SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution | Approved by AICTE | Affiliated to Anna University | Accredited by NAAC with A++ Grade
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Curriculum & Syllabi

Regulation 2022

2022-2026 Batch

DEPARTMENT OF MECHATRONICS ENGINEERING

DEPARTMENT OF MECHATRONICS ENGINEERING

(Batch 2022-2026)

VISION OF THE INSTITUTION

- To Produce Globally Competitive Engineers with High Ethical Values and Social Responsibilities

MISSION OF THE INSTITUTION

- To impart the highest quality state-of-the-art technical education by providing impetus to innovation, research, and development and empowering students with entrepreneurship skills
- To instill ethical values, imbibe a sense of social responsibility, and strive for societal well-being
- To identify the needs of society and offer sustainable solutions through outreach programs

DEPARTMENT OF MECHATRONICS ENGINEERING

VISION OF THE DEPARTMENT

- To Provide world class education in the fields of Robotics and Automation to make Mechatronics Engineering the most preferred program among engineering aspirants

MISSION OF THE DEPARTMENT

To impart knowledge and skill to the students participating in the program by providing

M1: Expert Faculty to teach, inspire, mentor and motivate.
M2: Excellent Infrastructure with facilities to learn Mechatronics, research and experiment.
M3: Motivation towards self-learning, social responsibility and entrepreneurship.
M4: Exposure to the latest technologies through industry-institute interaction.
M5: Environment to develop their innovative thoughts, moral values, communication and multidisciplinary skills.

I.	PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)
PEO 1	Apply knowledge of mathematics, science and engineering to solve contemporary engineering problems in the field of automation
PEO 2	Design, analyze, fabricate and test smart products
PEO 3	Exhibit the skills of simulation and experimentation using advanced engineering tools of industrial standards
PEO 4	Communicate and develop strong interpersonal abilities to prepare them for placement and higher studies
PEO 5	Be self-motivated towards lifelong learning and entrepreneurship

II.	PROGRAMME OUTCOMES (POs)
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**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 the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**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.
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to

	one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

III. PROGRAMME SPECIFIC OUTCOMES (PSOs)

The Graduates of B.E – MECHATRONICS programme will be able to:

PSO 1	Design, simulate and create automation systems for various applications
PSO 2	Apply the Knowledge of Robotics for addressing Societal, health and Safety Issues

IV. MAPPING OF PEOs WITH POs

PEO	POs											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
1	3	2	3	1	2	3	2	2	3	3	3	2
2	3	3	2	2	3	2	2	1	2	2	2	3
3	3	3	3	2	1	3	2	2	2	3	1	3
4	3	2	3	1	2	3	2	2	2	3	3	3
5	3	3	3	1	2	3	3	2	2	3	1	3
	1- low, 2 - medium, 3 - high, '-' - no correlation											

AUTONOMOUS CURRICULUM AND SYLLABI

Regulations 2022

SEMESTER I							
S. No	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22MT101	Production Technology	3/0/0	3	3	60/40	ESC
2	22MA105	Matrices and Calculus I	3/1/0	4	4	60/40	BSC
Theory with Practical (Internal 50 Marks & External 50 Marks)							
3	22EN101	Technical Communication Skills	2/0/2	4	3	50/50	HSMC
4	22CS101	Problem Solving using C++	3/0/2	5	4	50/50	ESC
5	22PH104	Applied Physics	3/0/2	5	4	50/50	BSC
Practical (Internal 60 Marks & External 40 Marks)							
6	22MT102	Computer Aided Drawing Laboratory for Mechatronics	0/0/3	3	1.5	40/60	ESC
7	22MT103	Production Technology Laboratory	0/0/3	3	1.5	40/60	ESC
Mandatory Course (Internal 100 Marks)							
8	Mandatory Course – I	22MC1XX	Three Weeks		0	0/100	MC
TOTAL			**14/1/12**	**27**	**21**	**800**	

SEMESTER II							
S. No	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22MT201	Applied Mechanics	3/0/0	3	3	60/40	ESC
2	22GE201	Universal Human Values	3/0/0	3	3	60/40	HSMC
3	22MT202	Analog and Digital Electronics	3/0/0	3	3	60/40	ESC
4	22MA204	Calculus II and Transforms	3/1/0	4	4	60/40	BSC

Theory with Practical (Internal 50 Marks & External 50 Marks)							
5	22CS201	Data Structures and Algorithms	3/0/2	5	4	50/50	ESC
6	22CH101	Engineering Chemistry	3/0/2	5	4	50/50	BSC
Practical (Internal 60 Marks & External 40 Marks)							
7	22MT203	Analog and Digital Electronics Laboratory	0/0/2	2	1	40/60	ESC
Indian Knowledge System - Blended Learning							
8	22TA101	Heritage of Tamils	1/0/0	1	1	60/40	HSMC
Mandatory Course (Internal 100 Marks)							
9	22MC1XX	Mandatory Course – II	2/0/0	2	0	0/100	MC
TOTAL			**21/1/6**	**28**	**23**	**900**	

SEMESTER III							
S. No	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22MT301	Control Systems for Mechatronics	3/0/0	3	3	60/40	PCC
2	22MT302	Electrical Machines for Mechatronics	3/0/0	3	3	60/40	PCC
3	22MT303	Design and Modelling of Mechatronics Systems	3/0/0	3	3	60/40	PCC
4	22MT304	Theory of Machines	3/0/0	3	3	60/40	PCC
5	22MA305	Fourier Series and Partial Differential Equations	3/1/0	4	4	60/40	BSC
Theory with Practical (Internal 50 Marks & External 50 Marks)							
6	22IT311	Introduction to Python Programming	1/0/4	5	3	50/50	ESC
Practical (Internal 60 Marks & External 40 Marks)							
7	22MT305	Electrical Machines for Mechatronics Laboratory	0/0/2	2	1	40/60	PCC
8	22MT306	Mechanics of Machines and Materials Laboratory	0/0/2	2	1	40/60	PCC
Indian Knowledge System - Blended Learning							

9	22TA201	Tamils and Technology	1/0/0	1	1	60/40	HSMC	
Mandatory Course (Internal 100 Marks)								
10	22MC1XX	Mandatory Course – III	2/0/0	2	0	0/100	MC	MC
TOTAL			**19/1/8**	**28**	**22**	**1000**		

SEMESTER IV							
S. No	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22MT401	Computer Networks and Cybersecurity	3/0/0	3	3	60/40	PCC
2	22MT402	Basics of Digital Signal Processing	3/0/0	3	3	60/40	PCC
3	22XX0XX	Open Elective – I	1/0/4 or 3/0/0	5 or 3	3	50/50 or 60/40	OEC
4	22MT403	Microcontroller and Its Applications	3/0/0	3	3	60/40	PCC
5	22MA402	Probability and Computational Methods	3/1/0	4	4	60/40	BSC
Theory with Practical (Internal 50 Marks & External 50 Marks)							
6	22MT404	Sensors, Measurements, and Instrumentation	3/0/2	5	4	50/50	PCC
Practical (Internal 60 Marks & External 40 Marks)							
7	22MT405	Microcontroller Laboratory for Mechatronics	0/0/2	2	1	40/60	PCC
8	22MT406	Basics of Digital Signal Processing Laboratory	0/0/2	2	1	40/60	PCC
Mandatory Course (Internal 100 Marks)							
9	22MC1XX	Mandatory Course – IV	2/0/0	2	0	0/100	MC
TOTAL			**18/1/10 or 20/1/6**	**29 or 27**	**22**	**900**	

SEMESTER V							
S. No	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22MT501	Machine Design	3/0/0	3	3	60/40	PCC
2	22MT502	Robotic Systems	3/0/0	3	3	60/40	PCC
3	22MT503	Power Electronics and Drives	3/0/0	3	3	60/40	PCC
4	22MT9XX	Professional Elective – I	3/0/0	3	3	60/40	PEC
5	22XX0XX	Open Elective -II	1/0/4 or 3/0/0	5 or 3	3	50/50 or 60/40	OEC
Theory with Practical (Internal 50 Marks & External 50 Marks)							
6	22MT504	Artificial Intelligence for Robotics	3/0/2	5	4	50/50	PCC
Practical (Internal 60 Marks & External 40 Marks)							
7	22MT505	Power Electronics and Drives Laboratory	0/0/2	2	1	40/60	PCC
8	22MT506	Robotic Systems Laboratory	0/0/2	2	1	40/60	PCC
Project (Internal 60 Marks & External 40 Marks)							
9	22MT507	Mini Project	0/0/2	2	1	40/60	PROJ
TOTAL			**16/0/12 or 18/0/8**	**28 or 26**	**22**	**900**	

SEMESTER VI							
S. No	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22MT601	Autotronics and Vehicle Intelligence	3/0/0	3	3	60/40	PCC
2	22MT602	Industrial Management and Professional Ethics	3/0/0	3	3	60/40	HSMC

3	22MT603	Hydraulics and Pneumatics Systems	3/0/0	3	3	60/40	PCC
4	22MT9XX	Professional Elective – II	3/0/0	3	3	60/40	PEC
5	22MT9XX	Professional Elective – III	3/0/0	3	3	60/40	PEC
6	22MTXXX	Emerging Elective- I	3/0/0	3	3	60/40	EEC
Practical's (Internal 60 Marks & External 40 Marks)							
7	22MT604	Hydraulics and Pneumatics System Laboratory	0/0/2	2	1	40/60	PCC
TOTAL			**18/0/2**	**20**	**19**	**700**	

SEMESTER VII							
S. No	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22MT701	Computer Integrated Manufacturing	3/0/0	3	3	60/40	PCC
2	22MT702	Industrial Automation	3/0/0	3	3	60/40	PCC
3	22MT9XX	Professional Elective – IV	3/0/0	3	3	60/40	PEC
4	22MT9XX	Professional Elective – V	3/0/0	3	3	60/40	PEC
5	22MT9XX	Professional Elective – VI	3/0/0	3	3	60/40	PEC
6	22MTXXX	Emerging Elective – II	3/0/0	3	3	60/40	EEC
Practical's (Internal 60 Marks & External 40 Marks)							
8	22MT703	Computer Aided Engineering laboratory	0/0/2	2	1	40/60	PCC
9	22MT704	Industrial Automation Laboratory	0/0/2	2	1	40/60	PCC
Project (Internal 60 Marks & External 40 Marks)							
10	22MT705	Project – I	0/0/4	4	2	40/60	PROJ
Internship (Internal 100 Marks)							
11	22EES01	Employability Enhancement Skills	-	-	2	0/100	EES
TOTAL			**18/0/8**	**26**	**24**	**1100**	

SEMESTER VIII							
S. No	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Project (Internal 60 Marks & External 40 Marks)							
1	22MT801	Project -II	0/0/24	24	12	40/60	PROJ
TOTAL			**0/0/24**	**24**	**12**	**100**	

SCHEME OF CREDIT DISTRIBUTION – SUMMARY											
S. No.	**Stream**	**Credits/Semester**								**C**	**%**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
1	**Humanities & Social Sciences Including Management (HSMC)**	3	4	1	-	-	3	-	-	11	6.75
2	**Basic Sciences (BSC)**	8	8	4	4	-	-	-	-	24	14.72
3	**Engineering Sciences (ESC)**	10	11	3	-	-	-	-	-	24	14.72
4	**Professional Core (PCC)**	-	-	14	15	15	7	8	-	59	36.20
5	**Professional Electives (PEC)**	-	-	-	-	3	6	9	-	18	11.04
6	**Open/Emerging/Industry (OEC)**	-	-	-	3	3	3	3	-	12	7.36
7	**Project Work (PROJ)**	-	-	-	-	1	-	4	12	17	10.03
8.	**Mandatory Course (MC) / Spoken Hindi**	-	-	-	-	-	-	-	-	-	-
Total		**21**	**23**	**22**	**22**	**22**	**19**	**24**	**12**	**165**	**100**

STRUCTURE FOR UNDERGRADUATE ENGINEERING PROGRAM

S. No.	Course Work - Subject Area	AICTE Suggested Credits	SKCET Credits (MCT)
1.	Humanities and Social Sciences (HS), including Management;	12	11
2.	Basic Sciences (BS) including Mathematics, Physics, Chemistry, Biology;	21	24
3.	Engineering Sciences (ES), including Materials, Workshop, Drawing, Basics of Electrical/Electronics/Mechanical/Computer Engineering, Instrumentation;	-	24
4.	Professional Subjects-Core (PC), relevant to the chosen specialization/branch; (May be split into Hard (no choice) and Soft (with choice), if required	101	59
5.	Professional Subjects – Electives (PE), relevant to the chosen specialization/ branch;	6	18
6.	Open Subjects- Electives (OE), from other technical and/or emerging subject areas;	6	12
7.	Project Work, Seminar and/or Internship in Industry or elsewhere.	17	17
8.	Mandatory Courses (MC)		-
	Total	**163**	**165**
Minor Variations is allowed as per need of the respective disciplines			

HUMANITIES & SOCIAL SCIENCES INCLUDING MANAGEMENT (11 Credits)

S. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Ext/ Int	Cat.
1.	22GE201	Universal Human Values	3/0/0	3	3	60/40	HSMC
2.	22EN101	Technical Communication Skills	2/0/2	4	3	50/50	HSMC
3.	22MT602	Industrial Management and Professional Ethics	3/0/0	3	3	60/40	HSMC
4.	22TA101	Heritage of Tamils	1/0/0	1	1	60/40	HSMC
5.	22TA201	Tamils and Technology	1/0/0	1	1	60/40	HSMC

BASIC SCIENCE COURSES (24 Credits)

S. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Ext/ Int	Cat.
1.	22MA105	Matrices and Calculus I	3/1/0	4	4	60/40	BSC
2.	22MA204	Calculus II and Transforms	3/1/0	4	4	60/40	BSC
3.	22MA305	Fourier Series and Partial Differential Equations	3/1/0	4	4	60/40	BSC
4.	22CH101	Engineering Chemistry	3/0/2	5	4	50/50	BSC
5.	22PH104	Applied Physics	3/0/2	5	4	50/50	BSC
6.	22MA402	Probability and Computational Methods	3/1/0	4	4	60/40	BSC

ENGINEERING SCIENCE COURSES (24 Credits)

S. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Ext/ Int	Cat.
1.	22MT101	Production Technology	3/0/0	3	3	60/40	ESC
2.	22CS101	Problem Solving using C++	3/0/2	5	4	50/50	ESC
3.	22MT102	Computer Aided Drawing Laboratory for Mechatronics	0/0/3	3	1.5	40/60	ESC
4.	22MT103	Production Technology Laboratory	0/0/3	3	1.5	40/60	ESC
5.	22MT201	Applied Mechanics	3/0/0	3	3	60/40	ESC
6.	22MT202	Analog and Digital Electronics	3/0/0	3	3	60/40	ESC
7.	22CS201	Data Structures and Algorithms	3/0/2	5	4	50/50	ESC
8.	22MT203	Analog and Digital Electronics Laboratory	0/0/2	2	1	40/60	ESC
9.	22ITXXX	Python Programming	1/0/4	5	3	50/50	ESC

PROFESSIONAL CORE COURSES (69 Credits)

S. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Ext/ Int	Cat.
1.	22MT301	Control Systems for Mechatronics	3/0/0	3	3	60/40	PCC
2.	22MT302	Electrical Machines for Mechatronics	3/0/0	3	3	60/40	PCC

3.	22MT303	Design and Modelling of Mechatronics Systems	3/0/0	3	3	60/40	PCC
4.	22MT304	Theory of Machines	3/0/0	3	3	60/40	PCC
5.	22MT305	Electrical Machines for Mechatronics Laboratory	0/0/2	2	1	40/60	PCC
6.	22MT306	Mechanics of Machines and Materials Laboratory	0/0/2	2	1	40/60	PCC
7.	22MT401	Computer Networks and Cyber Security	3/0/0	3	3	40/60	PCC
8.	22MT402	Basics of Digital Signal Processing	3/0/0	3	3	40/60	PCC
9.	22MT403	Microcontroller and Its Applications	3/0/0	3	3	40/60	PCC
10.	22MT404	Sensors, Measurements, and Instrumentation	3/0/2	5	4	50/50	PCC
11.	22MT405	Microcontroller Laboratory for Mechatronics	0/0/2	2	1	40/60	PCC
12.	22MT406	Basics of Digital Signal Processing Laboratory	0/0/2	2	1	40/60	PCC
13.	22MT501	Machine Design	3/0/0	3	3	40/60	PCC
14.	22MT502	Robotic Systems	3/0/0	3	3	40/60	PCC
15.	22MT503	Power Electronics and Drives	3/0/0	3	3	40/60	PCC
16.	22MT504	Artificial Intelligence for Robotics	3/0/2	5	4	50/50	PCC
17.	22MT505	Power Electronics and Drives Laboratory	0/0/3	3	1.5	40/60	PCC
18.	22MT506	Robotic Systems Laboratory	0/0/3	3	1.5	40/60	PCC
19.	22MT601	Autotronics and Vehicle Intelligence	3/0/0	3	3	60/40	PCC
20.	22MT603	Hydraulics and Pneumatics Systems	3/0/0	3	3	60/40	PCC
21.	22MT604	Hydraulics and Pneumatics System Laboratory	0/0/2	2	1	40/60	PCC
22.	22MT701	Computer Integrated Manufacturing	3/0/0	3	3	60/40	PCC
23.	22MT702	Industrial Automation	3/0/0	3	3	60/40	PCC

24.	22MT703	Computer Aided Engineering laboratory	0/0/2	2	1	40/60	PCC
25.	22MT704	Industrial Automation Laboratory	0/0/2	2	1	40/60	PCC

PROFESSIONAL ELECTIVE COURSES (18 Credits)							
S. No.	**Course Code**	**Course Title**	**L/T/P**	**Contact hrs./Wk.**	**C**	**Ext/ Int**	**Cat.**
ELECTIVE STREAM I – APPLIED ROBOTICS							
1.	22MT901	Mobile Robotics	3/0/0	3	3	60/40	PEC
2.	22MT902	Agricultural Robotics and Automation	3/0/0	3	3	60/40	PEC
3.	22MT903	Bio-Mechatronics	3/0/0	3	3	60/40	PEC
4.	22MT904	Robot Operating System	1/0/4	3	3	60/40	PEC
5.	22MT905	Micro Robotics	3/0/0	3	3	60/40	PEC
6.	22MT906	Humanoids	3/0/0	3	3	60/40	PEC
7.	22MT937	Introduction to Marine and Aerial Robotics	3/0/0	3	3	60/40	PEC
8.	22MT938	Robot Motion Planning	3/0/0	3	3	60/40	PEC
9.	22MT939	Robot Control	3/0/0	3	3	60/40	PEC
ELECTIVE STREAM II – DESIGN AND MANUFACTURING							
1.	22MT907	Product Design and Manufacturing	3/0/0	3	3	60/40	PEC
2.	22MT908	Robots and System in Smart Manufacturing	3/0/0	3	3	60/40	PEC
3.	22MT909	CNC Machines and Part Programming	3/0/0	3	3	60/40	PEC
4.	22MT910	Additive Manufacturing Processes	3/0/0	3	3	60/40	PEC
5.	22MT911	Robotic Welding Technology	3/0/0	3	3	60/40	PEC
6.	22MT912	Digital Manufacturing	3/0/0	3	3	60/40	PEC
7.	22MT940	Micro and Nano Manufacturing	3/0/0	3	3	60/40	PEC
8.	22MT941	Industrial Metrology	3/0/0	3	3	60/40	PEC
9.	22MT942	Micro Electro Mechanical Systems	3/0/0	3	3	60/40	PEC
ELECTIVE STREAM III - SMART MOBILITY SYSTEMS							
1.	22MT913	Advanced Driver Assistance Systems	3/0/0	3	3	60/40	PEC
2.	22MT914	Vehicle Ergonomics	3/0/0	3	3	60/40	PEC

