1	-	-	-	-	2	3	3
CO4	3	3	2	2	2	1	-	-	2	3	3	3	3
CO5	3	2	3	2	2	1	-	-	3	3	3	3	3
Mean	**3**	**2.2**	**1.6**	**1.4**	**1.8**	**1**	**-**	**-**	**1**	**1.2**	**2**	**3**	**2.8**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="9">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Sixth</td><td colspan="5">Course Category Code: ANC</td><td colspan="4">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUI103</td><td colspan="2">Digital Manufacturing and IoT</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="9"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td colspan="8">Explain the principles of digital manufacturing systems, including product life cycle.</td></tr>
<tr><td>CO2</td><td colspan="8">Analyze the architecture and components of IoT-enabled smart manufacturing systems.</td></tr>
<tr><td>CO3</td><td colspan="8">Apply IoT technologies sand communication protocols in a manufacturing context.</td></tr>
<tr><td>CO4</td><td colspan="8">Demonstrate the structure, features, and implementation of digital twin systems, including digital thread and digital shadow.</td></tr>
<tr><td>CO5</td><td colspan="8">Evaluate the benefits, challenges, and future impact of digital twins and Industry 4.0 technologies on manufacturing ecosystems.</td></tr>
<tr><td>UNIT-I</td><td colspan="5">Introduction</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="9">Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td colspan="5">Digital life cycle & supply chain management</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="9">Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC – Effective Digital Transformation - Future Practices in SCM</td><td>CO1, CO3</td></tr>
<tr><td>UNIT-III</td><td colspan="5">Smart factory</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="9">Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cybersecurity.</td><td>CO1, CO3</td></tr>
<tr><td>UNIT-IV</td><td colspan="5">Industry 4.0</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="9">Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems –Machine to Machine communication – Case Studies.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td colspan="5">Study of digital twin</td><td colspan="4">Periods: 09</td></tr>
<tr><td colspan="9">Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins</td><td>CO4, CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 45</td><td colspan="2">Tutorial Periods: Nil</td><td colspan="3">Practical Periods: Nil</td><td colspan="3">Total Periods: 45</td></tr>
<tr><td colspan="10">Reference Books:</td></tr>
<tr><td colspan="10">1. Zudezhou, Shanexie, Dejunchen, “Fundamentals of digital manufacturing science”. Springer, 2012.
2. Lihui, Wang, Andrew, Y C Nee, “Collaborative Design and Planning for Digital Manufacturing”, springer, 2009.
3. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.
4. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019.</td></tr>
</table>

<u>**CO-PO / PSO Mapping**</u>

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	2	3	2
CO2	2	3	-	-	3	-	-	-	-	-	2	3	2
CO3	3	3	3	3	3	-	-	-	-	-	2	3	2
CO4	-	2	3	2	3	-	-	2	2	2	3	3	2
CO5	3	2	2	-	-	3	2	-	2	2	3	3	3
Mean	**2.2**	**2.2**	**1.6**	**1**	**2.2**	**0.6**	**0.4**	**0.4**	**0.8**	**0.8**	**2.4**	**3**	**2.2**

Score : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="5">Programme: B.Tech. (MT)</td><td colspan="3"></td></tr>
<tr><td colspan="2">Semester : Seventh</td><td colspan="4">Course Category Code: ANC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUI104</td><td>Introduction to Industry 5.0</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
</table>

Course Outcome At the end of the course, the students will be able to		
	CO1	**Describe** the evolution, components, and key design principles of Industry 4.0 and Industry 5.0.
	CO2	**Compare and contrast** the characteristics, drivers, and technological foundations of Industry 4.0 and 5.0.
	CO3	**Apply** enabling technologies such as AI, ML, IoT, Big Data, and exoskeletons in smart manufacturing contexts.
	CO4	**Evaluate** real-time applications of Industry 5.0 in areas like digital supply chains, predictive maintenance, and energy management.
	CO5	**Assess** the societal, ethical, and cybersecurity challenges associated with the adoption of Industry 5.0.

