SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY

An Autonomous Institution | Approved by AICTE | Affiliated to Anna University
Accredited by NAAC with A++ Grade, Kuniamuthur, Coimbatore - 641008

83rd Rank

DEPARTMENT OF MECHATRONICS ENGINEERING

(Accredited by NBA)

AUTONOMOUS CURRICULUM AND SYLLABI

2022-2026 BATCH

REGULATIONS 2022

SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution | Approved by AICTE | Affiliated to Anna University | Accredited by NAAC with A++ Grade
Kuniamuthur, Coimbatore – 641008
Phone : (0422)-2678001 (7 Lines) | Email : info@skcet.ac.in | Website : www.skcet.ac.in

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

I.	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	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO 8	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO 9	**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 10	**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 11	**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

Knowledge and Attitude Profile (WK)

WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline much is at the forefront of the discipline
WK5	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues
WK9	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes

III.	**PROGRAMME SPECIFIC OUTCOMES (PSOs)**
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

III. MAPPING OF PEOs WITH POs and PSOs													
PEO	**POs**											**PSO**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**1**	**2**
1	3	2	3	1	2	3	2	3	3	3	2	3	3
2	3	3	2	2	3	2	1	2	2	2	3	3	3
3	3	3	3	2	1	3	2	2	3	1	3	3	3
4	3	2	3	1	2	3	2	2	3	3	3	2	2
5	3	3	3	1	2	3	2	2	3	1	3	2	2
	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
TOTAL			**19/1/8**	**28**	**22**	**1000**	

MC

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

OEC : Open and Emerging Elective Courses

BSC	**:** Basic Science Courses	**PRJ**	**:** Project Work
ESC	**:** Engineering Science Courses	**INT**	**:** Internship
PCC	**:** Professional Core Courses	**MC**	**:** Mandatory Course
PEC	**:** Professional Elective Courses		

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 I

22MT101	PRODUCTION TECHNOLOGY	3/0/0/3

Nature of Course: Theory

Pre requisites : Nil

Course Objectives:

1. To understand the various methods of manufacturing processes.
2. To develop the knowledge on machines and related tools for manufacturing various components.
3. To impart the knowledge of relative advantages of advanced manufacturing processes over conventional techniques.

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

C101.1	Identify the most appropriate manufacturing process for a given material and product.	[R]
C101.2	Understand basic manufacturing operations, including their capabilities, limitations.	[U]
C101.3	Enumerate the construction of Lathe, Milling, Drilling and grinding machine.	[U]
C101.4	Infer the significance of unconventional machining processes	[AP]
C101.5	Choose the process parameters for different manufacturing processes.	[AP]

Course Contents:

MATERIALS AND MANUFACTURING PROCESSES

Steel-Types- Cast Iron- Types- Casting: Sand casting, Die casting, Investment casting. Forging- Rolling- Extrusion - Sheet metal Process: Blanking, Punching and Bending. Welding – Electric arc welding-Resistance Welding-Submerged arc welding, Tungsten inert gas welding-Powder metallurgy process. **(15 Hours)**

MACHINE TOOLS

Lathe machine –Types and Operations - Construction of Engine lathe –Construction of horizontal milling machine – Keyway and gear milling – Construction of Shaping machine–Construction of radial drilling machine - Construction of cylindrical grinding and Surface grinding machine. **(15 Hours)**

ADVANCED MANUFACTURING PROCESSES

Classification - Construction, Working Principle and Applications of: Ultrasonic Machining, Electrical Discharge Machining, Laser Beam Machining, Plasma Arc Machining, Electro chemical Machining-Introduction to Additive Manufacturing. **(15 Hours)**

Total hours: 45

Text Books:

1.	R.K. Rajput, “A Text book of Manufacturing Technology (Manufacturing Processes)”, Lakshmi Publications (P) Ltd., New Delhi, 2019.
2.	Pandey P.C. and Shan H.S., “Modern Machining Processes”, Tata McGraw-Hill, New Delhi, 2017.