3.	22MT915	Autonomous Underwater Vehicles	3/0/0	3	3	60/40	PEC
4.	22MT916	Electric and Hybrid Vehicles	3/0/0	3	3	60/40	PEC
5.	22MT917	Automobile Engineering	3/0/0	3	3	60/40	PEC
6.	22MT918	Battery Management System	3/0/0	3	3	60/40	PEC
7.	22MT943	Connected Vehicles	3/0/0	3	3	60/40	PEC
8.	22MT944	Safety, Ethics and Regulations for Driverless Cars	3/0/0	3	3	60/40	PEC
9.	22MT945	Foundations of Autonomous Vehicles	3/0/0	3	3	60/40	PEC
ELECTIVE STREAM IV – INTELLIGENCE SYSTEMS							
1.	22MT919	Introduction to Machine Learning	3/0/0	3	3	60/40	PEC
2.	22MT920	AI for Perception Planning and Control	3/0/0	3	3	60/40	PEC
3.	22MT921	Condition Monitoring and Fault Diagnostics	3/0/0	3	3	60/40	PEC
4.	22MT922	Intelligent Control System	3/0/0	3	3	60/40	PEC
5.	22MT923	Haptics	3/0/0	3	3	60/40	PEC
6.	22MT924	Computer Vision and Deep Learning	3/0/0	3	3	60/40	PEC
7.	22MT946	Reinforcement Learning for Robotics	3/0/0	3	3	60/40	PEC
8.	22MT947	Virtual Reality and its Applications	3/0/0	3	3	60/40	PEC
9.	22MT948	Augmented and Mixed Reality	3/0/0	3	3	60/40	PEC
ELECTIVE STREAM V – AUTOMATION							
1.	22MT925	Embedded System for Automation	3/0/0	3	3	60/40	PEC
2.	22MT926	Robotic Process Automation	3/0/0	3	3	60/40	PEC
3.	22MT927	Industrial Networking	3/0/0	3	3	60/40	PEC
4.	22MT928	Virtual Instrumentation and its Applications	3/0/0	3	3	60/40	PEC
5.	22MT929	Digital Twin and Industry 5.0	3/0/0	3	3	60/40	PEC
6.	22MT930	Internet of Things for Mechatronics	3/0/0	3	3	60/40	PEC
7.	22MT949	AI and Machine Learning in Automation Testing	3/0/0	3	3	60/40	PEC
8.	22MT950	Planning and Decision Making in Robotics	3/0/0	3	3	60/40	PEC
9.	22MT951	Automation in Production Systems and Management	3/0/0	3	3	60/40	PEC
ELECTIVE STREAM VI – AVIONICS AND DRONE TECHNOLOGY							
1.	22MT931	Avionics	3/0/0	3	3	60/40	PEC
2.	22MT932	Drone Technologies	3/0/0	3	3	60/40	PEC

3.	22MT933	Navigation and Communication System	3/0/0	3	3	60/40	PEC
4.	22MT934	Unmanned Aerial Vehicles	3/0/0	3	3	60/40	PEC
5.	22MT935	Aircraft Stability and Control	3/0/0	3	3	60/40	PEC
6.	22MT936	Aircraft Mechatronics	3/0/0	3	3	60/40	PEC
7.	22MT952	Introduction to Aircraft Control System	3/0/0	3	3	60/40	PEC
8.	22MT953	Introduction to Airplane Performance	3/0/0	3	3	60/40	PEC
9.	22MT954	Introduction to Aircraft design	3/0/0	3	3	60/40	PEC

OPEN/ EMERGING/ INDUSTRY (12 Credits)

S. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Ext/ Int	Cat.
OPEN ELECTIVES (OE): Offered to other departments							
1.	22MT001	Basics of Robotics	3/0/0	3	3	60/40	OEC
2.	22MT002	Basics of Automation Systems	3/0/0	3	3	60/40	OEC
3.	22MT003	Smart Sensors for IoT	3/0/0	3	3	60/40	OEC
4.	22MT004	Basics of Unmanned Aerial Vehicles	3/0/0	3	3	60/40	OEC
5.	22MT005	Fundamentals of Arduino and Raspberry Pi	3/0/0	3	3	60/40	OEC
EMERGING ELECTIVES (EE): Offered to MCT							
1.	22MT006	Collaborative Robotics	3/0/0	3	3	60/40	EEC
2.	22MT007	Design Thinking and Entrepreneur Development	3/0/0	3	3	60/40	EEC
3.	22MT008	Brain Computer Interface	3/0/0	3	3	60/40	EEC
4.	22MT009	Social Robotics	3/0/0	3	3	60/40	EEC
5.	22MT010	Cognitive Robotics	3/0/0	3	3	60/40	EEC
6.	22MT011	Data Analytics for Robotics and Automation	3/0/0	3	3	60/40	EEC
7.	22MT012	Ethical Hacking	3/0/0	3	3	60/40	EEC
8.	22MT013	Communication Networks in IoT	3/0/0	3	3	60/40	EEC
9.	22MT014	Vision Guided Robots	3/0/0	3	3	60/40	EEC

PROJECT WORK (15 Credits)							
S. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Ext/ Int	Cat.
1.	22MT507	Mini Project	0/0/2	2	1	40/60	PROJ
2.	22MT705	Project - I	0/0/4	4	2	40/60	PROJ
3.	22MT801	Project - II	0/0/24	24	12	40/60	PROJ

PROFESSIONAL ELECTIVE COURSES: VERTICALS					
Vertical I	**Vertical II**	**Vertical III**	**Vertical IV**	**Vertical V**	**Vertical VI**
APPLIED ROBOTICS	**DESIGN AND MANUFACTURING**	**SMART MOBILITY SYSTEMS**	**INTELLIGENCE SYSTEMS**	**AUTOMATION**	**AVIONICS AND DRONE TECHNOLOGY**
22MT901- Mobile Robotics	22MT907- Product Design and Manufacturing	22MT913- Advanced Driver Assistance Systems	22MT919 - Introduction to Machine Learning	22MT925- Embedded System for Automation	22MT931-Avionics
22MT902-Agricultural Robotics and Automation	22MT908- Robots and System in Smart Manufacturing	22MT914- Vehicle Ergonomics	22MT920- AI for Perception Planning and Control	22MT926- Robotic Process Automation	22MT932-Drone Technologies
22MT903- Bio-Mechatronics	22MT909- CNC Machines and Part Programming	22MT915- Autonomous Underwater Vehicles	22MT921- Condition Monitoring and Fault Diagnostics	22MT927- Industrial Networking	22MT933-Navigation and Communication System
22MT904- Robot Operating System	22MT910-Additive Manufacturing Processes	22MT916-Electric and Hybrid Vehicles	22MT922- Intelligent Control System	22MT928-Virtual Instrumentation and its Applications	22MT934- Unmanned Aerial Vehicles
22MT905- Micro Robotics	22MT911-Robotic Welding Technology	22MT917-Automobile Engineering	22MT923- Haptics	22MT929-Digital Twin and Industry 5.0	22MT935- Aircraft Stability and Control
22MT906-Humanoids	22MT912- Digital Manufacturing	22MT918-Battery Management System	22MT924- Computer Vision and Deep Learning	22MT930- Internet of Things for Mechatronics	22MT936-Aircraft Mechatronics

22MT937 - Introduction to Marine and Aerial Robotics	22MT940 - Micro and Nano Manufacturing	22MT943 - Connected Vehicles	22MT946- Reinforcement Learning for Robotics	22MT949 - AI and Machine Learning in Automation Testing	22MT952 - Introduction to Aircraft Control System
22MT938 - Robot Motion Planning	22MT941 - Industrial Metrology	22MT944- Safety, Ethics and Regulations for Driverless Cars	22MT947 - Virtual Reality and its Applications	22MT950 - Planning and Decision Making in Robotics	22MT953 - Introduction to Airplane Performance
22MT939 - Robot Control	22MT942 - Micro Electro Mechanical Systems	22MT945 - Foundations of Autonomous Vehicles	22MT948 - Augmented and Mixed Reality	22MT951 - Automation in Production Systems and Management	22MT954 - Introduction to Aircraft design

INTERNSHIP (2 Credits)							
S. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Ext/ Int	Cat.
1.	22EES01	Employability Enhancement Skills	-	-	2	0/100	EES

VALUE ADDED COURSES (Based on student's interest)			
S. No	Course Code	Course Title	Sem
1.	22VA600	Solidworks	III/IV
2.	22VA601	MATLAB programming	III/IV
3.	22VA602	Android Studio	III/IV
4.	22VA603	Intellectual Property Rights & Entrepreneurship	IV/V
5.	22VA604	Financial Literacy	IV/V
6.	22VA605	Automation Studio	IV/V
7.	22VA606	Electric Vehicle Design & Fabrication	IV/V
8.	22VA607	Mastering Embedded Systems: Unleash the Power of Controller Boards	V/VI
9.	22VA608	Programming with LabVIEW	V/VI

MANDATORY COURSES (Non-Credits) (Courses conducted either by internal faculty or through MOOCs)							
S. No.	Course Code	Course Title	L/T/P	Contact hrs./ Wk.	C	Ext/ Int	Cat.
1.	22MC101	Induction Programme	3 weeks		0	0/100	MC
2.	22MC102	Environmental Sciences	2/0/0	2	0	0/100	MC
3.	22MC103	Soft Skills	2/0/0	2	0	0/100	MC
4.	22MC104	Management Organizational Behavior	2/0/0	2	0	0/100	MC
5.	22MC105	General Aptitude	2/0/0	2	0	0/100	MC

6.	22MC106	Life Skills and Ethics	2/0/0	2	0	0/100	MC
7.	22MC107	Stress Management	2/0/0	2	0	0/100	MC
8.	22MC108	Constitution of India	2/0/0	2	0	0/100	MC
9.	22MC109	Essence of Indian Traditional Knowledge	2/0/0	2	0	0/100	MC
10.	22MC110	Biology	2/0/0	2	0	0/100	

L: Lecture **T:** Tutorial **P:** Practical **C:** Credit **O:** Outside Class hours **Cat.:** Category

HSMC : Humanities and Social Sciences including Management
BSC : Basic Science Courses
ESC : Engineering Science Courses
PCC : Professional Core Courses
PEC : Professional Elective Courses
OEC : Open and Emerging Elective Courses
PRJ : Project Work
INT : Internship
MC : Mandatory Course

Definition of Credit:

L – Lecture	1 Hr. Lecture (L) per week	1 credit
T – Tutorial	1 Hr. Tutorial (T) per week	1 credit
P - Practical/Practice (Project and Industry based Courses)	1 Hr. Practical (P) per week	0.5 credit

SEMESTER – VII

22MT701	COMPUTER INTEGRATED MANUFACTURING	3/0/0/3
Nature of Course: Theory skill based		
Pre requisites : Nil		

Course Objectives:

1. To provide the overview of evolution of automation, CIM and NC system
2. To train students to apply group technology, FMS and process planning in manufacturing
3. To learn the various Automation tools, various material handling systems
4. To introduce the basics of data transaction, information integration and control of CIM

Course Outcomes:
Upon completion of the course, students shall have ability to

C701.1	Outline the working of CIM and NC machines and its various elements	[U]
C701.2	Illustrate the overview of group technology, part classifications and coding system	[U]
C701.3	Develop computer aided process planning for manufacturing of various components	[AP]
C701.4	Identify the different types of FMS layouts, AGVs and material handling storage and retrieval systems	[AP]
C701.5	Interpret the modelling methods with their impact on the designed systems	[U]

CIM AND CNC PROGRAMMING

CAD/CAM Integration - CIM wheel and Components: Evolution, Needs and Benefits – CIM business functions - NC System - NC Motion control system - Applications of NC – NC Part Programming using G and M codes - Drilling, Turning and Milling. Part families – Parts classification and coding – Production flow analysis – Grouping of parts and Machines by rank order clustering method – Benefits of GT – Case studies. FMS – Components – workstations – layout configurations – Computer control systems – FMS planning and implementation issues – applications and benefits.

(15 Hours)

AUTOMATED MANUFACTURING SYSTEMS

Process planning – classification, selection of manufacturing processes. Computer Aided Process Planning – module and database – Variant process planning – Generative process planning. Automated production line – Fundamentals of Automated assembly system – Overview of material handling equipment – Automated Guided Vehicle system – Types & applications – Storage system – Conventional storage methods and equipment – Automated storage/Retrieval system and Carousel storage system – Smart manufacturing – Industry 4.0 - Digital manufacturing – Virtual manufacturing. **(15 Hours)**

PROCESS CONTROL SYSTEMS

Introduction to process model formulation – linear feedback control systems – Optimal control – Adaptive control –Sequence control and PLC & SCADA. Computer process control – Computer process interface – Interface hardware – Computer process monitoring – Direct digital control and Supervisory computer control - Overview of Automatic identification methods – Bar code technology – Automatic data capture technologies - Quality management (SPC) and automated inspection. **(15 Hours)**

Total Hours:	**45**

Text Books:

1.	Mikell P. Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India Private Ltd., New Delhi, 2016.
2.	Radhakrishnan P, Subramanian S and Raju V, CAD/CAM/CIM, New Age International Publishers, 2023.

Reference Books:	
1.	Cheng, “Computer Aided Manufacturing”, Pearson India, 2017
2.	Shivanand H K, Benal M M and Koti V, Flexible Manufacturing System, New Age, 2016
Web References:	
1	https://nptel.ac.in/courses/112104289
2.	https://www.sciencedirect.com/topics/engineering/computer-integrated-manufacturing
3.	https://www.n-ix.com/computer-integrated-manufacturing-use-cases/

22MT702	INDUSTRIAL AUTOMATION	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1. To understand the concept of Industrial Automation
2. To study about the hardware and programming software of PLC
3. To explain the control functions involved in DCS and SCADA
4. To give adequate information about the interfaces used in HMI

Course Outcomes:

Upon completion of the course, students shall have ability to

C702.1	Outline the PLC architecture and networking concepts	[U]
C702.2	Select the PLC peripherals and build ladder logic programming	[AP]
C702.3	Infer the concepts of DCS and its architecture, reliability, and SCADA systems	[U]
C702.4	Construct real-time systems, SCADA-PLC interfacing, and FPGA fundamentals	[AP]
C702.5	Apply the concepts of HMI for diverse industrial applications, emphasizing cybersecurity measures	[AP]

PLC AND NETWORKING

Industrial Automation: Overview, Types, Control Elements - PLC architecture: Parts, CPU, Memory, Input/output modules, Timers and Counters – Instruction set - Selection of PLC based on input and output - PLC programming languages: Ladder logic – Wiring of PLC - Industrial Networking: Modbus – Profibus – Fieldbus – Ethernet. **(15 Hours)**

DCS AND SCADA

Distributed Control System (DCS): Architecture, Database organization, System elements - Field station - Intermediate station - Central computer station, Reliability parameters - SCADA: Introduction, Architecture, Application areas, Major elements, Considerations and benefits - Real time systems - Interfacing of SCADA with PLC and other field devices - Comparison of SCADA, DCS and PLC. **(15 Hours)**

HMI AND APPLIED AUTOMATION

Human Machine Interface (HMI) –Automation system structure, Instrumentation subsystem, control subsystem, Human interface subsystem-operator panel-construction of the panel-Interfacing with control sub system-Types of Mimic panels, Advance HMI system-Intelligent operator panel - Interfacing PLC to HMI – Basics of Cyber security in Industrial automation – Applied Automation : PLC in wind turbine control - DCS in cement plants - HMI in Material Transfer application. **(15 Hours)**

Total hours: 45

Text Books:

1. Jon Stenerson, “Industrial Automation and Process Control”, 4th edition, Prentice Hall, 2018.
2. Frank D Petruzella, “Programmable Logic Controllers”, Tata McGraw Hill Publications, 6th edition, 2019.

Reference Books:

1. Stuart A Boyer, “SCADA-supervisory control and data acquisition”, International Society of automation, 4th edition, 2016.
2. Dobrivoje Popovic and Vijay Bhatkar, “Distributed control for Industrial Automation”, Marcel Dekker Inc, 5th edition, 2017.

3	Webb, John W, "Programmable Logic Controllers - Principles and applications", PHI Publication, 5th edition, 2016.
Web Resources:	
1	https://nptel.ac.in/courses/108106022/8
2	https://instrumentationtools.blogspot.com/2019/03/plc-study-material.html
3	https://examsdaily.in/dcs-study-materials
4	https://nptel.ac.in/courses/108106022/8

22MT703	COMPUTER AIDED ENGINEERING LABORATORY	0/0/2/1
Nature of Course: Practical		
Pre-requisites: Nil		

Course Objectives:

1. To provide the practical exposure to the student regarding analysis of Beams, Trusses, L Bracket and Heat Sink
2. To impart the experiment knowledge of G codes and M codes used in automated CNC
3. To understand the Master CAM software and to simulate Turning, Milling and Drilling operations using Fanuc software

Course Outcomes:

Upon completion of the course, students shall have ability to

C703.1	Apply structural analysis in Beams, Trusses and L bracket	[AP]
C703.2	Examine the thermal analysis of a heat sink	[A]
C703.3	Make use of G codes and M codes using Master CAM software	[AP]
C703.4	Model Turning, Milling and Drilling operation using Fanuc software	[AP]
C703.5	Analyze the significance of SAP	[A]

S.No	List of Exercises	CO Mapping	BT
1.	Introduction to FEA and ANSYS Commands - Structural analysis of Beams and Trusses	C703.1	[AP]
2.	Structural analysis of a L Bracket	C703.1	[AP]
3.	Thermal analysis of a Heat sinks	C703.2	[A]
4.	Introduction to CAM and CNC Machining	C703.3	[AP]
5.	Automated CNC Tool path & G - Code generation using Master CAM - Turning	C703.3	[AP]
6.	Automated CNC Tool path & G - Code generation using Master CAM - Milling	C703.3	[AP]
7.	Turn-mill & Multi axis CNC tool path using Master CAM	C703.3	[AP]
8.	Turning operations using Fanuc simulator software.	C703.4	[AP]
9.	Milling operation using Fanuc simulator software.	C703.4	[AP]
10.	Drilling using Fanuc simulating software.	C703.4	[AP]
11.	Introduction to SAP.	C703.5	[A]
			Total Hours: 30

Reference Books:

1	Sham Tickoo, “Finite Element Analysis with ANSYS Workbench”, BPB Publications, Jan 2019.
2	Harshal Dhawas, “Guide On CNC Operating Skills for Fanuc: Program Entry and work offset setting” Pacific Holdings Private Limited, April 2020.

Web Resources:

1	https://archive.nptel.ac.in/courses/112/105/112105211/
2	https://onlinecourses.nptel.ac.in/noc23_me143/preview
3	https://proleantech.com/a-beginners-guide-to-cnc-drilling-from-programming-to-execution/

22MT704	INDUSTRIAL AUTOMATION LABORATORY		0/0/2/1
Nature of Course: Practical			
Pre-requisites: Nil			
Course Objectives:			
1. To experimentally learn about PLC and HMI and its ladder logic techniques and perform various experiments for given applications. 2. To become familiar with ABB PLC and HMI software and to simulate and various experiments. 3. To learn about SCADA and perform program for given industrial application			
Course Outcomes: **Upon completion of the course, students shall have ability to**			
C704.1	Examine various PLC blocks and I/O modules interfaces.		[AP]
C704.2	Apply the concept of ladder programming for implementing basic logic gates in PLC systems.		[AP]
C704.3	Construct and simulate water level and temperature control using PLC and HMI programming.		[AP]
C704.4	Examine control systems for belt conveyors and servomotors with both PLC and HMI.		[AP]
C704.5	Develop SCADA programs for temperature and water level control applications.		[AP]
S. No.	**List of Exercises**	**CO Mapping**	**BT**
1.	To study the block diagram and input and output module interfaces of programmable logic controller.	C704.1	[AP]
2.	Introduction to ladder programming and to implement basic logic gates	C704.2	[AP]
3.	(a) Water level control with PLC programming (b) Water level control using HMI	C704.3	[AP]
4.	(a) Temperature control with PLC programming (b) Temperature control using HMI	C704.3	[AP]
5.	(a) Flow control with PLC programming (b) Flow control using HMI	C704.3	[AP]
6.	(a) Pressure control with PLC programming (b) Pressure control using HMI	C704.3	[AP]
7.	(a) Belt conveyor control with PLC programming (b) Belt conveyor control using HMI	C704.4	[AP]
8.	(a) Servomotor control for linear applications using PLC (b) Servomotor control for linear applications using HMI	C704.4	[AP]
9.	(a) Servomotor control for rotary applications using PLC (b) Servomotor control for rotary applications using HMI	C704.4	[AP]
10.	Develop SCADA program for temperature and water level control application	C704.5	[AP]
			Total Hours: 30

Reference Books:

1	Jon Stenerson, “Industrial Automation and Process Control”, 4th edition, Prentice Hall, 2018.
2	Frank D Petruzella, “Programmable Logic Controllers”, Tata McGraw Hill Publications, 6th edition, 2019.