UNIT-I	**Overview of Industry 4.0**	**Periods: 09**
Evolution of Industrial Revolution (1.0 to 4.0), Industry 4.0- Historical Context -Definition, components, characteristics, design principles, Building blocks of fourth industrial revolution - Industry 4.0 Current scenario – real time studies.		**CO1, CO2**
UNIT-II	**Introduction to Industry 5.0**	**Periods: 09**
Emergence of Industry 5.0 - Key characteristics – Drivers of Industry 5.0, Impact of Industry 5.0 – Potential, Societal & Business. Comparison of Industry 4.0 and 5.0 – Advantages and disadvantages.		**CO1, CO2**
UNIT-III	**Enabling Technologies of Industry 5.0**	**Periods: 09**
Artificial Intelligence & Machine Learning, Role of Internet of Things – Big Data & Analytics , Exoskeleton Technology, Other technologies.		**CO3, CO4**
UNIT-IV	**Industry 5.0 Applications**	**Periods: 09**
Smart Manufacturing and Factories of the Future, Digital Supply Chains and Logistics, Predictive Maintenance and Asset Management, Smart Energy Management of manufacturing processes and facilities- Case studies.		**CO4, CO5**
UNIT-V	**Challenges in Industry 5.0**	**Periods: 09**
Cyber Security challenges in Industry 5.0, Threats to interconnected systems and devices, Ethics and principles of human-machine interfaces – risks involved, Emerging Trends and Technologies, Impact of industry 5.0 in Business and Engineering.		**CO5**

Lecture Periods: 45	**Tutorial Periods: Nil**	**Practical Periods: Nil**	**Total Periods:45**

Reference Books:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress; 1st Ed. Edition
2. Uthayan Elangovan, Industry 5.0, “The Future of the Industrial Economy”, First Edition, Taylor & Francis, ISBN: 978-1-032-04127-8, 2022.
3. Alessandro Massaro, “Electronics in Advanced Research Industries: Industry 4.0 to Industry 5.0 Advances”, Wiley-IEEE Press, 2021, ISBN: 2021028944.
4. Charles J. Brooks, Philip A. Craig Jr., “Practical Industrial Cybersecurity”, John Wiley & Sons, Inc., Hoboken, New Jersey, 2022, ISBN: 978-1-119-88302-9.

CO-PO / PSO Mapping

POs/PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	1	-	-	-	-	-	2	2	-
CO2	2	3	-	-	2	-	-	-	-	-	2	2	-
CO3	3	2	3	2	2	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	3	-	2	3	2	3	3	2
CO5	2	2	2	-	1	3	3	-	2	2	3	3	2
Mean	**2.4**	**1.8**	**1.6**	**0.8**	**1.6**	**1.2**	**0.6**	**0.4**	**1**	**0.8**	**2.6**	**2.6**	**1.2**