Reference Books:

1.	R.S. Khurmi & J.K. Gupta, “A Text book of Workshop Technology: Manufacturing Processes”, Nirja Publishers & Printers Pvt. Ltd., Uttarakhand, 2021
2.	V.K.Jain ,”Advanced Machining Processes”, Allied Publishers Pvt. Ltd., Bengaluru, 2016

Web References:

1	http://nptel.ac.in/courses/webcourse-contents/iit-roorkee/manufacturing-processes/
2.	http://nptel.ac.in/courses/112105126/
3.	https://www.edx.org/course/fundamentals-manufacturing-processes-mitx-2-008x
4.	https://www.trendmicro.com/vinfo/us/security/definition/industrial-internet-of-things-iiot
5.	https://www.twi-global.com/technical-knowledge/faqs/what-is-additive-manufacturing

22MA105	MATRICES AND CALCULUS I (COMMON TO MECH, MCT)	3/1/0/4
Nature of Course	B (100% analytical)	
Pre requisites	-	

Course Objectives:

1.	To develop the skill to use matrix algebra techniques that are needed by engineers for practical applications.
2.	To know about system of linear equations and its solution set and how to write down the coefficient matrix and augmented matrix of a linear system
3.	To familiarize the concepts of differential calculus which are applicable in many branches of engineering.
4.	To find the solution of ordinary differential equations as most of the engineering problems are characterized in this form.
5.	To make the student acquire sound knowledge of numerical techniques in solving ordinary differential equations that model engineering problems.

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

C105.1	Use the matrix algebra methods for solving practical problems	[R]
C105.2	Solve systems of linear equations and differential equations in numerical way.	[U]
C105.3	Implement the concepts of eigenvalues and eigenvectors in various Engineering problems.	[AP]
C105.4	Apply the concepts and principles of differential calculus to find the curvature of different curves.	[AP]
C105.5	Find the solution to second and higher order differential equations and to apply numerical techniques to analyse and visualize data to solve basic engineering-related problems.	[AP]

Course Contents

MODULE I - MATRICES **(20 Hrs)**

Definition – Types of matrices – Characteristic equation – Eigenvalues and Eigenvectors of a real matrices and their properties (excluding proofs) – Orthogonal transformation of a real symmetric matrix to diagonal form – Quadratic form– Reduction of quadratic form to canonical form by Orthogonal transformation– Nature of Quadratic forms – Cayley Hamilton Theorem(excluding proof) – Applications of Cayley Hamilton theorem in finding inverse and higher powers - Solution of linear system by Gauss Elimination method – Gauss Seidel iterative method – Eigenvalue of a matrix by Power method.

MODULE II - APPLICATIONS OF DIFFERENTIAL CALCULUS **(20 Hrs)**

Curvature, Centre, Radius and Circle of curvature in cartesian co-ordinates – Evolutes – Envelopes – Evolute as envelope of normals.

MODULE III - ORDINARY DIFFERENTIAL EQUATIONS **(20 Hrs)**

Second and Higher order linear differential equations with constant coefficients – Second and Higher order linear differential equations with variable coefficients – Euler Cauchy's and Legendre's linear equations – Numerical solutions for ordinary differential equations: Taylor series method – Euler's method – Modified Euler's method – Fourth order Runge Kutta method for solving first order equations–Milne's and Adams's predictor and corrector methods.

Total hours	**60**

Text Books:

1.	G.B. Thomas and R.L. Finney, Calculus and Analytic Geometry, 14th Edition, Pearson, Reprint, 2018.
2.	Kreyszig. E, "Advanced Engineering Mathematics" Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore 2020.

3.	Grewal. B.S, “Higher Engineering Mathematics”, 44rd edition, Khanna Publications, Delhi, 2021.
4.	Grewal. B. S, “Numerical methods in Engineering and Science”, Khanna Publications, Delhi, 2016.
Reference Books:	
1.	Veerarajan. T, “Engineering Mathematics I”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2018.
2.	Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, 5th edition, 2018.
3.	N.P. Bali and Dr. Manish Goyal,” A Text book of Engineering Mathematics” 10th edition, Laxmi publications ltd, 2020.
Web References:	
1.	https://nptel.ac.in/courses/111105121
2.	https://nptel.ac.in/courses/111106100
3.	https://nptel.ac.in/courses/111107106
4.	https://nptel.ac.in/courses/111107107
Online Resources:	
1.	https://www.coursera.org/learn/matrix-algebra-engineers
2.	https://www.coursera.org/learn/differentiation-calculus
3.	https://www.coursera.org/lecture/discrete-calculus/numerical-o-d-e-s-cre5Q
4.	https://ocw.mit.edu/courses/18-03-differential-equations-spring-2010/