Web Resources:

1	https://nptel.ac.in/courses/108106022/8

2	https://instrumentationtools.blogspot.com/2019/03/plc-study-material.html
3	https://examsdaily.in/dcs-study-materials

22MT705	PROJECT – I	0/0/4/2
Nature of Course	Practical	
Pre Requisites	-	

Course Objectives:

1. To demonstrate the technical and literature survey abilities
2. To identify suitable tools and techniques to solve the practical problems

Course Outcomes:

Upon completion of the course, students shall have ability to

C705.1	Inspect the problem and identify the solution space	[AN]
C705.2	Survey the relevant literature	[AN]
C705.3	Develop technical skill, presentation skill and interpersonal behavior	[AP]
C705.4	Demonstrate interdisciplinary skill, ethical values and team work	[U]
C705.5	Examine business/market trend in terms of economics and finance	[AN]

Course Guidelines:

1. Each student is expected to do a project and form a team of 3-4 members.
2. Every team shall have a guide who is the member of the faculty of the institution. Identification of faculty guide has to be completed within a week from the day of beginning of seventh semester.
3. The student has to identify and select the problem to be addressed as his/her project work by conducting a complete literature survey and finalize a comprehensive aim and scope of his/her work to be done.
4. 25% of the total project work (up to design phase) has to be completed by the end of seventh semester.
5. A project report (of the phase-I) to this effect has to be submitted by the team. Also, the complete design project report has to be submitted by team.
6. Two mid semester reviews and one end semester review of the progress of the project work have to be conducted by a team of faculty (minimum 3 and a maximum of 5) along with their faculty guide as a member of the faculty team.
7. During the end semester exam, one internal examiner and one external examiner, appointed by the COE will examine the Project- I done by the students.

Assessment Components

S.No.	Category	Marks
1	Problem Statement	**50**
2	Project Evaluation (Up to design phase)	**50**
	Total	**100**

PROFESSIONAL ELECTIVES

22MT901	MOBILE ROBOTICS	3/0/0/3
Nature of Course: Theory		
Pre-Requisites: Nil		
Course Objectives:		
1. To familiarize the students with mobile robots		
2. To understand the basic methods for achieving mobility and autonomy		
3. To provide a practical understanding of robot navigation and locomotion		
Course Outcomes: Upon completion of the course, students shall have ability to		

C901.1	Illustrate different robot configuration for various applications	[U]
C901.2	Select various sensors used for perception, localization and mapping	[U]
C901.3	Outline control algorithms involved in mobile robots	[U]
C901.4	Apply the concept of kinematics in modelling mobile robots	[AP]
C901.5	Apply various algorithms in path planning and navigation	[AP]

KINEMATIC OF MOBILE ROBOTS

Introduction to Mobile Robotics - Key issues for locomotion, Legged and Wheeled mobile robots - Representing Robot position - Forward Kinematic models, Wheel kinematic constraints - Robot kinematic constraints –Mobile Robot Manoeuvrability-Mobile Robot Workspace - Domestic Robots - Education Robots. **(15 Hours)**

SENSORS AND TYPES

Sensors for Mobile Robots – Classification –- characterizing sensor performance, wheel/motor sensor, heading sensor, Ground-based beacons, Active ranging, motion/speed sensor, Vision-based sensors- Representing Uncertainty- Feature Extraction - Sensor Integration, fusion and state estimation – Global Positioning System - Bayes filter- Gyroscope – Kalman filters – Compass – Force and Tactile Sensors. **(15 Hours)**

LOCALIZATION AND NAVIGATION

Mobile Robot Localization, localization-based navigation versus programmed solutions, Belief and Map representation, Probabilistic Map based Localization, Landmark based Navigation, Route-based localization. Autonomous map building. Introduction to Planning and Navigation, Path Planning, Obstacle avoidance, bug algorithm, Vector Field Histogram, curvature velocity techniques, Navigation architecture. **(15 Hours)**

Total Hours	**45**

Text Books:

1	Roland Siegwart, IllahR. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, 2nd Edition, 2014.
2	Spyros G Tzafestas, “Introduction to Mobile Robot Control”, First Edition, Elsevier Insights, 2014.

Reference Books:

1	Luc Jaulin, Mobile Robotics, Wiley,2019
2	Siciliano, Khatib, Eds., “Handbook of Robotics”, Springer, 2016
3	Farid Golnaraghi, Benjamin C. Kuo, “Automatic control systems”, McGraw Hill Edition, 10th edition 2018

Web References:

1	http://nptel.ac.in/courses/112101099/
2	https://www.conveyco.com/types-and-applications-of-amrs/
3	https://www.roboticsbusinessreview.com/supply-chain/mobile-robot-technology-imts/

22MT904	ROBOT OPERATING SYSTEM	1/0/4/3

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1.	To interpret the essential concepts and architecture of Robot Operating Systems.
2.	To select appropriate operating systems for on the hardware interfacing aspects
3.	To Understand how ROS can be used in real-world and sophisticated applications

Course Outcomes:
Upon completion of the course, students shall have ability to

C904.1	Outline the need for ROS and its significance	[U]
C904.2	Illustrate the concepts behind navigation through file system	[U]
C904.3	Interpret the concepts of Visualization.	[U]
C904.4	Identify the different type of hardware interfacing	[AP]
C904.5	Model the applications of ROS in real world complex applications	[AP]

INTRODUCTION TO ROS

Overview – file system level, Computational graph level, Community level. Creating ROS package. Working with ROS Services, creating launch files- 3D robot Modelling in ROS - Visualizing using Rviz.

(15 Hours)

SIMULATION AND NAVIGATION

Simulating Robotic arm, Differential Wheeled robot using coppeliasim and ROS - MoveIt motion planning Framework- Understanding ROS Navigation - Stack, building map using SLAM.

(15 Hours)

I/O INTERFACE

ROS Controller – ROS Control Packages, join controller in ROS - Interfacing I/O boards, Sensors, actuators – Arduino ROS interface– Building and interfacing differential drive mobile robot. Case study: ROS network and Simulation of swarm robots

(15 Hours)

Total hours: 45

Lab Component:

S. No.	List of Experiments
1	Create ROS Workspaces and Packages
2	Publish/subscribe communication paradigms
3	3D robot Modelling Using Unified Robot Description Format
4	Simulating robot Arm using Gazebo and PID Tuning
5	Simulate the Forward and Inverse kinematics of robotics arm in gazebo
6	Simulate the different sensor using Gazebo (Lidar, Camera, Depth sensor)
7	Simulate differential wheeled robot using ROS
8	Robotic arm using coppeliasim/robodk and ROS
9	Differential wheeled robot using coppeliasim/ robodk and ROS
10	Interfacing the Arduino with ROS LED Blink and sensor.

Text Books:

1	Lentin Joseph, “Mastering ROS for Robotics Programming”, Second Edition, Packt Publishing Ltd, 2018
2	Aaron Martinez, Enrique Fernández, “Learning ROS for Robotics Programming”, Packt Publishing Ltd, 2013.

Reference Books:

1	Lentin Joseph, “Robot Operating Systems (ROS) for Absolute Beginners, Apress, 2018.
2	Anis Koubaa, “Robot Operating System (ROS) – The Complete Reference Vol.3, Springer, 2018
Web Resources:	
1	http://wiki.ros.org/ROS/Tutorials
2	https://www.udemy.com/course/ros-essentials/

22MT906	HUMANOIDS	3/0/0/3
Nature of Course: Theory		
Pre requisites : Nil		
Course Objectives:		

1. To know the basic knowledge about Humanoid robots.
2. To impart knowledge in kinematics and dynamics of humanoids.
3. To understand the basics in biped walking and different walking patterns.

Course Outcomes:
Upon completion of the course, students shall have ability to

C906.1	Describe the evolution of Humanoid robots.	[U]
C906.2	Explain the basic knowledge in kinematics of humanoids.	[U]
C906.3	Calculate the Humanoid Robot Motion and Ground Reaction	[AP]
C906.4	Identify Two-Dimensional Walking patterns on different terrain.	[U]
C906.5	Design and implement stabilization techniques	[AP]

INTRODUCTION
Historical development of Humanoids, Human Likeness of a Humanoid Robot, Trade-Offs and Human-Friendly Humanoid Robot Design, characteristics of humanoid robots. Human activity recognition using vision, touch, sound, tactile Sensing, Models of emotion and motivation. Performance, Interaction. **(15 Hours)**

KINEMATICS AND DYNAMICS
Kinematic structure, forward and inverse kinematics, differential kinematics, Twist, Spatial Velocity, and Spatial transform. - Gait Analysis. Zero Moment Point (ZMP) Overview,2D Analysis,3D Analysis, Measurement of ZMP, General Discussion- ZMP of Each Foot and Both Feet Contact, Dynamics of Humanoid Robots, Humanoid Robot Motion and Ground Reaction Force, momentum, Angular Momentum and Inertia tensor. **(15 Hours)**

BIPED WALKING AND PATTERN GENERATION
Two-Dimensional Walking Pattern Generation - Linear Inverted Pendulum Behavior, Orbital Energy, Support Leg Exchange, Planning a Simple Biped Gait, Extension to a Walk on Uneven Terrain. ZMP Based and offline Walking Pattern Generation, Cart-Table Model, Stabilizer, Principles of Stabilizing Control - Honda Humanoid Robot, Advanced Stabilizers.
(15 Hours)

Total hours:	**45**

Text Books:

1.	Dragomir N. Nenchev, Atsushi Konno, “Humanoid Robots Modeling and Control”, Butterworth Heinemann, 2019
2.	Shuuji K, Hirohisa H, Kensuke H, Kazuhito, Springer-Verlag GmbH”, Introduction to Humanoid Robotics”, Springer, London, 2014
3	J. Craig, "Introduction to Robotics: Mechanics and Control", Fourth Edition, Pearson, 2022

Reference Books:

1.	A. Goswami, P. Vadakkepat (Eds.), “Humanoid Robotics: A Reference”, Springer, Netherlands, Dordrecht, 2018
2.	J K. Harada, E. Yoshida, K. Yokoi (Eds.), “Motion Planning for Humanoid Robots”,Springer, London, 2010.
3	Harada, K., Roa, M.A. (2019). Manipulation and Task Execution by Humanoids. In: Goswami, A., Vadakkepat, P. (eds) Humanoid Robotics: A Reference. Springer, Dordrecht.2019

Web Resources:	
1	https://onlinecourses.nptel.ac.in/noc24_ge31/preview
2.	https://aimagazine.com/top10/top-10-humanoid-robots
3.	https://www.science.org/doi/10.1126/scirobotics.aar4043
4.	https://github.com/jonyzhang2023/awesome-humanoid-learning
5.	http://human-as-robot.github.io/

22MT911	ROBOTIC WELDING TECHNOLOGY	3/0/0/3

Nature of Course: Theory

Pre-requisites: Nil

Course Objectives:

1. To provide various welding techniques, automation principles, and robotic system integration.
2. To assess welding parameters, identify defects, and implement corrective actions to meet industry quality standards.
3. To equip the ability to set up, program, and operate robotic welding systems used in industrial applications

Course Outcomes:

Upon completion of the course, students shall have ability to

C911.1	Outline the principles of manual, automatic, and automated welding in various applications	[U]
C911.2	Identify key welding processes with power sources, electrodes, shielding gases, and process parameters for optimal performance.	[U]
C911.3	Describe the features, motions, and components of welding robots with e controllers	[U]
C911.4	Develop programming skills for robotic welding operations, including lead-through and simulation techniques	[AP]
C911.5	Employ the robots for real time industrial, automotive, aerospace and complex applications	[AP]

ROBOTIC WELDING PROCESS

Concept of manual, automatic and automated welding; Need for Welding Automation – merits, limitations, arc and work motion devices, Robotic part-holding positioners, Flexible automation of arc welding, remote welding. Review of welding process GTAW, GMAW – welding power sources, electrodes, shielding gases, process parameters, Hot wire, ATIG processes, synergic GMAW, CMT, Rapid Arc GMAW process - RSW – power sources, electrodes, process variables. **(15 Hours)**

WELDING ROBOTS AND SYSTEM

Types - features - Wrist motions - Specifying the welding Robot - controllers- major components, functions- Interfacing welding power source with robotic controller - Robotic welding system, Programmable and flexible control facility - Types - Flex Pendant - Lead through programming, Operating mode of robot, Jogging - Types, programming for robotic welding, simulation, sequences and Profile welding **(15 Hours)**

ROBOT APPLICATIONS

Robots for car body's welding - box fabrication - microelectronic welding and soldering - Applications in nuclear, aerospace and shipbuilding - case studies for simple and complex systems **(15 Hours)**

Total hours:	**45**

Text Books:

1.	Pires J N, Loureiro A, Bolmsjo G, "Welding Robots: Technology, System Issues and Application", 1st Edition Reprint, Springer, 2010.
2.	Shan-Ben Chen, Tzyh-Jong Tarn, Xiao-Qi Chen, "Robotic Welding, Intelligence and Automation", Springer International Publishing, 2015.

Reference Books:	
1.	Parmar R S, "Welding Processes and Technology", Khanna Publishers, New Delhi, 2012.
2.	Syed Quadir Moinuddin, Shaik Himam Saheb, Ashok Kumar Dewangan, Murali Mohan Cheepu, S. Balamurugan, “Automation in the Welding Industry: Incorporating Artificial Intelligence, Machine Learning and Other Technologies”, Scrivener Publishing, John Wiley & Sons, 2024.
Web Resources:	
1	https://archive.nptel.ac.in/courses/112/103/112103263/
2.	https://www.coursera.org/learn/fundamentals-of-robotics--industrial-automation
3.	https://www.saiw.co.za/saiw/welding-courses/practical-welding/robotic-welding/

22MT912	DIGITAL MANUFACTURING	3/0/0/3

Nature of Course: Theory

Pre requisites : -

Course Objectives:

1. To inculcate the importance of DM in Product Lifecycle and Supply chain Management.
2. To formulate IoT and smart manufacturing systems in the digital work environment
3. To elaborate the significance of the digital twin.

Course Outcomes:
Upon completion of the course, students shall have ability to

C912.1	Illustrate the knowledge to use various elements in the digital manufacturing.	[U]
C912.2	Differentiate product development life cycle and supply chain management in a digital environment.	[U]
C912.3	Select the proper digital procedure of validating practical work in factories.	[AP]
C912.4	Model the role of IoT in digital manufacturing.	[AP]
C912.5	Develop various practical manufacturing processes through digital twins.	[AP]

DIGITAL LIFE CYCLE

Overview and Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management. 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.

(15 Hours)

SMART FACTORY AND INDUSTRY 4.0

Smart Factory – Levels – Benefits – Technologies – Smart Factory in IoT- Key Principles – Creating a Smart Factory – Smart Factories and Cybersecurity - Industrial Internet of Things – Framework - Connectivity devices and services – Cyber physical systems- Cybersecurity Standards – Machine to Machine communication- Intelligent networks of manufacturing – Cloud computing – Data analytics

(15 Hours)

DIGITAL TWIN

Basic Concepts – Features and Implementation - Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins: Industrial Case study of Smart factory

(15 Hours)

Total hours: 45

Text Books:

1.	Chandrakant D. Patel and Chun-Hsien Chen, Digital Manufacturing: Key Elements of a Digital Factory,Elsevier - Health Sciences Division,2023
2.	Ronald R. Yager and Jordan Pascual Espada, “New Advances in the Internet of Things”, Springer,Switzerland, 2018.
3	Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2017

Reference Books:

1.	Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.
2.	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019.
3	Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital

	Manufacturing Science, Springer-Verlag London Limited, 2012.
Web Resources:	
1	https://onlinecourses.nptel.ac.in/noc21_mg83/preview
2.	https://www.coursera.org/learn/digital-twins
3.	https://www.classcentral.com/course/udemy-introduction-to-industry-50-405027

22MT915	AUTONOMOUS UNDERWATER VEHICLES	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1.	To learn about locomotion principles, kinematics of underwater robots.
2.	To familiarize the concept of selection of sensors for underwater robots.
3.	To learn about motion control methodology and robust feedback control design.

Course Outcomes:

Upon completion of the course, students shall have ability to

C915.1	Explain the principle of locomotion and describe different types of mobile robots.	[U]
C915.2	Associate the degree of freedom to maneuverability of various robots.	[A]
C915.3	Discuss the use of various sensors deployed in autonomous robots.	[U]
C915.4	Calculate motion path planning and its control for an autonomous robot.	[AP]
C915.5	Examine the various feedback control methods.	[AP]

INTRODUCTION AND KINEMATICS OF UNDERWATER VEHICLE

Principle of locomotion – types - Underwater robot and water-surface robot - principles of underwater vehicle construction - Equations for moving frame - rigid motion in a plane - representation of a rotated frame - holonomic and non-holonomic systems.

(15 Hours)

SENSORS FOR ROBOT NAVIGATION

Types of sensors - magnetic and optical position sensor - gyroscope - accelerometer - magnetic compass inclinometer - tactile and proximity sensor - ultrasound range finder - laser scanner, infrared range finder - visual and motion sensing systems.

(15 Hours)

PATH PLANNING, STABILITY AND FEEDBACK CONTROL

Path planning algorithms - collision-free path planning - sensor-based obstacle avoidance - motion control methods: kinematic control, dynamic control, controllability and stability about a point and trajectory - Based on kinematic model - Based on dynamic model -

(15 Hours)

Total hours: 45

Text Books:

1	Sabiha Wadoo, Pushkin Kachroo, Autonomous Underwater Vehicles, 1st Edition, CRC Press, 2011.
2	Yu Junzhi, Visual Perception and Control of Underwater Robots, 1st Edition, CRC Press, 2018.

Reference Books:

1	Nikolaus Correll, Introduction to Autonomous Robots, 1st edition, April 23, 2016
2	Gerald Cook, Feitian Zhang, Mobile Robots: Navigation, Control and Sensing, Surface Robots and AUVs, 2nd Edition, Wiley Publication, 2020.