Score : 3 – High 2 – Medium 1 – Low

HONORS COURSES

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fourth</td><td colspan="4">Course Category Code: HNC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUH101</td><td>MEMS AND NEMS</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td colspan="7">Describe the fundamental principles, working mechanisms, and applications of MEMS and NEMS devices.</td></tr>
<tr><td>CO2</td><td colspan="7">Analyze various microfabrication and nanofabrication techniques used in the development of MEMS/NEMS.</td></tr>
<tr><td>CO3</td><td colspan="7">Design simple MEMS/NEMS devices considering application-specific constraints and requirements.</td></tr>
<tr><td>CO4</td><td colspan="7">Evaluate the performance and reliability of MEMS/NEMS devices using simulation and modeling tools.</td></tr>
<tr><td>CO5</td><td colspan="7">Apply MEMS/NEMS concepts to solve interdisciplinary engineering problems in real-world scenarios.</td></tr>
<tr><td>UNIT-I</td><td colspan="4">INTRODUCTION TO MEMS</td><td colspan="4">Periods: 12</td></tr>
<tr><td colspan="8">Overview of MEMS, new trends in engineering and science, micro and nano scale systems, intrinsic characteristics of MEMS, elements of MEMS: micro sensors and micro actuators, microelectronics fabrication process, energy domains, materials for MEMS: silicon, polymers, metals; Packaging and integration: glass encapsulation, MEMS process integration strategies, applications of micro and nanoelectromechanical systems.</td><td>CO1, CO5</td></tr>
<tr><td>UNIT-II</td><td colspan="4">FABRICATION TECHNOLOGIES</td><td colspan="4">Periods: 12</td></tr>
<tr><td colspan="8">Surface micromachining: Sacrificial layer processes, micro motors; Bulk micromachining: micro needles, micro nozzles; Etching: dry etching, plasma etching; Wet etching: principle and process architect; High Aspect-Ratio Processes: LIGA process, Deep Reactive Ion Etching (DRIE); Thin film deposition: Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD); Evaporation and sputtering.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-III</td><td colspan="4">POLYMER AND OPTICAL MEMS</td><td colspan="4">Periods: 12</td></tr>
<tr><td colspan="8">Polymer MEMS: Introduction, Polymers in MEMS-Polyimide, SU-8, Liquid Crystal Polymer (LCP), PDMS, PMMA, Parylene, Fluorocarbon, Representative Applications-Acceleration Sensors, Pressure Sensors, Flow Sensors, Tactile Sensors. Optical MEMS: Passive MEMS Optical Components-Lenses, Mirrors, Actuators for Active Optical MEMS Actuators for Small Out-of-Plane Translation, Actuators for Large In Plane Translation Motion, Actuators for Out-of-Plane Rotation.</td><td>CO3, CO4</td></tr>
<tr><td>UNIT-IV</td><td colspan="4">CASE STUDIES OF MEMS</td><td colspan="4">Periods: 12</td></tr>
<tr><td colspan="8">MEMS inertial sensors in automobiles: airbag deployment, automobile navigation; MEMS vibratory gyroscope, MEMS accelerometer. MEMS devices in commercial applications: Inkjet printers, digital micro mirror devices (DMD), radio frequency MEMS switches, scanning tunneling microscopes (STM).</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td colspan="4">NANOSYSTEMS AND QUANTUM MECHANICS</td><td colspan="4">Periods: 12</td></tr>
<tr><td colspan="8">Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.</td><td>CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 45</td><td colspan="2">Tutorial Periods: 15</td><td colspan="3">Practical Periods: Nil</td><td colspan="2">Total Periods: 60</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
</table>

1. Chang Liu, Foundations of MEMS, Pearson Education Inc., 2012.
2. Stephen D Senturia, Microsystem Design, Springer Publication, 2000.
3. Tai Ran Hsu, MEMS & Micro systems Design and Manufacture, TMH, New Delhi, 2002
4. Reza Ghodssi, Pinyen, “MEMS Materials and Processes Handbook”, Springer Science Business Media, 2011.
5. Rai-Choudhury P., “MEMS and MOEMS Technology and Applications”, Prentice Hall of India Learning Private Limited, 2009.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	2	-	-	-	1	2	3	2
CO2	3	3	2	3	3	2	-	-	-	-	2	3	2
CO3	3	3	3	3	3	2	-	-	-	2	2	3	3
CO4	3	3	3	3	3	2	-	-	2	-	2	3	3
CO5	3	2	3	3	3	2	-	-	3	2	3	3	2
Mean	**3**	**2.6**	**2.6**	**2.8**	**2.8**	**2**	**-**	**-**	**1**	**1**	**2.2**	**3**	**2.4**

Score : 3 – High   2 – Medium   1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="6">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Fifth</td><td colspan="4">Course Category Code: HNC</td><td colspan="2">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUH102</td><td>Autonomous Vehicles and Navigation Systems</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
</table>