22EN101	TECHNICAL COMMUNICATION SKILLS (MCT/CIVIL/IT/EEE/ECE/AI&DS/CYBER/CSE/CSD) (SEMESTER I) (MECH- SEMESTER II)	2/0/2/3
Nature of Course	: Theory Skill Based	
Pre requisites	Basics of English Language	
Course Objectives:		
1	To enhance learners' LSRW skills.	
2	To develop students' ability to understand the process of communicating and interpreting ideas and human experiences.	
3	To facilitate learners to acquire effective technical writing skills.	
4	To prepare learners for placement and competitive exams.	
5	To facilitate effective language skills for academic purposes and real-life situations.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C101.1	Remember language skills for technical communication.	[R]
C101.2	Apply communication skills in a corporate environment.	[AP]
C101.3	Understand and communicate effectively in personal and professional situations.	[AP]
C101.4	Understand and analyse a variety of reading strategies to foster comprehension and to construct meaningful and relevant connections to the text.	[U]
C101.5	Apply technical writing skills to write letters, emails and prepare technical documents.	[AP]

Course Contents:

Module I **10 Hours**

Introduction-Listening: - Listening to News in NDTV and Times Now Channels. **Speaking**: Introduction to Effective Communication - Barriers to Effective Communication- Tips to develop Communication Skills - Self Introduction - Overview of Business Communication-Short Talk on Business Topics -Impromptu Speaking (Public Speaking) - Non-Verbal Communication-SATORI-Sharing Personal Information-**Reading**: Reading Comprehension- Values and its Importance. **Writing**: SWOT Analysis -Book Review - Movie Review-Vocabulary Building.

Module II **10 Hours**

Listening: Listening to Specific Information. **Speaking**: Speaking on Specific Information. **Reading**: Skimming and Scanning-Reading Short Texts - Comparing Facts and Figures - Short Stories and Scientific Articles. **Writing**: Good and Bad Writing- Note Making - Writing Formal Letters (Inviting, Accepting and Declining Invitations)- Writing Business Letters (Calling for Quotations, Seeking Clarifications, Placing an Order and Complaint Letter)- Transcoding (Bar chart, Flowchart. Pie chart and Table)-Job Application Letter- Resume Writing.

Module III **10 Hours**

Listening: Listening to Narrations and Persuasive speech and identifying narrative and persuasive techniques. **Speaking**: 21st Century Skills- Narrative Skills- Leadership- Conflict Resolution-Persuasive Speaking-How to Tell a Story with Charts and Graphs **Reading:**Product Description and Product Review. **Writing**: Email Writing –Advantages and Disadvantages- Circular – Agenda and Minutes of the Meeting - Proofreading- Subject Verb Agreement-Tenses-Active Voice- Passive Voice- Impersonal Passive Voice-Report Phrases – Report Writing **(30 Hours)**

Lab Components		
1	**Listening Comprehension** **1.News in NDTV and Times Now Channels** **2.Listening to Specific Information**	[AP]

2	**Impromptu Speaking**	[AP]
3	**Reading Comprehension related to Competitive Exams**	[U]
4	**Immersion Activity and Presentation**	[AP]
5	**Group Discussion**	[AP]
6	**Group Assignment – Form an NGO**	[AP]
		30 Hours
	Total Hours:	**30+30=60 Hours**
Text Books:		
1	Basic Communication Skills for Technology, by Andrea J Rutherford, Pearson Publishers.2000	
2	Remedial English Grammar. F.T. Wood. Macmillan.2007	
3	Oxford Guide to Effective Writing & Speaking by John Seely, Oxford University Press.2005	
4	Dr Sumanth S, English for Engineers, Vijay Nicole Imprints Private Limited 2015.	
Reference Books:		
1	Touchstone Student's Book 1 by Michael McCarthy, Jeanne McCarten, Helen Sandiford, Cambridge University Press.2005	
2	Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.	
3	Touchstone Student's Book 2 by Michael McCarthy, Jeanne McCarten, Helen Sandiford, Cambridge University Press.2015	
Web References:		
1	http://www.academiccourses.com/Courses/English/Business-English	
2	https://www.liveworksheets.com/worksheets/en/English_as_a_Second_Language_(ESL)/Technical_English	
Online Resources:		
1	https://www.coursera.org/specializations/business-english	
2	https://www.businessenglishresources.com/learn-english-for-business/student-section/practice-exercises-new/	