Web Resources:

1	https://onlinecourses.nptel.ac.in/noc20_me03/preview
2	https://onlinecourses.nptel.ac.in/noc22_me38/preview

22MT920	INTELLIGENT PERCEPTION PLANNING IN CONTROL	3/0/0/3

Nature of Course: Theory

**Pre requisites : ** Nil

Course Objectives:

1. To get exposed to classical and convolutional neural networks and deep learning philosophy
2. To realize various convolutional neural network architectures that are applied for computer vision tasks
3. To provide the knowledge about the applications of reinforcement learning in planning and control tasks

Course Outcomes:

Upon completion of the course, students shall have ability to

C939.1	Illustrate various terminologies and concepts in artificial intelligence and machine learning	[U]
C939.2	Examine the mathematical basics of neuro fuzzy logic and apply fuzzy logic problems to robotics applications	[A]
C939.3	Express the concepts of classical and convolutional neural networks	[AP]
C939.4	Utilize the convolutional neural network architectures to various perception tasks	[AP]
C939.5	Describe the applications of reinforcement learning for planning and control tasks	[U]

NEURO-FUZZY SYSTEMS

Introduction to fuzzy logic -- Fuzzy set theory, properties of fuzzy sets and their operations - Fuzzy composition - Numerical examples - Membership functions - Fuzzy rule generation - Fuzzification and defuzzification - Fuzzy inference system -Introduction to neuro-fuzzy system - Architecture of neuro-fuzzy networks - Classical neural networks vs. deep learning - Convolutional neural networks - Activation functions - Optimization techniques - Deep learning hardware. **(15 Hours)**

CNN FOR PERCEPTION

Image classification - LeNet, AlexNet, ResNet, and Inception architectures - Object detection - RCNN and YOLO architectures - Semantic and instance segmentation - Panoptic segmentation - Visual racking. **(15 Hours)**

PLANNING AND CONTROL

Markov decision process - Deep reinforcement learning - POMDP - Deep-Q learning - Curriculum learning - Proximal policy optimization - Deep reinforcement learning in planning and control of autonomous ground robots and aerial robots: implementation in end-to-end decomposition manner

(15 Hours)

Total hours: 45

Text Books:

1.	J Bruno Siciliano, Oussama Khatib, "Handbook of Robotics", 2ndEdition, Springer, 2016.
2.	Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", 1st Edition, MIT Press, 2016

Reference Books:	
1.	Simon Haykin, "Neural Networks and Learning Machines: A Comprehensive Foundation", 3rd Edition, Pearson, 2011.
2.	Timothy J Ross, "Fuzzy Logic with Engineering Applications", 3rdEdition, Wiley, 2011.
Web Resources:	
1	https://aitskadapa.ac.in/e-books/AI&ML/MACHINE
2.	https://arxiv.org/pdf/2209.07042
3.	https://errin.eu/calls/ai-advanced-and-collective-perception-and-decision-making-ccam-applications-ccam-partnership

22MT922	INTELLIGENT CONTROL SYSTEM	3/0/0/3
Nature of Course	: Theory	
Pre Requisites	: Nil	

Course Objective:

1.	To understand the concepts of fuzzy logic and neural networks
2.	To apply proper tools for various systems
3.	To impart the knowledge of Genetic algorithm

Course Outcomes:
Upon completion of the course, students shall have ability to

C922.1	Outline the concepts of neural networks and fuzzy logic	[U]
C922.2	Apply the fuzzy logic techniques and neural networks for various applications	[AP]
C922.3	Illustrate the adaptive neuro fuzzy system	[U]
C922.4	Interpret the basic concepts of Genetic Algorithm	[U]
C922.5	Model the various applications of Genetic Algorithm	[AP]

CONCEPTS OF NEURAL NETWORKS

Introduction to Intelligence systems – Basic Concepts of Neural Networks, Human Brain, Model of an Artificial Neuron, Architectures and Characteristics of Neural Networks, Types of Learning Methods, Back Propagation Learning and Algorithms. ANN based face and fingerprint recognition system-ANN based Perception, Planning, and Control for Automated Vehicles.

(15 Hours)

FUNDAMENTALS OF FUZZY LOGIC AND CONTROL

Basic concepts of Fuzzy logic -Membership functions, Fuzzy rules– Mamdani model and Takagi Sugeno kang model, Defuzzification methods. Auto tuning of PID Controller using Fuzzy logic - Fuzzy logic control: Mobile autonomous robot system- Fuzzy Logic based Mobile robot navigation- Application of Adaptive Neuro-Fuzzy Inference Systems to Robotics.

(15 Hours)

GENETIC ALGORITHM

Biological Background, Genetic algorithm vs. traditional algorithms- Basic Terminologies- Simple Genetic Algorithm (GA) - operators - problem solving using GA- Schema Theorem, Classification-Holland classifier systems--Fuzzy Systems for Control of Flexible Robots - Introduction to swarm intelligence and particle swarm optimization. **(15 Hours)**

45

Text Books:

1.	Saroj Kaushik, Sunita Tiwari, Saroj Kaushik, Sunita Tiwari, “Soft Computing: Fundamentals, Techniques and Applications”, McGraw-Hill Education,2018
2.	S. N. Sivanandam,S. N. Deepa, “Principles of Soft Computing”, 3rd Edition, Wiley,January 2018

Reference Books:

1	S. Rajasekaran, G.A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Applications”, 5th Edition, PHI, 2017.
2	Behera, L., Kumar, S., Patchaikani, P. K., Nair, R. R., & Dutta, S. “Intelligent control of robotic systems” CRC Press,2020

Web References:

1	https://nptel.ac.in/courses/106105173/
2	https://archive.nptel.ac.in/courses/127/105/127105006/
3.	https://www.intechopen.com/books/fuzzy-inference-system-theory-and-applications/fuzzy-logic-controller-for-mechatronics-and-automation
4.	https://arxiv.org/pdf/2209.07042

22MT924	COMPUTER VISION AND DEEP LEARNING		3/0/0/3
Nature of Course: Theory			
Pre requisites : Nil			
Course Objectives:			
1. To recall the basic concepts of image formation and camera modelling. 2. To interpret 3D structure and motion features for computer vision applications. 3. To examine the fundamentals of neural networks and deep learning in application to computer vision.			
Course Outcomes: **Upon completion of the course, students shall have ability to**			
C924.1	Illustrate the fundamentals of image formation, projective geometry, and camera calibration techniques.		[U]
C924.2	Explain the 3D structure and motion for a computer vision application.		[U]
C924.3	Interpret LIDAR features and develop solutions using Visual SLAM, Kalman Filtering and visual servoing for robotic vision.		[U]
C924.4	Apply the neural networks and deep learning techniques.		[AP]
C924.5	Model the deep learning CNN architecture for computer vision.		[AP]
VISION AND CALIBRATION Terminologies of Vision Fields, Comparison of Biological and Computer Vision, Projective Geometry Basics, Modelling of Geometric Image Formation, Modelling of Camera Distortion, Camera Calibration, Methods of Camera Calibration, Estimation of Projection Matrix, Experimental performance assessment in Computer Vision. **(15 Hours)** **3D STRUCTURE AND MOTION** Computational Stereopsis – Geometry, Parameters – Correspondence Problem, Visual motion, 3D Structure and Motion from Sparse and Dense Motion Fields – Motion Based Segmentation – Image Processing. LIDAR - Construction, Working Principle, Specifications and Selection Criteria. Point Cloud Data Processing. Visual Tracking – Kalman Filtering – Visual SLAM, Solutions, Visual Servoing, Types and Architecture. **(15 Hours)** **DEEP LEARNING** Types of Neural Networks- Back propagation- Multilayer Perceptron- Conventional Neural Networks vs. Deep Learning in the Context of Computer Vision, Convolutional Neural Networks, Deep Learning Hardware, Tuning Neural Networks, Best Practices, Training Neural Networks, Update Rules, Ensembles, Data Augmentation, Transfer Learning, Popular CNN Architectures-Image Classification, Object Detection, Segmentation, Deep Learning frameworks. **(15 Hours)**			
		Total hours:	**45**

Text Books:	
1.	Boguslaw Cyganek, J. Paul Siebert, “An Introduction to 3D Computer Vision Techniques and Algorithms”, 2nd edition, John Willey, 2017.
2.	Ian Goodfellow and YoshuaBengio and Aaron Courville, “Deep Learning”, First Edition, MIT Press, 2018.
3.	Rajalingappaa Shanmugaman,” Deep Learning for Computer Vision” Packt Publishing Ltd ,first edition 2018
Reference Books:	

1.	Davies E.R, “Computer and Machine Vision: Theory, Algorithm, Practicalities”, 4th edition Academic Press, Elsevier, Waltham 2012.
2.	Forsyth and Ponce, “Computer Vision: A Modern Approach”, 2nd edition Pearson, Harlow Uk 2015.
3.	Nielsen, Michael A. Neural networks and deep learning. San Francisco, CA, USA: Determination press, 2015
Web Resources:	
1	https://onlinecourses.nptel.ac.in/noc21_cs93/preview
2.	https://www.coursera.org/specializations/deep-learning-computer-vision
3.	https://www.coursera.org/learn/introduction-computer-vision-watson-opencv

22MT925	EMBEDDED SYSTEM FOR AUTOMATION	3/0/0/3

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1. To understand the basic concept of Embedded systems.
2. To know about the working principles of buses and devices for Embedded networking
3. To study the concept of Real time operating systems.

Course Outcomes:

Upon completion of the course, students shall have ability to

C925.1	Describe the Embedded system hardware and its software	[U]
C925.2	Explain Devices and Buses used in Embedded networking	[U]
C925.3	Apply task synchronization using Inter Process communication and develop programs using Embedded C	[AP]
C925.4	Illustrate knowledge on various Real Time Operating Systems	[U]
C925.5	Model embedded system in various applications	[AP]

ESSENTIALS OF EMBEDDED SYSTEMS

Introduction to embedded systems - Hardware and software in a system, Structural Units of advanced processor, Selection of Processors, System on Chip- I/O Devices- Timer and counting devices, Serial Communication Buses: USB, I2C, CAN Bus. **(15 Hours)**

EMBEDDED PROGRAMMING

Programming in C- Header, Source Files, Preprocessor Directives, Macros, Functions, Data types, Queue, Stacks, Loops, Pointers - Processes, Tasks and Task scheduler, Task synchronization using Inter Process communication, Priority inversion, Embedded C Program for 7 segment display, Timer/Counter Calculations in 8051. **(15 Hours)**

REAL TIME OPERATING SYSTEM

MicroC/OS-II, VxWorks, Basics of Embedded Linux: Architecture of Embedded Linux, Hardware Abstraction Layer (HAL), Cross compilation tool chain – Boot loaders, Board Support Package, Case studies: Embedded system in Adaptive Cruise Control Systems in a Car, ATM Machine, Home Automation. **(15 Hours)**

Total hours: 45

Text Books:

1	Rajkamal, “Embedded Systems Architecture, Programming and Design”, TATA McGraw-Hill, Third Edition, 2017.
2	Marilyn Wolf, "Computers as Components: Principles of Embedded Computer Systems Design, Elsevier Publications, Fourth Edition, 2017.

Reference Books:

1	David E Simon, ― An Embedded Software Primer‖, Pearson Education India, New Delhi, 2013.
2	Neelakandan, S., Raghavan, P., Lad, A, “Embedded Linux System Design and Development” CRC Press, 2019.

Web Resources:

1	https://www.elprocus.com/basics-and-structure-of-embedded-c-program-with-examples-for-beginners/
2	https://nptel.ac.in/courses/108/102/108102045/
3	https://microcontrollerslab.com/embedded-linux/
4	https://www.embedded.com/home-automation-system-design-the-basics/

22MT926	ROBOTIC PROCESS AUTOMATION	3/0/0/3

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1.	To understand the basics of automation process and RPA and the different variables used in automation
2.	To know the advanced automation techniques and to handle user events and exceptions in robotic automation process
3.	To acquaint deploying and maintenance of BOTs

Course Outcomes:
Upon completion of the course, students shall have ability to

C926.1	Illustrate RPA, its applications and implementations	[U]
C926.2	Outline the different types of variables, Control Flow and data manipulation techniques	[U]
C926.3	Identify and understand Image, Text and Data Tables Automation	[A]
C926.4	Develop concepts to handle the User Events and various types of Exceptions and strategies	[AP]
C926.5	Model the Deployment of the Robot	[AP]

Course Contents:

RPA BASICS AND TOOL INTRODUCTION

Scope and techniques of automation - Robotic process automation (RPA) - Benefits - Components - platforms - RPA vs Automation - Processes and Flowcharts - Programming Constructs - Processes Automation - Types of Bots - Workloads. RPA Tool -User Interface - Managing Variables and types - Managing Arguments and panels - Importing New Namespaces- Control Flow Introduction - If-else Statements - Loops - Advanced Control Flow - Sequences - Flowcharts -Activities **(15 Hours)**

ADVANCED AUTOMATION CONCEPTS AND TECHNIQUES

Recording Introduction - Basic and Desktop Recording - Web Recording - Input / Output Methods - Screen Scraping - Data Scraping - Scraping advanced techniques - Selectors - Defining and Assessing Selectors - Customization - Debugging - Dynamic Selectors - Partial Selectors - RPA Challenge - Image, Text & Advanced Citrix Automation - Introduction to Image & Text Automation - Image based automation **(15 Hours)**

TRIGGERS AND SERVERS

Assistant bots - Monitoring system event triggers - Hotkey trigger - Mouse trigger - System trigger - Monitoring image and element triggers - monitoring email - copying event and blocking - Launching an assistant bot on a keyboard event. Publishing using publish utility - Creation of Server - bot control and robot creation using server - Managing, uploading and deleting. **(15 Hours)**

Total hours: 45

Text Books:

1	Alok Mani Tripathi, “Learning Robotic Process Automation”, Packt Publishing, 2018.
2	The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems Paperback – 29 February 2020, by Tom Taulli.

Reference Books:

1	Richard Murdoch, Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant”, Independently Published, 1st Edition 2018

2	Srikanth Merianda, Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation", Consulting Opportunity Holdings LLC, 1st Edition 2018.
Web Resources:	
1	https://ace.nus.edu.sg/pc/professional-certificate-in-robotic-process-automation/
2	https://www.coursera.org/specializations/roboticprocessautomation
3	https://www.udemy.com/course/robotic-process-automation/?couponCode=IND21PM
4	https://www.uipath.com/rpa/academy

22MT927	INDUSTRIAL NETWORKING	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1.	To know the basic knowledge about networking in industries
2.	To understand the evolution of computer networks using the layered network architecture
3.	To understand the concepts of data communications

Course Outcomes:

Upon completion of the course, students shall have ability to

C927.1	Apply the concepts of data communications and to design computer networks using subnetting and routing concepts	[AP]
C927.2	Compare the various medium access control techniques	[U]
C927.3	Illustrate the characteristics of physical layer	[U]
C927.4	Analyze the different protocols	[AN]
C927.5	Select different network components for appropriate applications	[AP]

Course Contents:

INSTRUMENTATION SYSTEM

Modern instrumentation and control systems – Terminology – Topology – Mechanisms - Protocols – Standards – Common problems and solutions – Grounding/shielding and noise - EIA-232 interface standard – EIA-485 interface standard – Current loop and EIA-485 converters - Fiber optic cable components and parameters – Basic cable types – Connection fibers – Troubleshooting.

(15 Hours)

COMMUNICATION PROTOCOLS

Overview – Protocol structure – Function codes – Modbus plus protocol –Data Highway – AS interface (AS-i)-Device Net: Physical layer – Topology – Device taps –Profibus PA/DP/FMS: Protocol stack – System operation. Field Bus, CAN BUS: Concepts of bus access and arbitration – CAN: Protocol-Errors: Properties – Detection – processing – Introduction to CAN 2.0B. Radio spectrum – Frequency allocation – Radio modem – Intermodulation – Implementing a radio link – RFID: Basic principles of radio frequency identification – Transponders – Interrogators, Wireless HART, Wireless Networking – Evolution, Types, Design Considerations, Network Security, Protocol and Standards.

(15 Hours)

NETWORK PROTOCOLS

IEEE 802.3 – Physical layer - Medium access control – Collisions - Ethernet design rules - Fast and gigbit Ethernet systems - design considerations - Internet layer protocol - UDP - TCP/IP - ProfiNet - LAN system components – Structured cabling – Industrial Ethernet – Troubleshooting Ethernet. Automotive communication technologies – Design of automotive X-by-Wire systems, - The LIN standard – The IEC/IEEE Train communication network: Applying train communication network for data communications in electrical substations.

(15 Hours)

45

Text Books:

1	Steve Mackay, Edwin Wright, Deon Reynders and John Park, “Practical Industrial Data Networks: Design, Installation and Troubleshooting”, Newnes (Elsevier), 2014
2	Dominique Paret, “Multiplexed Networks for Embedded Systems”, John Wiley & Sons, 2007
3	Richard Zurawski, “The Industrial Communication Technology Handbook-Ⅱ”, Taylor and

	Francis, 2005.
Reference Books:	
1	Deon Reynders and Edwin Wright, ―Practical TCP/IP and Ethernet Networking, IDC Technologies, 2016.
2	James Powell, Henry Vandelinde, ―Catching the Process Fieldbus an Introduction to PROFIBUS for Process Automation", Momentum Press, 2013
3	Albert Lozano-Nieto, ―RFID Design Fundamentals and Applications‖, CRC Press, 2011.
Web Resources:	
1	https://study.com/academy/lesson/industrial-networks-definition-types-examples.html
2	https://www.rockwellautomation.com/en-in/capabilities/industrial-networks.html
3	https://www.controleng.com/industrial-networking-101-everything-you-need-to-know/
4	https://www.renesas.com/en/blogs/evolution-industrial-networking-and-best-practices?srsltid=AfmBOookLCxjoGlCMQbmLepn2D3sw6H7oI3O5dcZiy2oWSEjumXwaJ7e

22MT928	VIRTUAL INSTRUMENTATION AND ITS APPLICATIONS	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1. To familiarize the basics of Virtual Instruments
2. To implement basic programming concepts in LabVIEW
3. To understand various interfacing buses

Course Outcomes:

Upon completion of the course, students shall have the ability to

C928.1	Explain basic concepts of Virtual Instruments	[U]
C928.2	Develop the programming concepts using LabVIEW	[AP]
C928.3	Identify suitable interfacing buses and acquire real time data	[U]
C9284	Apply Virtual Instrumentation concepts for various applications	[AP]
C928.5	Infer the operation of my RIO	[U]

Course Contents:

VIRTUAL INSTRUMENTATION AND LABVIEW

Introduction to Virtual Instrumentation - Block diagram of Virtual Instrumentation – Graphical and data flow programming, comparison with conventional programming - Introduction to LabVIEW – Programming concepts: Loops, arrays, Cluster, Plotting data, Structures, Strings and File IO.
(15 Hours)

COMPONENTS OF DATA ACQUISITION SYSTEM

Introduction to data acquisition on PC, Sampling fundamentals, ADCs, DACs, Calibration, Resolution, - analog inputs and outputs - Single-ended and differential inputs - Digital I/O, counters and timers, DMA, Data acquisition: Issues involved in selection of cards - Use of timer-counter and analog outputs, Components, Bus, Signal and accuracy consideration hardware – Measurement of analog signal with Finite and continuous buffered acquisition- analog output generation – Signal conditioning systems – Synchronizing measurements in single & multiple Devices. **(15 Hours)**

APPLICATIONS

Hardware in the Loop (HIL) – Image acquisition and processing- Motion control – Graphical system design application for Material handling system and Plastic Injection Molding System, Data logging and Supervisory Control-Introduction to my RIO - Autonomous Robotics using NI My RIO-Introduction to LabVIEW Robotics Module-IoT Remote Monitoring and Control with LabVIEW.
(15 Hours)

Total hours: 45

Text Books:

1	Jovitha Jerome, “Virtual Instrumentation using LabVIEW”, PHI Learning Private Limited, 2012.
2	Richard Jennings, “LabVIEW Graphical Programming” Fifth Edition, McGraw-Hill Education 2019.

Reference Books:

1	S. Sumathi and P. Surekha, “LabVIEW based Advanced Instrumentation Systems” Springer-Verlag Berlin Heidelberg, 2011.
2	Rick Bitter, Taqi Mohiuddin, Matt Nawrocki, “LabView Advanced Programming Techniques”, Second Edition, CRC Press, 2017.