<table>
<tr><td>Prerequisite:</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td>Describe the types, components, and control mechanisms of autonomous and unmanned vehicles.</td></tr>
<tr><td>CO2</td><td>Analyze the role of sensors and actuators in perception and control of autonomous systems.</td></tr>
<tr><td>CO3</td><td>Design navigation systems using satellite, inertial, and feature-based techniques.</td></tr>
<tr><td>CO4</td><td>Evaluate radar-based guidance systems for range, velocity, and noise considerations.</td></tr>
<tr><td>CO5</td><td>Develop control strategies and communication protocols for aerial vehicles.</td></tr>
</table>

<table>
<tr><td>UNIT-I</td><td>INTRODUCTION TO AUTONOMOUS VEHICLES</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Introduction to Connected, automated and Intelligent cars, Degree of Autonomy- different types of unmanned vehicles: ground (wheeled and legged), aerial (fixed, flapping, and rotary wings), underwater vehicles, Modelling of unmanned vehicles considering basic forces, kinematics, and dynamics, Different types of control for aerial, underwater (fins and propulsion control), ground (biped and quadruped motion control for legged robots) - Case studies.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td>SENSORS AND ACTUATORS</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Sensor Technology for unmanned vehicles - proximity, IMU, magnetometers, thermal imaging, vision, Ultrasonic Sonar Systems, LiDAR, Night Vision Technology, GPS, RTK, Sensor for Driver Impairment Detection, Transfer of Control Technology. Sensor data aggregation, processing, and sensor fusion. Different types of actuators: motors, servos, harmonic drive, linear actuators.</td><td>CO2</td></tr>
<tr><td>UNIT-III</td><td>NAVIGATION SYSTEMS</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">What Is Navigation, Position Fixing, Dead Reckoning, Inertial Navigation, Radio and Satellite Navigation, Terrestrial Radio Navigation, Satellite Navigation, Feature Matching, The Complete Navigation System. Advanced Satellite Navigation: Differential GNSS, Carrier-Phase Positioning, and Attitude, Poor Signal-to-Noise Environments, Multipath Mitigation, Signal Monitoring.</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td>GUIDANCE USING RADAR</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Introduction to radars, Radar equation. Block Diagram and Operation, Radar Frequencies. Application of Radars, Range performance of radars, Minimum detectable signal, Noise effects, Continuous wave and Frequency modulated radars, Doppler effect, CW-radar, Isolation between transmitter and receiver. Radial velocity, CW radar applications, Frequency modulated CW radars, MIT and Pulse Doppler radars, Description of operation.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td>CONTROL OF AERIAL VEHICLE AND COMMUNICATION</td><td colspan="2">Periods: 12</td></tr>
<tr><td colspan="3">Basic Aerial Robot Flight Concepts, Micro-aerial vehicle, Frame Rotations and Representations, Aerial robots equations of motion, State-Space Form, Time, Motion, and Trajectories, Linearization, 2-D and 3-D control of Aerial robots, PID Control, LQR control, Motion planning, Collision-free Navigation, Sensing and Estimation, Vision-based Guidance for aerial robots. Vehicle communication technologies: Bluetooth, CAIN, LIN,Cellular, DSRC, MAVLink.</td><td>CO4, CO5</td></tr>
</table>

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: Nil**	**Total Periods: 60**

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.
2. Godfrey C. Onwubolu, Mechatronics: Principles and Applications, Butterworth-Heinemann (Elsevier), 2005.
3. Nikolaus Correll, Bradley Hayes, and Bradley M. Kuszmaul, Introduction to Autonomous Robots: Mechanisms, Sensors, Actuation, and Algorithms, 2nd Edition, MIT Press (Open Access), 2022.