22CS101	PROBLEM SOLVING USING C++	3/0/2/4

Nature of Course: C(Theory Concept), K (Problem Programming)

Pre requisites

Course Objectives:

1	To learn the fundamental programming concepts and methodologies which are essential to build good C++ programs.
2	To gain knowledge on control structures and functions in C++
3	To provide the basic object-oriented programming concepts and apply them in problem solving.
4	To introduce file streams and operations for storing data permanently.
5	To know generic programming paradigm

Course Outcomes:

Upon completion of the course, students shall have ability to

C101.1	Solve problems using operators and control Statements	[AP]
C101.2	Write C++ programs for processing strings and arrays	[AP]
C101.3	Apply the concepts of pointers and functions in programs.	[AP]
C101.4	Develop C++ programs using various object-oriented concepts to solve real world problems	[A]
C101.5	Implement the concepts on file streams and operations	[AP]

Course Contents:

Module – I: C++ Programming Fundamentals (15 Hours)

C vs C++, Basic of OOPS, the main () function, Header files, Basic Input and Output (I/O) using cin and cout, Variable, Constant. **Operators:** Arithmetic Operators, Assignment Operators, Relational Operators, Logical Operators, Bitwise Operators, Other Operators, Operator Precedence. Control Statements: if, if...else and Nested if...else, switch. Case, break and continue, Loops - for loop, while loop, do while loop, goto. **Arrays and Strings**: 1D array, 2D array, Strings, String functions. **Function:** Basics, call by value, call by reference & return by reference, Inline function, overloading Functions, inline Functions, Recursive Functions. **Pointers:** Pointer, Dynamic Memory Allocation.

Module – II: Object Oriented Concepts (15 Hours)

Classes and Objects, public, private, protected. **Constructors and destructors**: Overloaded Constructor, Copy Constructor, Shallow Copying Deep Copying. **Overloading:** this' Pointer, structs vs Classes, Friends of a class, Operator Overloading Inheritance, Overloading vs overriding, Polymorphism, Virtual Functions, Pure Virtual Functions and Abstract Classes.

Module – III: Files and Generic Programming (15 Hours)

Abstract Classes as Interfaces, Exception, Files, Streams and I/O, STL, Generic Programming, Lambda Expression.

Total Hours (Theory)	**45**

Lab Component

S. No	Lab Exercises
1.	Practice of C Programming using Branching and Iterative constructs.
2.	Programs using arrays and strings
3.	Programs using Functions
4.	Programs using Structures and Pointers.
5.	Programs using classes and objects
6.	Programs using constructor and destructor
7.	Programs using method overloading, operator overloading and polymorphism concepts.

8.	Programs using friend class
9.	Programs using virtual functions and abstract class.
10.	Programs using inheritance concepts
11.	Programs using exception handling concept
12.	Programs using Files.
13.	Mini project
Total Hours (Lab)	**30**
Total Hours (45+30)	**75**

Text Books:	
1.	E Balagurusamy, “Object Oriented Programming with C++”, 4th Edition, Tata McGraw-Hill Education, 2008.
2.	Yashavant P. Kanetkar, “Let us C++”, BPB Publications, 2020
3	M. Sprankle, “Problem Solving and Programming Concepts”, 9th Edition, Pearson Education, New Delhi, 2011
Reference Books:	
1.	Herbert Schildt, “The Complete Reference C++”, 4th Edition, MH,2015
2.	John Hubbard, “Schaum's Outline of Programming with C++”, MH,2016
Web References:	
1	https://www.geeksforgeeks.org/c-plus-plus/
2	http://web.stanford.edu/class/cs106l/
Online Resources:	
1	https://nptel.ac.in/courses/106101208
2	https://www.hackerrank.com/domains/cpp
3	https://codeforces.com/blog/entry/74684
4	https://www.hackerearth.com/practice/notes/tricky-and-fun-programming-in-c/

22PH104	APPLIED PHYSICS (Common to MECH. MCT and CIVIL)	3/0/2/4

Nature of Course	: E (Theory skill based)
Prerequisites	: Nil

Course Objectives:

1	To enable the students to understand the basics of harmonic oscillator and Laser.
2	To learn the basic concepts of Electromagnetic waves
3	To familiarize the principle of Quantum mechanics and crystallography.