Web Resources:

1	http://www.ni.com
2	https://onlinecourses.swayam2.ac.in/nou23_bt05/preview
3	https://nptel.ac.in/courses/108105064

22MT933	NAVIGATION AND COMMUNICATION SYSTEM	3/0/0/3

Nature of Course: Theory

Pre requisites : -

Course Objectives:

1. To explain the relationship between autonomy, sensing, navigation and control on an unmanned marine subsea vehicle.
2. To apply the concepts of various types of navigational equipment & sensors.
3. To recall the basic communication methods and signal losses, attenuation

Course Outcomes:

Upon completion of the course, students shall have ability to

C933.1	Outline the basics of Underwater Navigation System.	[U]
C933.2	Illustrate the Inertial Navigation System and sensors.	[U]
C933.3	Examine the integration of navigation system for manned and unmanned underwater vehicles	[A]
C933.4	Analyze Satellite navigation and global positioning system	[A]
C933.5	Interpret the deep space networks and inter planetary missions	[U]

NAVIGATION AND GLOBAL POSITIONING SYSTEM

Radio and Satellite Navigation- overview- GPS Principles, Signal model and Codes, Satellite Signal Acquisition, Mathematical model of GPS observables, Methods of processing GPS data, GPS Receiver Operation and Differential GPS. IRNSS, GAGAN, GLONASS and Galileo.

(15 Hours)

SATELLITE COMMUNICATION

IPv6 - Overview, Migration and Coexistence, Implementation scenarios and support, Preparations, Satellite specific Protocol issues – Impact of IPv6 on Satellite Network architecture and services Detailed transition plan- IPv6 demonstration over satellites - Key results and recommendations.

(15 Hours)

BASICS OF UNDERWATER COMMUNICATION

Introduction to underwater acoustics - Thermoclines in Ocean Waters, subsea communication sensors, Instruments and applications, Sound propagation in the ocean – Sound Velocity Profiles (SVP) in the deep water and shallow water; Sound attenuation in the sea – absorption, scattering, transmission loss, reverberation, Snell's law, target strength; Laser communication and limitations.

(15 Hours)

	45

Text Books:	
1.	L.M.Brekhovskikh and Yu. P. Lysano "Fundamentals of ocean acoustics" New Age International Publisher, New Delhi, 2022
2.	Hofmann-Wellenhof B., Lichtenegger H., and Elmar Wasle, "Global Navigational Satellite Systems" Springer-Verlag, 2023.
Reference Books:	
1.	Daniel Minoli' "Innovations in Satellite Communication and Satellite Technology" Wiley, 2022.
2.	Jim Taylor, "Deep Space Communications" John Wiley & Sons, 2022.
Web Resources:	
1	https://nptel.ac.in/courses/107106081
2.	https://www.isro.gov.in/pslv-c25-mars-orbiter-mission

3.	https://www.adityabooks.in/details/aircraft-communications-navigation-systems-/1824

	UNMANNED AERIAL VEHICLES	**3/0/0/3**

22MT934		

Nature of Course : Theory
Pre requisites :Nil

Course Objectives:

1. To learn the major subsystems and the fundamental design concepts of Unmanned Air Vehicle
2. To learn the important design concepts like reliability, stealth, and maintenance of UAV
3. To know the various communication media, navigation systems, control, and stability of UAVs
4. To learn the development, testing, certification, and deployment of UAV

Course Outcomes:
Upon completion of the course, students shall have ability to

C934.1	Infer the knowledge of performance characteristics of UAV systems	[U]
C934.2	Illustrate the basic aerodynamics and structures concepts for the design of UAV	[R]
C934.3	Discover the applications of UAV	[AP]
C934.4	Identify the appropriate communication and navigation systems for the UAVs as per the role requirements	[A]
C934.5	Build the different techniques used to achieve the control and stability of UAV systems	[AP]

UNMANNED AERIAL VEHICLES AND APPLICATIONS

Introduction - History of Unmanned Aerial Vehicles (UAV) –Models and prototypes – Classes and Missions of UAVs- Performance of Air vehicle - Drones: Types and Characteristics-Applications of UAV: Agriculture- Surveillance - Remote sensing. **(15 Hours)**

AERODYNAMICS PRINCIPLES

Aerodynamics: Structures and mechanisms - Lift-induced Drag - Parasitic Drag- Rotary-wing aerodynamics; Response to air turbulence- Airframe configurations scale Effects-Packaging Density- - Propulsion System-Modular Construction-Ancillary equipment. **(15 Hours)**

COMMUNICATION DEVICES

Communications-Media-Radio Communication-Mid-Air Collision Avoidance - Control and Stability: HTOL Aircraft-Helicopters- Air Vehicle and Payload Control- Planning and Navigation: Global Positioning System (GPS)- vertical take-off and landing (VTOL) UAV-Sensors: Airspeed Sensor-Attitude Sensors-Imaging Sensors-Meteorological Sensors. **(15 Hours)**

Total hours:	**45**

Text Books:

1	Paul Gerin Fahlstrom & Thomas James Gleason, Introduction To UAV Systems, A John Wiley & Sons, Ltd., Publication, United Kingdom,2012.
2	Reg Austin., Unmanned Aircraft Systems, John Wiley and Sons., 2010.

Reference Books:

1	Richard K. Barnhart, Stephen B. Hottman, Douglas M. Marshall, Eric Shappee, (eds.), Introduction to Unmanned Aircraft Systemsǁ, CRC Press, 2012.
2	Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing,2016.

Web Resources:

1	https://nptel.ac.in/courses/101104073
2	http://ardupilot.org/copter/docs/advanced-multicopter-design.html

3	https://www.dronezon.com/learn-about-drones-quadcopters/

22MT935	AIRCRAFT STABILITY AND CONTROL	3/0/0/3
Nature of Course: Theory		
Pre requisites : Nil		

Course Objectives:

1. To introduce the concept of stability and control of Aircraft
2. To impart knowledge about various Aircraft motions and related stability.
3. To learn the concept of dynamic stability of Aircraft.

Course Outcomes:
Upon completion of the course, students shall have ability to

C935.1	Describe the degree of freedom and static stability of aircraft system.	[U]
C935.2	Express the dynamic longitudinal stability of aircraft.	[U]
C935.3	Illustrate the stability of aircraft using dynamic analysis	[AP]
C935.4	Identify the requirement of control force and power plant.	[A]
C935.5	Analyze the motion of unstable aircraft and related modes of instability.	[A]

STATIC LONGITUDINAL STABILITY

Degrees of Freedom of a system, Basic equations of motion- Wing and tail contribution; Effects of Fuselage and nacelles- Stick fixed neutral points- Power effects - Jet driven airplane and Propeller driven airplane, Elevator Requirements. Basic equations of motion Elevator hinge moment and estimation - Stick Force gradients and per g load - Stick free Static Longitudinal Stability: Trim Taps, Neutral Point.

(15 Hours)

DIRECTIONAL AND LATERAL STABILITY

Stick fixed Directional Stability- Contribution of wing –Fuselage – Vertical tail- Propeller, Directional control- Adverse yaw, one engine In-operative Conditions, Cross wind Landing, Spin recovery- Rudder effectiveness- Rudder Lock –Dorsal Fins- Stick Free Directional Stability. Dihedral Effect- Criterion for stabilizing dihedral effect -Selection of dihedral angle - Contribution of wing –Fuselage –Vertical tail- Propeller and Flaps- Rolling moment and its convention; Lateral Control- Aileron effectiveness, Aileron control force requirements, Aerodynamic Balancing.

(15 Hours)

DYNAMIC LONGITUDINAL STABILITY

Stick fixed and stick free, stability derivatives, Phugoid and short period, Longitudinal Dynamic Stability - Lateral Dynamic Stability- Aileron fixed and free, Routh’s discriminant, Dutch roll and Spiral instability, Auto rotation and Spin recovery

(15 Hours)

Total hours:	**45**

Text Books:

1.	Perkins C. D, Robert Hage E (2010), Airplane Performance, Stability and Control, Wiley Toppan.
2.	Nelson R. C (2014), Flight Stability and Automatic Control, SIE edition, McGraw Hill, New York.

Reference Books:

1.	J D Anderson, “Aircraft performance and Design”, McGraw-Hill, New York, 2000.
2.	Etkin, B., “Dynamics of Flight Stability and Control”, John Wiley, New York, 1995

Web Resources:

1	https://nptel.ac.in/courses/101106042
2.	https://nptel.ac.in/courses/101106043
3.	https://ocw.mit.edu/courses/16-333-aircraft-stability-and-control-fall-2004/

22MT936	AIRCRAFT MECHATRONICS		3/0/0/3
Nature of Course: Theory			
Pre requisites : 22MT301 CONTROL SYSTEMS			
Course Objectives:			
COURSE OBJECTIVES: 1. To impart knowledge about the avionic architecture and various avionics data bases 2. To impart knowledge on aircraft materials 3. To analyse the application of Mechatronics in aircraft.			
Course Outcomes: **Upon completion of the course, students shall have ability to**			
C936.1	To understand the fundamental aerodynamic concepts, including lift, drag, and moments acting on an aircraft.		[U]
C936.2	Calculate and interpret aerodynamic performance parameters such as lift-to-drag ratio (L/D), drag polar, and high lift device performance.		[AP]
C936.3	Apply theoretical concepts to assess structural integrity, predict failure modes, and suggest improvements in material selection or design.		[AP]
C936.4	Evaluate the strength-to-weight ratio and mechanical properties of materials to make appropriate material choices for different aircraft components		[A]
C936.5	Analyze the operation and advantages of modern control systems such as Fly-By-Wire (FBW), Yaw Dampers, and Actuator Drive Units in ensuring safe and efficient flight.		[A]

AIRCRAFT AERODYNAMICS

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. Brief description of thermo dynamics of engines - Piston engines, Jet engines.

(15 Hours)

AIRCRAFT MATERIALS

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. 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. **(15 Hours)**

PRIMARY FLIGHT CONTROLS

Ailerons - Aileron Control System of a Commercial Aircraft - Elevators - Elevator control system of a commercial aircraft – Rudders- Rudder Control System. 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. **(15 Hours)**

Total hours:	**45**

Text Books:	
1.	Fundamentals of Flight; By Dr. O. P. Sharma and Lalit Gupta.2020
2.	Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc.2019
Reference Books:	

1.	Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 2018.
2.	Pallet. E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2019
Web Resources:	
1	https://onlinecourses.nptel.ac.in/noc23_ae15/preview
2.	https://www.coursera.org/courses?query=aerospace

22MT937	INTRODUCTION TO MARINE AND AERIAL ROBOTICS	3/0/0/3

Nature of Course: Theory

Pre requisites : Nil

Course Objectives:

1. To introduce the basic principles and the key elements of marine and aerial robot components.
2. To acquire Knowledge about the various categories of marine and aerial robots.
3. To gain Knowledge on the various navigation control systems.

Course Outcomes:

Upon completion of the course, students shall have ability to

C937.1	Describe the basic concepts of the marine and aerial robots.	[U]
C937.2	Discover the proper selection of robots for the specific marine application.	[U]
C937.3	Explain the basic principle of operation on aerial robots on its autonomous function.	[U]
C937.4	Predict the navigation systems for the path trajectory detection.	[AP]
C937.5	Discover the appropriate selection of control system on aerial robots.	[U]

INTRODUCTION TO MARINE AND AERIAL ROBOTS

Overview of a Robot - marine robotics and robotic configurations - Key components - Navigation and positioning - Sensors - Power systems - Communication - Types of marine robots - Systems & subsystems - Hydrostatics, Buoyancy and Stability of marine robots - Aerial robotics System & configuration - Core Components of Aerial Robots - Flight Controller

(15 Hours)

MARINE ROBOTICS AND CONTROL

Marine Robots - Remotely Operated Vehicles (ROVs) - Autonomous Underwater Vehicles (AUVs) - Hybrid ROVs/AUVs (HROVs) - Gliders - Micro/Mini ROVs/AUVs - Work-Class ROVs - Inspection-Class ROVs - AUV Size Classes) - Remote Control Assisted Control - Supervised Autonomy - Conditional Autonomy - High Autonomy - Full Autonomy

(15 Hours)

AERIAL ROBOTICS AND CONTROL

Aerial Robots - Multi-rotor - Fixed-wing - Single Rotor Helicopter - Hybrid VTOL - Remotely Piloted - Semi-Autonomous - Fully Autonomous – Swarming -Manipulation - Interaction guidance - navigation - control - mission control systems - Algorithms for simultaneous - localization and mapping (SLAM) - fault detection/tolerance systems - Maneuver and control of aerial robot at constant altitude - Inertial Navigation System - INS drift - Magnetometer - Barometer - Global Positioning System.

(15 Hours)

Total hours:	**45**

Text Books:

1	Daniel Tal, John Altschuld “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, John Wiley & Sons, Inc, 2021.
2	Anibal Ollero, Bruno Siciliano, “Aerial Robotic Manipulation: Research, Development and Applications”, Springer International Publishing, 2019.

3	Ikuo Yamamoto, “Practical Robotics and Mechatronics: Marine, Space and Medical Applications”, The Institution of Engineering and Technology, 2016.
Reference Books:	
1.	Steven W. Moore, Harry Bohm, Vickie Jensen, “Underwater Robotics : Science, Design and Fabrication”, Marine Advanced Technology Edu, 2010
2.	Yasmina Bestaoui Sebbane, “A First Course in Aerial Robots and Drones”, CRC Press, 2022.
3.	Luc Jaulin,Andrea Caiti , “Marine Robotics and Applications”, Springer International Publishing, 2018.
Web Resources:	
1	https://archive.nptel.ac.in/courses/112/105/112105249/
2.	https://www.maritimerobotics.com/
3.	https://www.ieee-ras.org/marine-robotics
4	https://www.environmental-robotics.com/aerial-robotics/

22MT938	ROBOT MOTION PLANNING	3/0/0/3
Nature of Course: Theory		
Pre requisites : -		
Course Objectives:		
1. To educate on the concepts of motion planning and collision avoidance algorithm 2. To introduce the concepts of localization and trajectory planning 3. To impart concept about navigating different types of robots		
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C938.1	Illustrate the basic concepts of motion and path planning, and algorithms	[AP]
C938.2	Summarize the localization and trajectories planning	[AP]
C938.3	Employ the Kalman filter for localization	[AP]
C938.4	Identify the appropriate navigation architecture for various robots.	[A]
C938.5	Devise the suitable algorithm and path smoothing technique for effective control.	[A]

MOTION AND PATH PLANNING

Overview of motion planning- Key issues of Locomotion-Leg configuration and stability- Specifying a Robot Configuration- Topology of the Configuration spaces - Bug Algorithms- Navigation-Potential Functions- Sphere to space- Star to space - Obstacles and Configuration space for Circular Mobile robot and Two Joint Planar arm- Collision avoidance algorithms **-** Path Planning for Articulated Bodies- Case study: Wheeled locomotion

(15 Hours)

LOCALIZATION AND TRAJECTORY PLANNING

Introduction to localization, Localization challenges - Belief and Map representations - Types, trade-offs -Introduction to Kalman filtering and Derivation of Kalman gain - Kalman Filter for localization and Sensor fusion - Particle Filter Based Localization - Joint Space Trajectories- Motion Through a Sequence of Points-Operational Space Trajectories

(15 Hours)

NAVIGATION ARCHITECTURES

Robot Motion-Smoothing Algorithm, Path Smoothing - Competences for Navigation: Planning and Reacting -Modularity for code reuse and sharing -Control localization -Techniques for decomposition -Case studies: tiered robot architectures-PID Tuning for autonomous mobile- - Go-goal Controller - Cruise Controller **(15 Hours)**

Total hours:	**45**

Text Books:	
1.	Bruno Siciliano , Giuseppe Oriolo , Lorenzo Sciavicco and Luigi Villani “Robotics: Modelling, Planning and Control”, Springer, London, 2010.
2.	George A. Kantor , Howie Choset , Kevin M. Lynch , Lydia E. Kavraki, Sebastian Thrun, Seth Hutchinson, Wolfram Burgard “Principles of Robot Motion: Theory, Algorithms, and Implementations “, Bradford Books ,2005.
Reference Books:	
1.	Siegwart, Nourbakhsh, “Introduction to Autonomous Mobile Robots”, 2nd Edition, MIT Press, 2011.
2.	Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012.
Web Resources:	
1	https://nptel.ac.in/courses/106105159
2.	https://www.classcentral.com/course/modernrobotics-course1-10632
3.	https://www.coursera.org/learn/robotic-path-planning-task-execution

22MT939	ROBOT CONTROL	3/0/0/3

Nature of Course: Theory

Pre requisites : Nil

Course Objectives:

1. To explore the general industrial manipulator control problem and to provide knowledge on various position control strategies.
2. To impart the concept and strategy of force control in manipulators
3. To introduce various adaptive control strategy applied to industrial manipulators

Course Outcomes:

Upon completion of the course, students shall have ability to

C939.1	Illustrate the various control architecture used in industrial manipulator	[U]
C939.2	Elaborate the various position control strategies applied for the manipulator	[U]
C939.3	Employ the various force control strategies applied for the manipulator	[AP]
C939.4	Apply the concept of adaptive controllers to manipulator robots	[AP]
C939.5	Illustrate the various applications of control strategy for robots	[U]

MANIPULATOR CONTROL

General manipulator control system architecture , Manipulator control problem , Joint space and task space control , Task space and joint space mapping -Linear and nonlinear control, Linear control schemes , Second-order system and its characteristics, Position Regulation of second order system, SISO and MIMO systems , Continuous and discrete time control, Sampling and sample rate. **(15 Hours)**

POSITION CONTROL OF MANIPULATORS

General Dynamic Model of a 1 DoF joint along with an actuator (DC motor), PI, PD,PID control of 1 DoF joint - Implementation and key considerations - Control law partitioning , Block diagram - Partitioned PD control scheme for 1 DoF rotary joint, Selection of PD gains- Effect of external Disturbance, Disturbance rejection in trajectory following control, Computed torque control for the manipulator.

(15 Hours)

FORCE CONTROL OF MANIPULATORS

Framework for the force control scheme - Artificial and natural constraints - Case study - Description of force control task : Peg in-hole assembly - Hybrid force/position control architecture, Selection matrices- Impedance force/torque control, Application of impedance control system for n DoF manipulator- Introduction to adaptive controllers and advantages, Types: model reference, self-tuning, Linear perturbation adaptive control

(15 Hours)

Total hours:	**45**

Text Books:

1.	John J. Craig “Introduction to Robotics: Mechanics and Control”, Pearson Publisher, New Delhi, 4th edition,2022
2.	Mark W. Spong, Seth Hutchinson, M. Vidyasagar.,” Robot modeling and control” 2nd Edition , 2020

Reference Books:

1.	Saeed B. Niku, “Introduction to Robotics: Analysis, Control, Applications”, 2nd edition, John Wiley & sons, Inc., 2020
2.	K.S.Fu, Gonzalez, R.C. and Lee, C.S.G. “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill, 2014.

Web Resources:

1	https://www.igus.in/info/robot-software
2.	https://cs.gmu.edu/~kosecka/cs685/cs685-control-1.pdf
3.	https://rozitek.com/the-ultimate-guide-to-robot-control-system-rcs/

22MT940	MICRO AND NANO MANUFACTURING	3/0/0/3

Nature of Course: Theory

Prerequisites : Nil

Course Objectives:

1. To introduce various Micro Fabrications involved in microsystem production
2. To acquire the knowledge about the working principles of micro manufacturing techniques
3. To apply the techniques involved in nano finishing of micro systems with good surface finish
4. To select the appropriate element involved in the design and packages of the micro system

Course Outcomes:

Upon completion of the course, students shall have ability to

C940.1	Explain the various micro fabrication processes	[U]
C940.2	Identify suitable micro manufacturing processes in the production unit	[A]
C940.3	Apply Nano finishing techniques in various systems	[AP]
C940.4	Examine the essentials of micro system packaging technologies	[AP]
C940.5	Predict the proper selection of packaging materials for micro/nano components	[AP]

MEMS AND ITS FABRICATION

MEMS and Microsystems, Evolution of Micro fabrication, Applications of Microsystems. Micro system fabrication processes - photolithography, Ion implantation, chemical vapour deposition, and etching. Bulk micromachining, Surface micromachining - Introduction to Micro-energy and chemical system (MECS). **(15 Hours)**

NANO FINISHING TECHNIQUES

Magnetic Abrasive Finishing (MAF), Magnetorheological Finishing (MRF), Elastic Emission Machining (EEM) - Chemical Mechanical Polishing (CMP). Production of carbon nanotubes: Chemical Vapour Deposition (CVD) and Arc discharge, Laser Micro welding- Electron Beam Micro welding. **(15 Hours)**

MICRO SYSTEM PACKAGING

General considerations, Die level -Device level - System level of packages in Microsystem Packaging. Die preparation - Surface bonding - Wire bonding - Sealing. Three - dimensional packaging - Assembly of microsystems - Selection of packaging materials. Clean room standards and clean room sub system **(15 Hours)**

Total hours: 45

Text Books:

1	Tai-Ran Hsu, “MEMS and Microsystems Design and Manufacture and Nanoscale Engineering “, John Wiley, 2020.
2	V. K. Jain, "Micromanufacturing Processes", CRC Press, 2016.