CO-PO / PSO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	1	1	-	-	-	2	-	3	-
CO2	3	3	-	2	3	1	-	-	2	2	-	3	2
CO3	2	2	3	2	3	1	-	1	2	2	-	2	2
CO4	2	2	2	3	3	-	-	-	-	-	-	-	3
CO5	3	2	3	2	3	2	1	1	3	3	2	3	3
Mean	**2.6**	**2.2**	**1.6**	**1.8**	**2.6**	**1**	**0.2**	**0.4**	**1.4**	**1.8**	**0.4**	**2.2**	**2**

Note : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Sixth</td><td colspan="4">Course Category Code: HNC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUH103</td><td>Nano Electronics & Nano Sensors</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td colspan="7">Explain the principles of nano-scale electronic behavior and quantum effects in nanomaterials.</td></tr>
<tr><td>CO2</td><td colspan="7">Analyze the characteristics and operation of nano electronic devices such as quantum dots, carbon nanotubes, and nanowires.</td></tr>
<tr><td>CO3</td><td colspan="7">Compare traditional microelectronic components with nano electronic counterparts in terms of performance and scalability.</td></tr>
<tr><td>CO4</td><td colspan="7">Describe the working principles, classifications, and applications of various nano sensors (chemical, biological, optical, etc.).</td></tr>
<tr><td>CO5</td><td colspan="7">Design simple nano electronic systems or sensor-based applications for real-world use cases.</td></tr>
<tr><td>UNIT-I</td><td colspan="4">INTRODUCTION TO NANOELECTRONICS</td><td colspan="4">Periods: 12</td></tr>
<tr><td colspan="8">Limitations of the conventional MOSFETs at Nanoscales, MOSFET Scaling & implications, Constant voltage and constant field scaling, Moore’s law, Classification of Nanostructures, electronics properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands. Current trends and challenges in scaling, Implications of quantum confinement and tunneling on nanoscale devices.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td colspan="4">NANOSTRUCTURES AND QUANTUM ELECTRONIC DEVICES</td><td colspan="4">Periods: 12</td></tr>
<tr><td colspan="8">Low-dimensional structures- Quantum wells, Quantum wires and Quantum dots; Density of states in low-dimensional structures; Quantum heterostructure, High Electron Mobility Transistors, Resonant tunneling phenomena and its applications in diodes and transistors. Tunnel junctions, Principle of operation- Single-Electron Effect, Coulomb Blockade Phenomenon; Theoretical Quantum Dot Transistor - Energy of Quantum Dot system, Single Electron Quantum-Dot Transistor.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-III</td><td colspan="4">CARBON NANOELECTRONICS AND 2D MATERIALS ELECTRONICS</td><td colspan="4">Periods: 12</td></tr>
<tr><td colspan="8">Carbon nanotubes - SWCNTs and MWCNTs; 1D quantization in nanotubes- van Hove singularities; Fabrication of CNTs; CNT FETs- Device characteristics, CNT-TUBFET, CNTSET; and NanoWire FETs; Electronic structure of graphene; Graphene FETs- GNRFETs. Transition-metal dichalcogenide (TMD) material devices. Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques</td><td>CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td colspan="4">MECHANICAL NANOSENSORS</td><td colspan="4">Periods: 12</td></tr>
<tr><td colspan="8">Introduction to Nanosensors – Types- Mechanical- Mass sensing- Nanogram Mass Sensing by Quartz Crystal Microbalance, MEMS/NEMS Resonators; Displacement sensor- Electron Tunneling Displacement Nanosensor, Coulomb Blockade Electrometer-Based Displacement Nanosensor, Nanometer-Scale Displacement Sensing by Single-Electron Transistor, Magnetomotive Displacement Nanosensor, Piezoresistive and Piezoelectric Displacement Nanosensors, Optical Displacement Nanosensor.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td colspan="4">CHEMICAL NANOSENSORS</td><td colspan="4">Periods: 12</td></tr>
<tr><td colspan="8">Gas Sensors Based on Metallic Nanoparticles, Metal Oxides, Carbon Nanotube, Porous Silicon; Thin Organic Polymer Film–Based Gas Sensors; Electrospun Polymer Nanofibers as Humidity Sensors; Nanoelectronic Nose. Case studies.</td><td>CO4, CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 45</td><td colspan="2">Tutorial Periods: 15</td><td colspan="3">Practical Periods: Nil</td><td colspan="2">Total Periods: 60</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
<tr><td colspan="9">1. Poole, Jr., Frank J. Owens and Charles, Introduction to Nanotechnology, John Wiley and sons, 2003.
2. G. Cao and Y. Wang, Nanostructures and nanomaterials: synthesis, properties and applications, World Scientific, 2nd edition, 2011
3. H.S. Nalwa, Encyclopedia of nanoscience and nanotechnology, American Scientific Publishers, 2007</td></tr>
</table>