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

C104.1	Understand the physical characteristics of Simple harmonic oscillation	[U]
C104.2	Recall the basic concept and applications of laser.	[R]
C104.3	Describe the basic principles of Electromagnetic waves, sensors and transducers.	[U]
C104.4	Interpret the central concepts and principles in quantum mechanics, such as the Schrödinger equation and the wave function.	[AP]
C104.5	Estimate the Atomic packing, acquire the basic knowledge about Crystal Lattice and Unit cell.	[AP]

Course Contents:

Harmonic oscillations and Laser ***15 Hours***

Harmonic oscillations: periodic motion – Simple harmonic motion: characteristics of simple harmonic motion – Simple spring-mass system – Resonance – Damped harmonic oscillator. Energy considerations, comparison with un-damped harmonic oscillator, logarithmic decrement, relaxation time, quality factor.

Laser: characteristics of laser – Principle of spontaneous emission and stimulated emission – Einstein's theory of matter radiation interaction and A and B coefficients (derivation) – Population inversion – Pumping – Different types of lasers: CO_2 laser - Semiconductor Laser (Homo-junction and Heterojunction), – Qualitative industrial applications of lasers: welding, drilling and cutting.

Electromagnetic waves: ***15 Hours***

Concept of Del operator, gradient, divergence and curl operators and their physical significances - Gauss divergence theorem, Stokes theorem.

Laws of Electromagnetism: Gauss law of electricity, Gauss law of magnetism, Faraday' law of electromagnetic induction, Ampere's circuital law- (Derivation only) – Dielectrics: Concept of different charge and current densities - free charges, bound charges; Maxwell's equations in free space and dielectric medium (equations only). **Sensors and Transducers:** Introduction, Classification of Transducers - Transducers Actuating Mechanisms - Resistance Transducers - Piezoelectric Transducers, Thermoelectric Transducers - Photoelectric Transducers.

Quantum mechanics and Crystallography: ***15 Hours***

Quantum mechanics: Planck's quantum theory (derivation) – Matter waves, de-Broglie wavelength – Heisenberg's uncertainty principle – Schrödinger's wave equation: time independent and time dependent – Physical significances of wave function – Particle in a one-dimensional potential box. **Crystallography:** crystal system – lattice – Bravais lattice, calculation of atomic packing factor for simple cubic, body centered cubic, face centered cubic and hexagonal close packed lattice – Miller indices – Problems - Crystal imperfections: point & line - burger vector. Basic concepts of band theory and classification of materials into conductor, semiconductor and insulator.

45 Hours

Lab Component ***30 Hours***

1	Determination of frequency of transverse and longitudinal wave modes – Melde's experiment.	[E]
2	Determination of characteristics of Simple harmonic motion – Simulation lab.	[E]