Reference Books:

1	N. P. Mahalik, “Micro-manufacturing and nanotechnology”, Springer, 2011
2	Sami Franssila, "Introduction to Microfabrication", 2nd Edition, Wiley, 2010

Web Resources:

1	https://micronanomanufacturing.asmedigitalcollection.asme.org/
2	https://archive.nptel.ac.in/courses/112/107/112107078/
3	https://nptel.ac.in/courses/112/103/112103202/

23MT941	INDUSTRIAL METROLOGY	3/0/0/3
Nature of Course	: Theory	
Pre-Requisites	: Nil	

Course Objectives:

1. To impart knowledge on measurements, industrial measuring instruments and their methods for inspection.
2. To provide in depth knowledge on surface and transmission system measurements.
3. To provide awareness on advanced measuring machines to attain better quality products.

Course Outcomes:
Upon completion of the course, students shall have ability to

C941.1	Outline the importance of measurements in engineering and the factors affecting measurements.	[U]
C941.2	Explain the working principles of linear and angular measuring instruments.	[U]
C941.3	Understand the principles of surface finish concept and gear terminologies	[U]
C941.4	Examine the principles of miscellaneous measurement concept for transmission elements	[A]
C941.5	Apply the advanced measurement techniques for quality control in manufacturing industries	[AP]

INTRODUCTION TO METROLOGY,
Need of measurement, Material characterization, Inspection methods, Selection of Instruments, Sources of errors, Accuracy and Precision, Standards of measurement, Calibration - Limits, fits and gauges - Linear and Angular measuring instruments - Vision measurement system - Measurement of straightness, flatness, squareness, parallelism, roundness and cylindricity, profile measurements. **(15 Hours)**

SURFACE FINISH AND MISCELLANEOUS MEASUREMENTS
Measurement of surface finish- terminology, analysis of surface traces, assessment of surface roughness - Screw thread terminology, effects of pitch error, thread measurement - Gear terminology, errors, measurement of gear elements - Miscellaneous measurements: angular measurement of V-groove, taper hole, internal dovetail and profile gauges – Measurement of radius of a portion of a circle and concave surface. **(15 Hours)**

ADVANCED METROLOGICAL MEASUREMENTS
Introduction to Coordinating measuring machine – Optical Microscopy - EBSD - Transmission Electron Microscope (TEM) - Scanning Electron Microscope (SEM) - Scanning Tunneling Microscope (STM) - Atomic Force Microscope (AFM) - Contact and non-contact type AFM - X-ray Diffraction Analysis (XRD). **(15 Hours)**

Total hours: 45

Text Books:

1	R. K. Jain, “Engineering metrology”, Jain Book Depot, 21st edition, 2019.
2	Dotson Connie, “Dimensional Metrology”, Cengage Learning, 6th edition 2019.

Reference Books:

1	Gupta I C, "A text book of Engineering Metrology", Dhanpat Rai Publications, New Delhi, 2018.

2	Ammar Grous, J "Applied Metrology for Manufacturing Engineering", Wiley-ISTE, 2011.
Web References:	
1	https://nptel.ac.in/courses/112/106/112106179/
2	https://www.coursera.org/learn/nanotechnology
3	https://gaugehow.com/2019/10/08/30-measuring-instruments-for-mechanical-engineer/
4	http://www.giauto.co.in/advanced-measuring-instruments

22MT942	MICRO ELECTRO MECHANICAL SYSTEMS	3/0/0/3

Nature of Course: Theory

**Pre requisites : ** Nil

Course Objectives:

1. To introduce the basic electro mechanical concepts in MEMS.
2. To acquire Knowledge about the various sensors and actuators.
3. To gain Knowledge on the material selection and the applications of MEMS to all disciplines.

Course Outcomes:

Upon completion of the course, students shall have ability to

C942.1	Explain the intrinsic principle of MEMS and their characteristics.	[U]
C942.2	Outline the basic concepts of MEMS and the semiconductor devices.	[U]
C942.3	Select the various types of sensors and the actuators of different applications	[AP]
C942.4	Model the proper selection of polymeric materials for MEMS structures.	[AP]
C942.5	Discover the appropriate selection of suitable MEMS in real time application.	[AP]

INTRODUCTION

Elements of MEMS - Intrinsic characteristics of MEMS – Transducers – Sensors & Actuators – Introduction to micro fabrication materials – Silicon as a MEMS material – Mechanical properties of silicon – Silicon based MEMS processes – Overview of Electrical and Mechanical concepts in MEMS – Semiconductor devices
. **(15 Hours)**

SENSORS

Characteristics of Sensors – Electrostatic sensors - Parallel Plate Capacitors - Piezoresistive sensors – Piezoresistive sensor materials – Accelerometers, Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators - piezoelectric effects – piezoelectric materials. **(15 Hours)**

POLYMERIC MEMS AND APPLICATIONS

Polymers in MEMS – Polyamide – SU-8 – Liquid Crystal Polymer (LCP) – PDMS (Polydimethylsiloxane) – PMMA - Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS –Lenses and Mirrors – Actuators **(15 Hours)**

Total hours: 45

Text Books:

1.	Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2014, 2nd edition .
2.	Stephen D Senturia, "Microsystem Design", Springer Publication, 2001.
3.	Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture”, Tata McGraw Hill, New Delhi, 2008.

Reference Books:

1.	D. V. S. Murthy, “Transducers and Instrumentation”, Prentice Hall of India Pvt. Ltd., New Delhi, 2009.
2.	James J.Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010.
3.	Nadim Maluf, “An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000.
4.	Thomas M.Adams and Richard A.Layton, “Introduction MEMS, Fabrication and Application, Springer 2012.

Web Resources:

1	https://nptel.ac.in/courses/117105082
2.	https://archive.nptel.ac.in/courses/108/108/108108147/

3.	https://ieeexplore.ieee.org/document/1496409/similar
4.	https://onlinecourses.nptel.ac.in/noc21_ee32/preview
5.	https://onlinecourses.nptel.ac.in/noc22_ee76/preview

22MT943	CONNECTED VEHICLES	3/0/0/3

Nature of Course: Theory

Pre requisites : Nil

COURSE OBJECTIVES:

1. To introduce the various technologies and systems used to implement smart mobility and intelligent vehicles.
2 To produce the overall impact of various driving functions, connecting the automobile with information.
3. To make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected technology.

Course Outcomes:

Upon completion of the course, students shall have ability to

C943.1	Illustrate the concept of cyber-physical control systems and their application to collision avoidance	[U]
C943.2	Select the types of sensors needed to implement remote sensing.	[AP]
C943.3	Assess the performance of fully autonomous vehicles	[A]
C943.4	Apply the basic concepts of wireless communications and networks	[AP]
C943.5	Examine the concept of the connected vehicles and its role in automated vehicles	[A]

INTELLIGENT VEHICLES

Concept of Automotive Electronics, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems. **(15 Hours)**

AUTONOMOUS VEHICLE TECHNOLOGY

Connectivity Fundamentals, Navigation, Vehicle-to-Vehicle Technology and its Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Road block Issues, Technical Issues, Security Issues.

(15 Hours)

CONNECTED AUTONOMOUS VEHICLE

Architecture of Electronic Control Units (ECUs), Role of Cyber-Physical Systems in autonomous vehicle operation,– Vehicle bus systems and protocols, Wireless Networking and Applications to Vehicle Autonomy, Role of IoT in modern transportation, Integration of Wireless Networking and On-Board Vehicle Networks. **(15 Hours)**

Total hours: 45

Text Books:

1.	C. S. Papacostas, “Transportation Engineering and Planning”, 3rd edition, Pearson, 2015
2.	Radovan Miucic, “Connected Vehicles: Intelligent Transportation Systems”, 2019, Springer.2019

Reference Books:

1.	Tom Denton, “Automobile Electrical and Electronic systems, Roult edge”, Taylor & Francis Group, 5th Edition, 2018.
2.	Gillespie.T.D., “Fundamental of vehicle dynamic society of Automotive Engineers “, USA,2021 Revised Edition

Web Resources:

1	https://onlinecourses.nptel.ac.in/noc25_ee33/preview

2.	https://www.coursera.org/specializations/autonomous-vehicle-engineering

22MT944	SAFETY, ETHICS AND REGULATIONS FOR DRIVERLESS CARS	3/0/0/3
Nature of Course: Theory		
Pre requisites : -		
Course Objectives:		

1. To impart the basic concepts of safety driverless car driving system and its feedback control.
2. To Interpret various time domain and frequency domain tools for analysis and design of safety in autonomous driving.
3. To analyze the stability of systems using various methods and to design compensators and controllers

Course Outcomes:
Upon completion of the course, students shall have ability to

C944.1	Illustrate the basics of automotive ECUs function in conjunction with the data bus networks and sensors.	[U]
C944.2	Outline the concept of cyber-physical control systems in application to collision avoidance and autonomous vehicles	[U]
C944.3	Utilize the fundamental principles of data networking	[AP]
C944.4	Identify the evolution of vehicle prognostics and impaired driver technology	[U]
C944.5	Analyze the regulatory systems of Driverless car to ensure the safety	[A]

AUTONOMOUS VEHICLE TECHNOLOGY
Introduction - SAE autonomous Level Classification - Application, Advantages and Disadvantages of Autonomous Vehicles. Principles of path planning and decision-making approaches-Approximation-Heuristic-Graph based -Point guidance. Verification and validation of decision making and path planning- Case Study: Task allocation and path planning algorithms.
(15 Hours)

FACTORS AND ETHICAL DECISION MAKING
Introduction to Human Factors-Human Performance: Perception and Attention-Situation Awareness and Error-Human Reliability: Driver Workload and Fatigue-Emotion and Motivation in Design-Trust in Autonomous Vehicles and Assistive Technology-Designing ADAS Systems Driverless Vehicles and Ethical Dilemmas: Decision-Making Software Application of Human Factors in Autonomous Vehicles. International and National regulatory frameworks for CAV.
(15 Hours)

REGULATIONS FOR DRIVERLESS CARS
Driverless Car Technology - Moral, Legal, Roadblock Issues - Technical Issues - Security Issues Monitoring of Vehicle Components - Basic Maintenance - End-of-Life Predictions -Advanced Driver Assistance System - Sensor Alignment and Calibration - Sensor Technology for Driver Impairment Detection- Transfer of Control Technology
(15 Hours)

Total hours:	**45**

Text Books:	
1.	Vivek Wadhwa and Alex Salkever“The Driver in the Driverless Car" New Age International Publisher, New Delhi, 2022
2.	Hod Lipson and Melba Kurman “Driverless Intelligent Cars and the Road Ahead," 2023
Reference Books:	
1.	Larry Burns co-authored "Autonomy: The Quest to Build the Driverless Car—And How it Will Reshape Our World". , 2021.

Web Resources:	
1	https://nptel.ac.in/courses/107106083
2.	https://waymo.com/
3.	https://www.abebooks.com/9780754642473/Safety-Ethics-Patankar-Manoj-Brown-075464247X/plp

22MT945	FOUNDATIONS OF AUTONOMOUS VEHICLES	3/0/0/3
Nature of Course: Theory		
Pre-requisites: Nil		
Course Objectives:		
1. To understand various levels of autonomous vehicles. 2. To assess various sensors, identify their functions for various autonomy levels. 3. To equip with the ability to set up sensor fusion and regulatory levels for driver assistance systems		

Course Outcomes:
Upon completion of the course, students shall have ability to

C945.1	Outline the architecture of connected and automated vehicles	[U]
C945.2	Explain the sensor technologies for intelligent vehicle navigation and environment perception.	[U]
C945.3	Illustrate the concepts of wireless networking, Internet of Things (IoT), and their integration with vehicle networks.	[U]
C945.4	Model the operation of ECUs and sensor-actuator integrations for vehicles.	[AP]
C945.5	Apply basic algorithms in autonomous vehicle applications for acceptance and safety systems.	[AP]

CONNECTED, AUTOMATED AND INTELLIGENT CARS AND SENSOR TECHNOLOGY
Introduction to Connected, automated and Intelligent cars- Automotive Electronics Overview, Advanced Driver Assistance Electronic Systems, Connected Car Technology- Connectivity Fundamentals and Navigation. Basic Control System Theory in Automobiles, Overview of the Operation of ECUs, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology. Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control. **(15 Hours)**

SELF- DRIVING VEHICLE TECHNOLOGY AND WIRELESS SYSTEM STANDARDS
SLAM overview, multi-sensor data fusion, and other SDV algorithms. Robot Operating System (ROS) and Open-Source Car Control (OSCC). Wireless Networking and Applications to Vehicle Autonomy: Computer Networking basics – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks
(15 Hours)

ACCEPTANCE, SAFETY, ETHICS AND RULES FOR SELF-DRIVING CARS
Ethics - Opportunities and Risks - User / public Acceptance - Regulatory bodies - Policies and policy making - Autonomous Driving - standardization bodies and standards. Integration of ADAS Technology into Vehicle Electronics - System – Examples - Role of Sensor Data Fusion, Recent Driver Assistance System Technology applied in various automobile companies dealing with Non-Passenger Car **(15 Hours)**

Total hours: 45

Text Books:	
1.	George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos, “Autonomous Vehicles Technologies, Regulations, and Societal Impacts”, Elsevier Publications, 2021.
2.	Dietmar P.F. Möller, Roland E. Haas, “Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies”, Springer Publications, 2019.
Reference Books:	

1.	Hanky Sjafrie, “Introduction to Self-Driving Vehicle Technology”, 1st Edition, Chapman and Hall/CRC, December 11,2019
2.	JG. Mullett, “Wireless Telecommunications Systems and Networks”, Thomson – Delmar Learning, ISBN#1-4018-8659-0, 2006
Web Resources:	
1	https://www.coursera.org/learn/ai-for-autonomous-vehicles-and-robotics
2.	https://www.coursera.org/specializations/self-driving-cars
3.	https://eicta.iitk.ac.in/product/autonomous-vehicle-and-adas/

22MT946	REINFORCEMENT LEARNING IN ROBOTICS	3/0/0/3
Nature of Course	: Theory	
Pre requisites	:Nil	

Course Objectives:

1.	To recall the basics of Reinforcement Learning techniques.
2.	To learn the concept of Markov Decision Process and Monte Carlo Methods through RL
3.	To study various applications in robotics related to RL.

Course Outcomes:
Upon completion of the course, students shall have ability to

C946.1	Explain the foundational principles of reinforcement learning	[U]
C946.2	Build algorithms for reinforcement learning	[AP]
C946.3	Utilize the Markov Decision Process and Monte Carlo Methods through Reinforcement Learning	[AP]
C946.4	Interpret various application methods through different performance criteria	[AP]
C946.5	Outline possibilities and limitations of reinforcement learning in robotics	[U]

INTRODUCTION

Reinforcement learning (RL): History - Elements, Model based Learning - Temporal Difference Learning - learning task - Q learning - The Q function - Algorithm for Q learning - SARSA (State-Action-Reward-State-Action) - convergence - experimentation strategies - Non deterministic rewards and actions - Comparing with Supervised and Unsupervised Learning Algorithms - Limitations and Scope. **(15 Hours)**

SOLUTION METHODS

Markov Decision Process: Markov chain and Markov process, MDP, Rewards and Returns, Episodic and Continuous tasks, policy and state value functions. Monte Carlo Methods - Predictions, first visit and every visit of Monte Carlo, Monte Carlo control, Markov Chain Monte Carlo method, On policy and off policy learning, Blackjack with Monte Carlo. **(15 Hours)**

CONCEPTS AND APPLICATIONS

Learning from rewards - passive and active RL - generalization in RL - policy search - inverse RL - Autonomous navigation in dynamic environments using RL - Obstacle avoidance and goal-reaching tasks - Applications: Robots - robotic perception - planning movements - RL in robotics - robotic frameworks - robotics Philosophy, ethics, and safety of AI

(15 Hours)

Total hours:	**45**

Text Books:

1	Richard S. Sutton and Andrew G. Barto, "Reinforcement learning: An introduction", Second Edition, MIT Press, 2019
2	Richard S. Sutton and Andrew G. Barto “Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) 2nd edition, , A Bradford Book; 2018.

Reference Books:

1	Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Fourth Edition, Pearson Education, 2020.
2	Li, Yuxi. "Deep reinforcement learning." arXiv preprint arXiv:1810.06339 (2018).
3	Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. "Deep learning." MIT press, 2016.