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	2	-	3	-
CO2	3	3	-	2	2	-	-	-	-	2	-	3	2
CO3	2	2	2	2	2	-	-	-	-	2	-	3	2
CO4	3	2	-	-	1	-	-	-	-	2	-	2	2
CO5	2	2	3	2	3	-	-	-	-	2	3	3	3
Mean	**2**	**2.2**	**1**	**1.2**	**1.8**	**-**	**-**	**-**	**-**	**2**	**0.6**	**3**	**1.8**

Note : 3 – High 2 – Medium 1 – Low

<table>
<tr><td colspan="2">Department: Mechatronics</td><td colspan="7">Programme: B.Tech. (MT)</td></tr>
<tr><td colspan="2">Semester : Seventh</td><td colspan="4">Course Category Code: HNC</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>MTUH104</td><td>Deep Learning for Mechatronics Applications</td><td>3</td><td>1</td><td>0</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
</table>

<table>
<tr><td>Prerequisite:</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Outcome
At the end of the course, the students will be able to</td><td>CO1</td><td>Explain the fundamental concepts of deep learning architectures including CNNs, RNNs, and autoencoders.</td></tr>
<tr><td>CO2</td><td>Apply deep learning techniques to process signals and data from mechatronic systems.</td></tr>
<tr><td>CO3</td><td>Train and validate neural networks for tasks such as object detection, motion recognition, and sensor fusion.</td></tr>
<tr><td>CO4</td><td>Analyze the performance of deep learning models in real-time mechatronics control and diagnostics.</td></tr>
<tr><td>CO5</td><td>Develop deep learning-based intelligent systems for applications such as robotics, autonomous systems, and smart manufacturing.</td></tr>
</table>

<table>
<tr><td>UNIT-I</td><td>FUNDAMENTALS OF DEEP LEARNING FOR MECHATRONICS</td><td>Periods: 12</td></tr>
<tr><td colspan="2">AI, Machine Learning, and Deep Learning- Importance of deep learning in mechatronics –robotics – automation - predictive maintenance - Basics of artificial neural networks (ANNs), perceptrons - multi-layer networks -Introduction to deep learning frameworks -TensorFlow, PyTorch- simple neural network for sensor data processing.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-II</td><td>NEURAL NETWORKS & FEATURE ENGINEERING</td><td>Periods: 12</td></tr>
<tr><td colspan="2">Activation functions –ReLU – Sigmoid – Softmax and their role in mechatronics- Backpropagation - gradient descent - optimization algorithms (SGD, Adam)- Convolutional Neural Networks (CNNs) - CNN for quality inspection in a manufacturing process - image-based mechatronic applications (defect detection)- Recurrent Neural Networks (RNNs) - Long Short-Term Memory (LSTM) - time-series analysis (sensor fusion)- Feature extraction and data pre-processing techniques for motion, force, and signal-based data - Transfer learning - model fine-tuning for small datasets.</td><td>CO1, CO2</td></tr>
<tr><td>UNIT-III</td><td>DEEP LEARNING FOR MECHATRONIC CONTROL & AUTOMATION</td><td>Periods: 12</td></tr>
<tr><td colspan="2">AI-based motion planning - trajectory prediction- Reinforcement Learning (RL) - autonomous robotic control- optimize robotic arm movements - Deep Q-Networks (DQN) - policy gradient methods - real-time decision-making - Predictive maintenance using deep learning -fault detection - anomaly detection-Adaptive control systems using AI-powered feedback loops.</td><td>CO3, CO4</td></tr>
<tr><td>UNIT-IV</td><td>EMBEDDED AI & EDGE COMPUTING FOR MECHATRONICS</td><td>Periods: 12</td></tr>
<tr><td colspan="2">Deep learning models on embedded systems –Microcontrollers - Raspberry Pi – NVIDIA Jetson- Real-time AI processing on hardware accelerators -TPUs, - FPGAs, - GPUs)- Model optimization techniques – quantization –pruning- compression- Edge AI and IoT integration - real-time decision-making.</td><td>CO4, CO5</td></tr>
<tr><td>UNIT-V</td><td>AI IN AUTONOMOUS MECHATRONIC SYSTEMS</td><td>Periods: 12</td></tr>
<tr><td colspan="2">AI-driven perception in robotics - sensor fusion- SLAM -visual processing- Swarm intelligence - multi-agent reinforcement learning for collaborative robotics- Deep learning for intelligent navigation in autonomous vehicles and drones - AI applications in smart sensors and IoT-enabled mechatronic devices-Ethical and safety considerations in AI-powered mechatronic systems. Case studies - AI-driven robotic arms, autonomous ground vehicles (AGVs)- unmanned aerial vehicles (UAVs).</td><td>CO4, CO5</td></tr>
</table>

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: Nil**	**Total Periods: 60**

Reference Books:

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza (2018), Introduction to autonomous mobile robots, MIT press.
2. Gerald Cook (2011), Mobile Robots: Navigation, Control and Remote Sensing, Wiley.
3. Kenzo Nonami et. al., (2010), Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Vehicles, 1st Edition, Springer

CO-PO / PSO Mapping

POs/ PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	-	-	-	2	1	2	3	2
CO2	2	3	3	2	3	-	-	-	2	2	2	3	2
CO3	2	3	3	3	3	-	-	-	2	2	2	3	3
CO4	2	3	3	2	3	-	-	-	2	2	2	3	3
CO5	2	3	3	2	3	-	-	-	2	2	3	3	3
Mean	**2.2**	**2.8**	**2.8**	**2**	**2.8**	**-**	**-**	**-**	**2**	**1.8**	**2.2**	**3**	**2.6**

Note : 3 – High 2 – Medium 1 – Low

Department : **Mechatronics**		Programme: **B.Tech. (MT)**						
Semester : **Eighth**		Course Category Code: **HNC**				Semester Exam Type:		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MTUH105	**Seminar**	-	-	-	2	100	-	100
Prerequisite:								

Course Outcome: At the end of the course the student will be able to	**CO1**	Carry out literature survey, understand state of art techniques.
	CO2	Apply theoretical knowledge to real-world scenarios or case studies
	CO3	Take initiative in exploring topics beyond the curriculum and developing self-directed research habits
	CO4	Present complex ideas concisely and clearly

The objective of the seminar is to enable the students to present a seminar on any chosen topic related to their field of study. The topic shall be chosen in consultation with the faculty coordinators. The student will present a Seminar on a topic in an emerging area in his/her discipline of Engineering. The student will make the presentation for duration of 20 to 25 minutes and also submit a brief report on the seminar topic for the purpose of evaluation. A departmental committee shall evaluate the performance of the students.	CO1, CO2, CO3, CO4

CO-PO Mapping

POs/ PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	3	3	-	1	-	1	2	-	1	3	3
CO2	3	-	2	2	-	1	-	1	2	-	2	3	3
CO3	3	-	3	3	-	1	-	1	3	-	1	3	3
CO4	2	-	2	2	-	1	-	2	3	-	2	3	3
Mean	**2.8**	-	**2.5**	**2.5**	-	**1**	-	**1.25**	**2.5**	-	**1.5**	**3**	**3**

Score: 3 – High; 2 – Medium; 1 – Low