Web Resources:	
1	https://lamarr-institute.org/blog/reinforcement-learning-and-robotics/
2	https://www.theconstruct.ai/robotigniteacademy_learnros/ros-courses-library/reinforcement-l earning-for-robotics/

22MT947	VIRTUAL REALITY AND ITS APPLICATIONS	3/0/0/3
Nature of Course: Theory		
Pre requisites : -		
Course Objectives:		
1. To describe VR hardware, locomotion methods, and controller-based interactions. 2. To provide a comprehensive understanding of user interactions in immersive environments. 3. To equip with the knowledge and skills necessary to create VR experiences effectively		
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C947.1	Identify the principles and techniques for implementing motion tracking, navigation, and controller interactions in virtual reality environments	[U]
C947.2	Outline the intricacies of user interactions in virtual reality environments	[U]
C947.3	Utilize the principles and techniques for creating visual, tracking, auditory, primary user input, haptic, and interfaces	[AP]
C947.4	Infer the structured workflow that encompasses planning, design, development, testing, and deployment	[U]
C947.5	Apply the VR technology across various industries	[AP

MOTION TRACKING, NAVIGATION AND CONTROLLERS

Importance of motion tracking, position tracking methods, rotational tracking, Navigation - Travel techniques, User-centred way finding, motion controllers- user interactions, Direct user interaction - Touch, gesture and proximity-based interaction, Virtual controls - buttons, dials, sliders, steering wheels, menus, Locomotion techniques - teleportation, walking, flying, Selection - Hand and Gaze based, Techniques for object grabbing and manipulation, Scaling objects, **(15 Hours)**

VR INTERFACES AND WORKFLOWS

Multimodal interfaces, Visual interface, tracking interface- head and eye tracking, Auditory interface, Primary user input interfaces, Haptic, tactiles, kinesthetic , Olfactory interfaces, Design - 3D model, animation, user interface, audio, VR development platform and programming languages, Testing and iteration, Quality assurance, **(15 Hours)**

APPLICATIONS OF VR

Virtual environment for teleoperation, conceptual learning, visual perceptual skills training, 3D interactive environments for special educational needs- clinical virtual reality- entertainment applications of virtual environments

(15 Hours)

Total hours:	**45**

Text Books:	
1.	Kay M. Stanney, Kelly S. Hale, Handbook of Virtual Environments Design, Implementation, and Applications, Second Edition, CRC Press, 2014
2.	Sherman, William R. and Alan B. Craig. Understanding Virtual Reality – Interface, Application, and Design, Morgan Kaufmann,2018
3	Ralf Doerner and et al., Virtual Reality and Augmented Reality (VR/AR): Foundations and Methods of Extended Realities (XR), Springer, 2022.
Reference Books:	
1.	Steven M. LaValle, Virtual Reality, Cambridge University Press, 2023
2.	Alan B. Craig, William R. Sherman, Jeffrey D. Will, Developing Virtual Reality Applications -Foundations of Effective Design, Elsevier Science, 2009
Web Resources:	

1	https://nptel.ac.in/courses/106/106/106106138/
2.	https://www.coursera.org/learn/introduction-virtual-reality
3.	https://www.cantorsparadise.com/modelling-and-simulation-of-inverted-pendulum

22MT948	AUGMENTED AND MIXED REALITY	3/0/0/3
Nature of Course: Theory		
Pre requisites : -		
Course Objectives:		

1. To get introduced to the various types and devices of AR.
2. To provide basic understanding of MR hardware and its technologies
3. To identify AR and MR techniques relevant to various application

Course Outcomes:
Upon completion of the course, students shall have ability to

C948.1	Compare the types of AR and the diverse range of AR devices	[U]
C948.2	Outline the principles of designing effective multimodal interfaces	[U]
C948.3	Explain Mixed Reality and differentiate between virtual and augmented reality	[U]
C948.4	Identify the tracking methods and navigate real-world environments.	[A]
C948.5	Apply Augmented and Mixed Reality for real-world issues	[A]

AR DEVICES AND TECHNIQUES
Augmented and Mixed Reality(AR): Types - Marker-based ,Markerless, Projection based, Superimposition-based, Outlining-based AR. AR devices- Smartphones and tablets-AR Kit and ARCore, AR glasses, HeadMounted displays, Smart Eyewear, Multimodal interaction techniques - Touch gestures, Hand gestures and tracking, voice commands, head and gaze tracking, physical controllers, Registration: Geometric and Photometric, Special AR Techniques: Head-up content, Occlusion and Phantom objects, Cross-fading markers, virtual holes, X-ray vision. Special AR Interaction **(15 Hours)**

FOUNDATIONS OF MIXED REALITY
I/O devices - Cave Automatic Virtual Environment, Head-Up display, Head-mounted display, Holograms, Algorithms in mixed reality, Calibration, Object Recognition, Object tracking, Cave Automatic in Virtual Environment and Microsoft HoloLens (**15 Hours)**

SPATIAL MAPPING AND SCENE UNDERSTANDING
Depth sensing, Mesh generation, Simultaneous Localization and Mapping (SLAM), Scene objects, Scene components - Quads and Meshes, bounding boxes, collision meshes, metadata, Case studies on Interactive gaming, educational simulations, medical visualization, Architectural design
(15 Hours)

Total hours:	**45**

Text Books:

1.	Bernhard Jung, Paul Grimm, Ralf Doerner, Wolfgang Broll, Virtual and Augmented Reality (VR/AR) Foundations and Methods of Extended Realities (XR), Springer International Publishing, 2022
2.	Dieter Schmalstieg, Tobias Hollerer, Augmented Reality Principles and Practice, Pearson Education, 2016
3	Ralf Doerner and et al., Virtual Reality and Augmented Reality (VR/AR): Foundations and Methods of Extended Realities (XR), Springer, 2022

Reference Books:

1.	Yuichi Ohta, Hideyuki Tamura, Mixed Reality: Merging Real and Virtual Worlds, Springer- Verlag, 2013
2.	Maas, M. J., & Hughes, J. M. (2020). Virtual, augmented and mixed reality in K–12 education: A review of the literature. Technology, Pedagogy and Education, 29(2), 231-249 Applications -Foundations of Effective Design, Elsevier Science, 2009

Web Resources:	
1	https://www.coursera.org/learn/ar
2.	https://www.udemy.com/course/develop-augmented-reality-book-ar-business-card-with-unity/?couponCode=IND21PM
3.	https://www.udemy.com/course/build-augmented-reality-app-without-coding-using-unity/?couponCode=IND21PM

22MT949	AI AND MACHINE LEARNING IN AUTOMATION	3/0/0/3

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1.	To provide a foundational understanding of AI and ML and their role in automation.
2.	To explain the practical applications of these algorithms in industrial automation, robotics, predictive maintenance, and other areas.
3.	To recognize the application of RNN in robotics and automation.

Course Outcomes:

Upon completion of the course, students shall have ability to

C949.1	Outline the basics of AI and ML and their application in automation systems.	[U]
C949.2	Explain the algorithms to solve automation-related problems, such as predictive maintenance and process optimization.	[U]
C949.3	Interpret models and choose the appropriate algorithm for automation tasks.	[AP]
C949.4	Describe reinforcement learning and its usage in autonomous systems	[U]
C949.5	Apply advanced AI systems in industrial and commercial automation environments.	[AP]

AI AND MACHINE LEARNING FOR AUTOMATION

Introduction - Types of Machine Learning: Supervised, Unsupervised and Reinforcement Learning - Overview of Neural Networks and Deep Learning in automation – Data Preprocessing and Feature Engineering - AI and ML in the automation. **(15 Hours)**

MACHINE LEARNING ALGORITHMS

Regression and Classification Algorithms (Linear Regression, Decision Trees, Random Forests) - Clustering and Dimensionality Reduction Techniques (K-Means, PCA) - Support Vector Machines (SVM) and Ensemble Methods (Random Forest, Gradient Boosting) - Model Evaluation and Hyperparameter Tuning - Real-World Applications in Automation: Predictive Maintenance, Robotics, Process Optimization. **(15 Hours)**

AI ALGORITHMS

Recurrent Neural Networks (RNN) and Long Short-Term Memory Networks (LSTM) for Time-Series Prediction - Reinforcement Learning and Autonomous Decision-Making - Applications in Autonomous Vehicles, Industrial Robots, and Smart Manufacturing.

(15 Hours)

Total hours: 45

Text Books:

1	Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning", The MIT Press, 2016.
2	Stuart Russell and Peter Norvig “Artificial Intelligence: A Modern Approach”, 3rd edition, Pearson, 2009
3	Kevin P. Murphy “Machine Learning: A Probabilistic Perspective”, The MIT Press, 2012.

Reference Books:

1	Reza Rawassizadeh, “Machine Learning and Artificial Intelligence: Concepts, Algorithms and Models”, 2025.
2	Christopher M. Bishop “Pattern Recognition and Machine Learning”, SPRINGER NP EXCLUSIVE, 2009.
3	Tom M. Mitchell “Machine Learning”, McGraw Hill Education, 2017.

Web Resources:	
1	https://www.ibm.com/think/topics/artificial-intelligence
2	https://www.ibm.com/think/topics/machine-learning
3	https://nptel.ac.in/courses/106102220
4	https://onlinecourses.nptel.ac.in/noc23_cs18/preview

22MT950	PLANNING AND DECISION MAKING IN ROBOTICS	3/0/0/3
Nature of Course: Theory		
**Pre requisites : ** Nil		
Course Objectives:		
1. To provide an overview of different planning approaches relevant to Robotics 2. To recall fundamentals knowledge in process of decision making and techniques 3. To impart basics of implementing algorithms through simulations		

Course Outcomes:
Upon completion of the course, students shall have ability to

C950.1	Interpret the planning problems using search algorithms in discrete space	[AP]
C950.2	Employ the different types of motion planning with and without constraints	[AP]
C950.3	Utilize decision making techniques to robot applications	[AP]
C950.4	Illustrate the position of a mobile robot using filtering techniques	[A]
C950.5	Solve planning and decision-making problems in robotics	[AP]

ALGORITHMS AND ROADMAP
Planning - Execution, refinement and inclusion- Search algorithms and Metrics- BFS- DFS- Heuristic search algorithms- Dijkstra, A-Star- Optimal path search- Dynamic programming - Motion planning algorithms: Roadmap methods: Visibility graph and Voronoi diagram-Cell decomposition and RRT
(15 Hours)

DECISION MAKING AND STATE ESTIMATION
Decision trees, Decision matrix, Linear Programming, Game theory, Statistical approaches, Bayesian approach - Kinematics of two-wheeled differential drive mobile robota-State and measurement uncertainties, Conditional probability and Bayes theorem, Belief function-Markov process and state transition **(15 Hours)**

KALMAN FILTERING
State estimation using Linear Kalman Filtering (LKF) – algorithm, Robot localization - Formulation of/for: probabilistic kinematic model, Position calculation, algorithm for odometry, Orientation calculation, Robot localization - Algorithm for probabilistic kinematic model.
(15 Hours)

Total hours: 45

Text Books:	
1.	Bruno Siciliano, Giuseppe Oriolo, Lorenzo Sciavicco and Luigi Villani "Robotics: Modelling, Planning and Control", Springer, London, 2010.
2.	Siegwart, Nourbakhsh, "Introduction to Autonomous Mobile Robots", 2nd Edition, MIT Press, 2011.
Reference Books:	
1.	Anis Koubaa, Hachemi Bennaceur, Imen Chaari, Sahar Trigui , Adel Ammar, Mohamed-Foued Sriti, Maram Alajlan, Omar Cheikhrouhou, Yasir Javed ,Robot Path Planning and Cooperation: Foundations, Algorithms and Experimentations", Springer International,2018.
2.	George A. Kantor, Howie Choset, Kevin M. Lynch, Lydia E. Kavraki, Sebastian Thrun, Seth Hutchinson, Wolfram Burgard "Principles of Robot Motion: Theory, Algorithms, and Implementations ", Bradford Books ,2005
Web Resources:	
1	https://www.coursera.org/learn/robotic-path-planning-task-execution
2.	https://www.classcentral.com/course/modernrobotics-course1-10632
3.	https://nptel.ac.in/courses/106105159

22MT952	INTRODUCTION TO AIRCRAFT CONTROL SYSTEM	3/0/0/3

Nature of Course: Theory

Pre requisites : Nil

Course Objectives:

1. To analyze and design a control system to meet desired specification for aircraft applications
2. Students will learn to analytically determine a control system's functionality and select appropriate tests to demonstrate system's performance
3. Develop an understanding of the elements of classical and modern control theory as applied to the control of aircraft.

Course Outcomes:
Upon completion of the course, students shall have ability to

C952.1	Illustrate the various control architecture used for aircraft system	[U]
C952.2	Outline the structure of aircraft system in static and dynamic mode	[U]
C952.3	Utilize the stability principles to aircraft system	[AP]
C952.4	Apply the concept and design of controllers applied to aircraft system	[AP]
C952.5	Illustrate the various applications of control strategy foraircraft system	[U]

CONTROL PROBLEM
Automatic control to Aerospace Systems. Elements of Closed-loop Control System. Linear Time Invariant System. Equilibrium Points, Static and Dynamic Stability.-Stability Analysis with Respect to Equilibrium points, Example on Nonlinear System, Linearization method, State-space model, Laplace transform and Transfer Function.

(15 Hours)

ANALYSIS OF AIRCRAFT SYSTEMS
Linearization to Aircraft's Rotational Motion. Linear state model of aircraft attitude motion. Transfer function of aircraft attitude motion with respect to reference attitude, disturbance, and noise. Effect of controller in closed-loop transfer function. Typical control laws- Proportional, Proportional plus Derivative, and Proportional-Integral- Derivative.

(15 Hours)

AIRCRAFT CONTROLLER
Gain Tuning method, PID control for the design of autopilot using Root Locus**,** Examples, Review on Aircraft Equation of motion, Aircraft Reference Model, Small perturbation to Aircraft Equation. Linearized State-Space Model of Longitudinal and Lateral / Directional Equations of Motion for the Aircraft Autopilot Design. Longitudinal motion approximation. Short period approximation. Spiral mode, Roll mode and Dutch Roll approximations. Examples for longitudinal and lateral approximations for the Aircraft Autopilot Design.

(15 Hours)

Total hours:	45

Text Books:

1.	Yeedavalli, K. R., "Flight Dynamics and Control of Aero and Space Vehicles", Willey, 1st Edition, 2020.
2.	Ruiter, A. H, Damaren, C., and Forbes, J. R., Spacecraft Dynamics and Control: An Introduction, Wiley, 1st Edition, 2013.

Reference Books:

1.	Tewari, A, Modern Control Design with MATLAB and Simulink, John Wiley & Sons,Chichester, 2002
2.	Franklin, G. F., Powell, J. D., and Naeini, A. E., Feedback Control of Dynamical Systems, Prentice Hall, 6th Edition, 2009.

Web Resources:	
1	https://onlinecourses.nptel.ac.in/noc24_ae05/preview
2.	https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/downloads/Aircraft_ctrl_Systems.pdf
3.	https://www.faa.gov/sites/faa.gov/files/08_phak_ch6.pdf

22MT953	INTRODUCTION TO AIRPLANE PERFORMANCE	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1. To equip the students with fundamental understanding of aircraft performance in various flight regimes.
2. To familiarize the concepts and parameters affecting the flight performance.
3. To evaluate the performance of aircraft.

Course Outcomes:

Upon completion of the course, students shall have ability to

C953.1	Explain the fundamental concept of aircraft performance.	[U]
C953.2	Describe the cruise performance of aircrafts.	[U]
C953.3	Illustrate the parameters affecting climb performance.	[AP]
C953.4	Discuss the descent performance in aircraft operations.	[U]
C953.5	Compute the Maneuver performance of military and transport aircraft.	[AP]

PERFORMANCE ASPECTS

The role and design mission of an aircraft - specification of the performance requirements and mission profile - Importance of performance analysis - estimation and measurements - Scheduled performance and operational performance of aircraft - The International standard Atmosphere - Off design atmosphere - Measurements of air data - Air data computers. **(15 hours)**

CRUISE PERFORMANCE

Maximum and minimum speeds in level flight - Range and endurance with thrust production and power producing engines - Cruise techniques: constant angle of attack, constant Mach number, constant altitude - comparison of performance - the effect of alternative fuel flow laws - the effect of weight, altitude and temperature on cruise performance. **(15 Hours)**

CLIMB, DESCENT AND MANEUVER

Importance of climb, descent and maneuver performance - safety considerations - Climb and descent techniques - generalized performance analysis for thrust producing, power producing - maximum climb gradient, climb rate - Measurements of climb performance - Descent performance in aircraft operations - Effect of wind on climb and descent performance. Longitudinal maneuvers - Lateral maneuvers- turn performance- turn rates, turn radius - limiting factors - Maneuver performance of military aircraft, transport aircraft. **(15 Hours)**

Total hours: 45

Text Books:

1	Eshelby, M.E., Aircraft Performance; Theory and Practice, AIAA Education Series, AIAA, 2019.
2	Raymer,D.P., Aircraft Design: A Conceptual Approach, sixth edition, AIAA Education Series, AIAA, 2020.
3.	Mc Cormic B. W, Aerodynamics, Aeronautics and Flight Mechanics, 2nd edition, Wiley India Ltd,2020

Reference Books:

1	Yechout, T.R. et al., Introduction to Aircraft Flight Mechanics, AIAA Education Series, AIAA,2022.
2	Anderson J. D , Aircraft Performance and Design, International edition, McGraw Hill, New Delhi,2017.

3.	Hull, D. G., Fundamentals of Airplane Flight Mechanics, Springer, 2007.
Web Resources:	
1.	https://onlinecourses.nptel.ac.in/noc22_ae11/preview
2.	https://open.umn.edu/opentextbooks/textbooks/1035
3.	https://arc.aiaa.org/doi/book/10.2514/4.861529
4.	https://www.faa.gov/sites/faa.gov/files/13_phak_ch11.pdf

22MT954	INTRODUCTION TO AIRCRAFT DESIGN	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1. To describe the purpose and scope of aircraft design.
2. To detail the layout procedure for evaluation of the aircraft design.
3. To fix the geometry and to investigate the performance and stability characteristics of airplanes.

Course Outcomes:

Upon completion of the course, students shall have ability to

C954.1	Illustrate the fundamental concepts and constraints during flight vehicle design process.	[AP]
C954.2	Discuss the layout procedure for evaluation of the aircraft design.	[U]
C954.3	Select the choices in design parameters.	[U]
C954.4	Explain the geometry and investigate the performance and stability characteristics of airplanes.	[U]
C954.5	Identify key design features of different types of flight vehicles.	[U]

DESIGN PROCEDURE

Purpose and scope of airplane design - Classification of airplanes - factors affecting configuration - Merits of different plane layouts - Stages in Airplane design - Designing for manufacturability, Maintenance, Operational costs, Data collection and 3-view drawings - purpose, weight estimation - Weight equation method – Development and procedures for evaluation of component weights - Weight fractions for various segments of mission. **(15 hours)**

DESIGN OF WING AND FUSELAGE

Selection of aerofoil and wing parameters - Effect of Aspect ratio - Wing Design - Airworthiness requirements - V-N diagram, loads, Structural features - Elements of fuselage design, loads on fuselage, Fuselage sizing - check for nose wheel lift off.

(15 Hours)

DESIGN OF EMPHANAGE AND LANDING GEAR

Tail sizing - Determination of tail surface areas, Tail design, Structural features, - Loads on landing gear and design - Elements of Computer Aided and Design - Special consideration in configuration layout - Performance estimation - Stability aspects on the design of control surface.

(15 Hours)

Total hours: 45

Text Books:

1	D. Raymer, Aircraft Design: A Conceptual Approach. American Institute of Aeronautics and Astronautics, Inc., 2018.
2	Torenbeck, E. Synthesis of Subsonic Airplane Design, Delft University Press, U.K. 2020.
3	Denis howe, Aircraft Conceptual Design Synthesis, Wiley, 2010.

Reference Books:

1	Kuechemann, D, “The Aerodynamic Design of Aircraft, American Institute of Aeronautics publishers, 2018.
2	S.A. Brandt, et al., Introduction to Aeronautics: A Design Perspective, American Institute of Aeronautics and Astronautics Inc., 2019.
3	Tomas C Corke., “Design of Aircraft,” Pearson Education, LPE, 2003.

Web Resources:

1.	https://onlinecourses.nptel.ac.in/noc20_ae14/preview

2.	https://alison.com/course/introduction-to-aircraft-design
3.	https://elearncollege.com/view-all-courses/fundamentals-of-aircraft-design/
4.	https://ae.ieu.edu.tr/documents/ae_405.pdf

22MT006	COLLABORATIVE ROBOTICS		3/0/0/3
Nature of Course : Theory			
Pre requisites :Nil			
Course Objectives:			
1.	To acquire the basic knowledge on fundamentals of Collaborative Robotics		
2.	To impart knowledge On Swarm robotics and trajectory planning for Swarm		
3.	To introduce Modular Robotics and its Mechanics and to learn about various Natural models of robot collaboration		
Course Outcomes: **Upon completion of the course, students shall have ability to**			
C006.1	Outline the fundamentals of Collaborative Robotics		[U]
C006.2	Describe swarm robot technology in real time applications		[U]
C006.3	Apply and select the suitable concept of Modular Robotics and its Mechanics for modelling a collaborative robot		[AP]
C006.4	Develop various Natural models for robot collaboration		[AP]
C006.5	Understand collaborative robots for various requirement in industrial tasks		[U]

INTRODUCTION TO COBOTICS & SWARM ROBOTICS

Introduction to Collaborative Robotics- Properties - Introduction to Modern Mobile Robots: Swarm Robots, Cooperative and Collaborative Robots. Mobile Robot Manipulators-Current Challenges. Introduction to swarm robots-mapping, kinematics and trajectory error compensation, state transitions, collective decision making and methodologies, swarm robot scenarios-aggregation, clustering dispersion, pattern formation, sorting, flocking and collective motion, shepherding, heterogeneous swarms, Error Detection and Security. **(15 Hours)**

MODULAR ROBOTICS

Modular robotics Module Designs - Modular Robot Representation -Modular Serial Robot Kinematics - Kinematic Calibration for Modular Serial Robots- Modular Serial Robot Dynamics - Modular Parallel Robot Kinematics: Humanoid Robot-Human-robot industrial interaction. **(15 Hours)**

NATURALLY INSPIRED COLLABORATION

Naturally inspired collaboration- Models for Collective Decision-Making Processes, Urn Models, Voter Model, Majority Rule, Hegselmann and Krause, Kuramoto Model, Axelrod Model, Ising Model, Fiber Bundle Model. Reconfigurable robots -formation of reconfigurable virtual linkage - Reconfigurable Formation Control of Multi-Agents - Self- Assembly Modular Robot Platform Based on Sambot; case studies: Cobot in Hospital laboratories, human-cobot collaboration in industry assembly line **(15 Hours)**

Total hours:	**45**

Text Books:

1	Giandomenico Spezzano, “Swarm Robotics”, Applied Sciences, MDPI, 2019.
2	Guilin Yang, I-Ming Chen, “Modular Robots: Theory and Practice”, Springer, 2022.

Reference Books:

1	Heiko Hamann, “Collective Decision-Making in Swarm Robotics: A Formal Approach”,Springer, 2019.

Web Resources:

1	https://onlinecourses.nptel.ac.in/noc25_me86/preview
2	https://www.cobottrends.com/about-us/
3	https://link.springer.com/article/10.1007/s10845-023-02137-w

4	https://builtin.com/robotics/cobot

22MT009	SOCIAL ROBOTICS	3/0/0/3

Nature of Course: Theory

Pre requisites :

Course Objectives:

1. To know the need and various systems of the Humanoid / Social robots.
2. To impart knowledge Human Robot Interaction through Collaborative Robots.
3. To extend the various roles of robotics play in healthcare

Course Outcomes:
Upon completion of the course, students shall have ability to

C009.1	Describe the evolution of Humanoid robots.	[U]
C009.2	Explain the various roles that robotics can play in healthcare.	[U]
C009.3	Discover the state of the art in applied medical robotics research	[AP]
C009.4	Illustrate the various types and characteristics of field and service Robots	[AP]
C009.5	Discuss with the applications of various field and service Robots	[U]

Course Contents:

HUMANOID ROBOTICS

Humanoid robot: Introduction - Design, Sensors - Control, actuation types, System Integration-Assistive and Social Robots in Healthcare - Need of HRI (Human Robot Interaction)-HRI Architecture. **(15 Hours)**

ROBOTS IN THERAPY AND REHABILITATION

Medical robotics: Core concepts, Technology, systems, Research areas and applications-Rehabilitation and Health care robotics: Overview, physical therapy and training Robots- Aids for people with disabilities- Smart prostheses and orthoses, diagnosis and monitoring. Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles **(15 Hours)**

FIELD AND ENTERTAINMENT ROBOTICS

Autonomous Robots for silviculture-Automatic guidance, sowing, weeding, spraying and broad-acre harvesting, Horticulture: picking of fruits- Robot milking - Robots in construction- Cleaning Robots, lawn mowing Robots- Smart appliances and smart homes- The role of Robots in education. **(15 Hours)**

Total hours: 45

Text Books:

1.	Elmer P. Dadios, “Humanoid Robot: Design and Fuzzy Logic Control Technique for Its Intelligent Behaviors”, 2012
2.	Paula Gomes, "Medical robotics Minimally invasive surgery", Woodhead, 2012
3	Yangsheng Xu Huihuan Qian Xinyu Wu, "Household and Service Robots", Elsevier Ltd, 2015.

Reference Books:

1.	Achim Schweikard, Floris Ernst, ―Medical Robotics‖, Springer, 2015
2.	Aleksandar Lazinica, ―Mobile Robots Towards New Applications‖, Advanced Robotic Systems International, 2015
3.	Bruno Siciliano, Oussama Khatib, ―Springer Handbook of Robotics‖, Springer-Verlag Berlin Heidelberg 2008.

Web Resources:

1	https://onlinecourses.nptel.ac.in/noc24_ge31/preview

2.	https://link.springer.com/article/10.1007/s43154-020-00035-0
3.	https://dl.acm.org/doi/10.1145/3707639
4.	https://github.com/jcarolinares/awesome-social-robots
5.	https://ideas.cs.purdue.edu/research/robotics/socialbots/

22MT011	DATA ANALYTICS FOR ROBOTICS AND AUTOMATION	3/0/0/3
Nature of Course: Theory		
Pre requisites : Nil		
Course Objectives:		

1. To introduce the fundamental concepts of data science in robotics and automation.
2. To develop the skills to analyze robotic sensor data using data analysis techniques and statistical models.
3. To enhance the capability to build predictive models for decision-making in automated systems

Course Outcomes:
Upon completion of the course, students shall have ability to

C011.1	Explain the need, benefits and uses of data science.	[U]
C011.2	Use the techniques such as Bayes Rule, regression, and k-nearest neighbors for data analysis	[AP]
C011.3	Interpret frequency distributions, outliers and variability using appropriate statistical techniques	[AP]
C011.4	Recognize linear and logistic regression models in data analysis	[U]
C011.5	Use the predictive models for time series analysis and parameter estimation in automation.	[AP]

INTRODUCTION TO DATA SCIENCE
Need for data science – benefits and uses – facets of data – data science process – setting the research goal – retrieving data – cleansing, integrating, and transforming data – exploratory data analysis – build the models – presenting and building applications- Getting started with R- Exploratory Data Analysis, Bayes Rule- Supervised Learning- Regression- polynomial regression- local regression- k-nearest Neighbors. **(15 Hours)**

DESCRIPTIVE ANALYTICS
Frequency distributions – Outliers –interpreting distributions – graphs – averages - describing variability – interquartile range – variability for qualitative and ranked data - Normal distributions – z scores –correlation – scatter plots – regression – regression line – least squares regression line – standard error of estimate – interpretation of R^2 – multiple regression equations – regression toward the mean. Case Study: Autonomous Vehicle Sensor Data Analysis. **(15 Hours)**

PREDICTIVE ANALYTICS
Linear least squares – implementation – goodness of fit – testing a linear model – weighted resampling. Regression using State Models – multiple regression – nonlinear relationships – logistic regression – estimating parameters – Time series analysis – moving averages – missing values – serial correlation – autocorrelation. Data Acquisition and Preprocessing in Robotics Sensors and IoT Data Collection for Automation **(15 Hours)**

Total hours:	**45**

Text Books:

1.	David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.
2.	Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.
3.	Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, “Fundamentals of Data Science”, CRC Press, 2022.

Reference Books:

1.	Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, “Fundamentals of Data

	Science”, CRC Press, 2022.
2.	Chirag Shah, “A Hands-On Introduction to Data Science”, Cambridge University Press, 2020.
3.	Vineet Raina, Srinath Krishnamurthy, “Building an Effective Data Science Practice: A Framework to Bootstrap and Manage a Successful Data Science Practice”, Apress, 2021.
Web Resources:	
1	https://onlinecourses.nptel.ac.in/noc25_cs20/preview
2.	https://aws.amazon.com/what-is/data-analytics/
3.	https://www.coursera.org/browse/data-science/data-analysis
4.	https://pll.harvard.edu/subject/data-analysis
5.	https://www.netacad.com/courses/data-analytics-essentials?courseLang=en-US
6.	https://onlinecourses.nptel.ac.in/noc21_cs45/preview

22MT013	COMMUNICATION NETWORKS IN IOT	3/0/0/3
Nature of Course: Theory		
Pre requisites : Nil		
Course Objectives:		
1. To recall the fundamentals of IoT and its access technologies 2. To discuss the design methodology and different IoT hardware platforms. 3. To impart the basics of IoT Data Analytics and supporting services.		
Course Outcomes: **Upon completion of the course, students shall have ability to**		

C013.1	Describe the basic components of IoT and its architecture.	[U]
C013.2	Summarize the design methodology and its technologies.	[U]
C013.3	Relate IoT systems using embedded logic and smart components.	[AP]
C013.4	Differentiate various IoT communication protocols and its application to evaluate their applicability in constrained environments.	[A]
C013.5	Infer data analytics strategies and support services for handling data for enabling IoT/M2M applications.	[A]

FUNDAMENTALS OF IoT

Evolution of Internet of Things, Enabling Technologies, M2M Communication, IoT World Forum (IoTWF) standardized architecture, Simplified IoT Architecture, Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects. case study**:** IoT applications in predictive maintenance system. **(15 Hours)**

IoT PROTOCOLS

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.11ah and Lora WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks,6LoWPAN, Application Transport Methods: SCADA, Application Layer Protocols: CoAP and MQTT. Data transfer: transferring data from DCS /SCADA to LAN network, Design Methodology, Embedded computing logic, IoT system building blocks. case study: Industry 4.0 concepts. **(15 Hours)**

DATA ANALYTICS AND SERVICES

Data Analytics: Introduction, Structured Versus Unstructured Data, Data in Motion versus Data at Rest, IoT Data Analytics Challenges, Data Acquiring, Organizing in IoT/M2M, Supporting Services: Computing Using a Cloud Platform for IoT/M2M Applications/Services, Everything as a service and Cloud Service Models**.** Case study: Smart Home Automation using IoT- Philips Hue Smart Lighting System. **(15 Hours)**

Total hours:	**45**

Text Books:	
1.	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things” Cisco Press, 2017

2.	Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach” Universities Press, 2015
3.	Internet of Things: Architecture, Design Principles and Applications, Rajkamal, McGraw Hill Higher Education 2nd edition 2022
Reference Books:	
1.	Pramod R. Gunjal, Satish R. Jondhale, Jaime Lloret Mauri, Karishma Agrawal “Internet of Things: Theory to Practice” RC Press Publication 2024
2.	Nishanta Ranjan Nanda, Subhasis Mohapatra, Aloka Natha, Saumya Ranjan Sahu “Fundamental Concepts of Internet of Things” Authors Click Publishing Publication 2024
3.	Olivier Hersent, David Boswarthick, Omar Elloumi “The Internet of Things – Key applications and Protocols,” Wiley, 2021.
Web Resources:	
1	https://onlinecourses.nptel.ac.in/noc22_cs53
2.	https://www.coursera.org/specializations/internet-of-things
3.	https://onlinecourses.nptel.ac.in/noc21_ee85

22MT014	VISION GUIDED ROBOTICS	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1.	To impart knowledge of computer vision to guide the manipulators and mobile Robots
2.	To learn the basic concepts of VSLAM
3.	To provide the knowledge in formulation of motion analysis.

Course Outcomes:

Upon completion of the course, students shall have ability to

C014.1	Describe the foundations of computer vision techniques for Robots.	[U]
C014.2	Examine the governing equations of vision guidance for manipulators.	[AN]
C014.3	Recognize the various ways to utilize computer vision for mobile Robots.	[U]
C014.4	Employ the different algorithms for Motion analysis.	[AP]
C014.5	Use the computer vision algorithms for Manipulators and mobile Robots.	[AP]

VISUAL SERVOING

Vision for robot manipulation and Navigation-Motivation. Modeling velocity of a rigid object-Camera configurations in vision guided Robots-Triangulation-Vision based pose estimation.
Classification of visual servoing Architectures-Image based visual servoing (IBVS), Interaction matrix derivation-Geometrical interpretation of IBVS, stability analysis-Case study: IBVS with stereo vision system **(15 Hours)**

MOBILE ROBOTIC VISION

Introduction to simultaneous localization and mapping, visual SLAM (VSLAM)-VSLAM Approaches. Introduction to visual odometry (VO). VO: Motion from Image feature correspondences, motion from 3D structure. Comparison between VSLAM and VO calibration Techniques. **(15 Hours)**

MOTION ANALYSIS

Formulation of the motion Analysis-Motion field of Rigid objects, Aperture Problem-Optical flow and motion field, brightness constancy equation and Validity-Estimating motion field: Differential techniques, feature based techniques. Target tracking: Challenges and solutions, Kalman filtering basics - Kalman tracking. **(15 Hours)**

45

Text Books:

1	Emanuele Trucco, Alessandro Verri, “Introductory Techniques for 3D Computer Vision”, Prentice Hall of India, 2018.
2	Bruno Siciliano, Oussama Khatib, “Springer Handbook of Robotics”, Springer, 2008
3	D. Scaramuzza and F. Fraundorfer, "Visual Odometry [Tutorial]", IEEE Robotics & Automation, Magazine, vol. 18, no. 4, pp. 80-92, December, 2011.

Reference Books:

1	F. Fraundorfer and D. Scaramuzza, "Visual Odometry: Part II: Matching, Robustness, Optimization, 1 EE Robotics & Automation Magazine, Vol 18, Issue 4, 2011.
2	Revisiting Visual Odometry for Real-Time Performance, Gaurav Singh, Meiqing Wu, S. Lam, Published 27 May 2019.

Web Resources:

1	https://www.cognex.com/en-in/industries/vision-guided-robotics
2	https://www.tm-robot.com/en/robot-vision-system/
3	https://www.baslerweb.com/en/industry-solutions/vision-guided-

	robotics/?srsltid=AfmBOopmrd-HLI7iXCQToXuvFz70wVWzrWUAmIPhxS6eNn06ETsB1aQ
4	https://www.tm-robot.com/en/robot-vision-system/

SEMESTER – VIII

22MT801	PROJECT - II	0/0/24/12
Nature of Course	Practical	
Pre-Requisites	-	

Course Objectives:

1. To demonstrate the interpersonal skills and technical abilities.
2. To apply suitable tools and techniques to solve the practical problems.
3. To develop a working model

Course Outcomes:
Upon completion of the course, students shall have ability to

C801.1	Identify the real-time problem in thrust areas	[A]
C801.2	Compare and contrast the several existing solutions for the problems identified	[AP]
C801.3	Design the proposed model using software tools	[A]
C801.4	Develop and fabricate the proposed model	[AP]
C801.5	Analyze and present the work carried out	[A]

SOP FOR PROJECT-II

1. Students must do the projects in Mechatronics domain.
2. Students can do projects either by individual or group containing maximum of 4 per batches.
3. Students should fix one External guide from Industry and One Internal guide from department based on their field of domain or area of interest.
4. Students have to carry project in the industry for the complete duration of the semester.
5. Students should present all their reviews compulsory as per the fixed schedule.
6. Students must publish a patent or paper in International Journals/International conference organized by premier institutions.
7. Students must produce Attendance and Industrial certificates from their project carrying Industry.
8. Students must prepare their documents without any plagiarism.
9. Students should follow all the procedures, formats and instructions in their documentation works as per the guidelines by the institution.

Week	Guidelines
0	Permission shall be obtained from the industries for doing project during mid of 7th semester
	Students shall visit the industries to identify Mechatronics domain problem for which solution has to be obtained
1	Students shall fix guide, one internal guide in department and one external guide in industry who is appropriate to their field of interest and fix the title of the project
2	ZEROTH REVIEW – Verification of Industry Finalization and Feasibility of Project • Review mark is based on Selection of industries, submitting the company letter/Acknowledgement, Title of project, Feasibility of project completion • Getting internal guide consent and approval in project diary. • Presentation, contribution, dress code and performance of individual students will be considered for evaluation.
3	Literature review pertaining to problem identified shall be done by the students

4	Students shall do design calculation and software modelling of the proposed project.
5	Verification by the guide and design expert. Further, approval is obtained from project coordinator.
6	FIRST REVIEW – Submission of Design calculation, Assembly, part drawings and bill of material Review mark is based on: • Submission of industry attendance for individual student approved by external guide and internal guide, submission of Design calculation, Assembly and part drawing approved by Project guide and Project coordinator • Project report includes Abstract, Introduction, Literature Review corrected by Internal guide and Project diary submission. • Presentation, contribution, performance and dress code of individual students.
7	Students shall collect the hardware components required for the project/ The simulation required for the project shall be carried out.
8	Evaluation team members of the department shall visit the industry concerned surprisingly to verify the progress of the project and necessary arrangement must be made by students.
9	Fabrication of the proposed project shall be accomplished by the student at the concerned industrial premises.
10	SECOND REVIEW – Verification of Industry attendance and Industry inspection. Review mark is based on: • Submission of industry attendance for individual student approved by external guide and internal guide • Work progress, Material purchase, fabrication status and its video • Project report with Abstract, Introduction, Literature Review, Design calculation, Assembly drawing and part drawing, Bill of Materials approved by Internal guide, project diary submission, • Attendance during Industry inspection. • Presentation, contribution performance and dress code of individual students.
11	Students shall publish a patent or paper in an International Journals/ international conference organized by premier institutions
12	Evaluation team members of the department shall visit the industry concerned surprisingly to verify the progress of the project and necessary arrangement must be made by students.
13	THIRD REVIEW – Verification of completion of project, documentation Review marks is based on: Submission of completion certificate, Paper publication proof, Submission of industry attendance for individual student approved by external guide and internal guide • Submission of final project working model, video submission of their work progress details, final Project report approved by internal guide, project diary submission, attendance during Industry inspection, feedback from industry. • Presentation, contribution and performance of individual students.
14	END SEMESTER PROJECT VIVA VOCE EXAM • The viva – voce examination is evaluated based on presentation by individual batch members, demonstration of the project, project diary, project report, dress code and the components decided by external examiner.

	• Final report copies (Number of batch members + 2) should be submitted to project guide one day prior to scheduled viva date duly signed by project guide and head of the department

General Guidelines:

Assessment Components		
S.No.	**Category**	**Marks**
1	Zeroth Review	**10**
2	First Review	**10**
3	Second Review	**15**
4	Third Review	**15**
5	Journal Publication/ International Conference/ Patent Publication	**10**
6	Report & Final Viva Voce	**40**
Total		**100**

OPEN ELECTIVES

22MT001	BASICS OF ROBOTICS	3/0/0/3

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1. To introduce the principles of robotics.
2. To understand the design and implementation of robot applications and their relationship to other automated technologies.
3. To understand the basis of machine vision & its application in robotics.

Course Outcomes:

Upon completion of the course, students shall have ability to

C001.1	Outline the basics of robotics and Robot components.	[U]
C001.2	Apply the machine vision techniques for robotics.	[AP]
C001.3	Identify the types of sensors and end effectors in robots	[A]
C001.4	Illustrate basic robot programming techniques.	[U]
C001.5	Model various applications of robots	[AP]

ROBOTICS

Introduction – Definition of a Robot – Laws of Robots – Robot Anatomy– Components of an Industrial Robot – Robot-work space – Classification of Robots – Machine Vision – Robotics & Machine Vision –Terminologies used for robotics specification and selection for industrial applications. **(15 Hours)**

ROBOTIC SENSORS

Introduction – Types of Sensors in Robots – Tactile Sensors – Proximity Sensors: Position sensors – Range sensors – Machine Vision Sensors, Robot End Effectors: Classification of End Effectors –Grippers – Types of Grippers – Mechanical Grippers–Vacuum/Suction Grippers – Magnetic Grippers. **(15 Hours**)

ROBOT PROGRAMMING

Introduction – Robot Programming Techniques – Online Programming – Lead Through Programming – Off Line Programming – Motion Programming – Applications: Manufacturing, Agricultural and Material Handling - Underwater robots, Medical robots, Landmine detection robots. **(15 Hours)**

Total hours: 45

Text Books:

1	M. P. Groover, “Industrial robotics- Technology, programming and Applications”, McGraw Hill Education, Second edition, 2017.
2	A. K. Gupta, S. K. Arora, “Industrial Automation and Robotics”, University Science Press, An Imprint of Laxmi Publications Pvt. Ltd, Third Edition, 2013.

Reference Books:

1	Sathya Ranjan Deb, “Robotics Technology & flexible Automation”, Sixth Edition, Tata McGraw-Hill Publication, 2011.
2	John. J. Craig, “Introduction to Robotics: Mechanics & control”, Third Edition, Pearson/Prentice Hall, 2012.

Web Resources:

1	http://www.gorobotics.net/
2	http://www.robotbooks.com/general-robotics-links.html
3	https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/lecture-notes/
4	http://nptel.ac.in/courses/112101099/