3	Determination of laser parameter	[E]
4	Determination of optical fiber parameters.	[E]
5	Determination of characteristics of LCR circuits.	[E]
6	Determination of characteristics of RC circuit to find the time constant	[E]
7	Determination of Magnetic field along the axis of current carrying coil- Stewart and Gee method.	[E]
8	Determination of Planck's Constant.	[E]
9	Determination of Stefan's Constant.	[E]
10	Determination of lattice constant of cubic crystal structure.	[E]
	Life Skills Experiments	
11	Determination of pressure required to shut off the fuel pump nozzle.	[E]
12	Determination of capacitance required to shut off the circuit in a circuit breaker.	[E]
13	Determination of earth, neutral and phase line in a circuit.	[E]
	Total Hours:	**75**
Text Books:		
1	David Halliday, Robert Resnick, Jearl Walker "Fundamentals of Physics" Wileyplus.2018	
2	Rajendran, V "Engineering Physics" Mc Graw Hill Publications ltd, New Delhi, 2016.	
Reference Books:		
1	Avadhanulu M.N., Kshirshagar P.G., Arun Murthy TVS "A Text Book of Engineering Physics"S. Chand& Co Ltd, 2018.	
2	Sawhney A.K., Puneet Sawhney "A Course In Mechanical Measurements And Instrumentation & Control" Dhanpat Rai & Co, 2013.	
3	**Richard P. Feynman. Robert B. Leighton, Matthew Sands**"The Feynman Lectures on Physics Vol. I": The New Millennium Edition.2015	
4	David J. Griffiths, "Introduction to Quantum Mechanics", 2nd edition, Cambridge university press, 2017.	
5	Chris Bernhardt, "Quantum Computing for Everyone" The MIT press, 2019	
Web References/ Online Resources:		
1	https://faraday.physics.utoronto.ca/IYearLab/Elastic-properties-of-solids-manual.pdf	
2	https://www.physik.uzh.ch/~matthias/espace-assistant/manuals/en/anleitung_102-tb_e.pdf	
3	https://ir.nctu.edu.tw/bitstream/11536/1680/1/A1995TF11100052.pdf	
4	http://www2.optics.rochester.edu/workgroups/cml/whole-enchilada-SPR05.pdf	
5	https://nptel.ac.in/courses/122/103/122103010/	
6	https://nptel.ac.in/courses/115/106/115106119/	
7	https://www.eatm.in/upload/srit___unit_i_laser.pdf	
8	https://nptel.ac.in/courses/115/101/115101107/	
9	https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/lecture-notes/	
10	http://nptel.ac.in/courses/113106032/4%20-%20Crystal%20structure.pdf	

22MT102	COMPUTER AIDED DRAWING LABORATORY FOR MECHATRONICS	0/0/3/1.5

Nature of Course: Practical

Pre requisites: Nil

Course Objectives:

1. To develop the visual science in the form of technical graphics.
2. To develop an understanding of Isometric to Orthographic Views and vice versa.
3. To develop 3D models for machine elements.

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

C102.1	Illustrate the dimensioning system in complex object.	[AP]
C102.2	Apply the different techniques of engineering drawing.	[AP]
C102.3	Examine their visualization skills for developing new products.	[AP]
C102.4	Develop projections of lines, planes, solids, isometric projections and sections of solids using software.	[AP]
C102.5	Simulate 3D models for machine elements.	[AP]

S.No	List of Exercises	CO Mapping	BT
Software used in Lab: 2D modelling software (AutoCAD)			
1.	Creation of simple component using Drawing and Modifying commands.	C102.1	[AP]
2.	Drawing front, top and side views of isometric drawings.	C102.2	[AP]
3.	Drawing front and top views for a prism and a pyramid.	C102.3	[AP]
4.	Drawing front and top views of Plane surfaces (Hexagon, Pentagon and circle) inclined to HP	C102.4	[AP]
Software used in Lab: 3D modelling Software (SolidWorks/ Creo)			
5.	Two shafts have to be connected for power transmission. Draw the part and assembly drawing of the any one of the components, which can solve this problem. (3D modelling of a Flange Coupling)	C102.5	[AP]
6.	Name a component that can be used to convert rotary motion to linear motion. Draw the part and assembly of that component. (3D modelling of Rack and Pinion)	C102.5	[AP]
7.	3D modelling of Plummer block	C102.5	[AP]
8.	3D modelling of Universal coupling	C102.5	[AP]
9.	3D modelling of Screw jack	C102.5	[AP]
10	3D modelling of Machine vice	C102.5	[AP]
		Total Hours : 45	

Text Books:

1. Venugopal. K, Prabu Raja. V, “Engineering Graphics” New Age International Publishers, 15th Edition, 2021.
2. Shah. M. B and Rana. B. C, “Engineering Drawing”, Pearson Education, 6th edition, 2018.

Reference Books:

1. Natarajan. K. V, “A textbook of Engineering Graphics”, Dhanalakshmi Publishers, 5th Edition, 2018.
2. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2019.
3. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2018.

Web References:

1. http://nptel.ac.in/courses/112104172/
2. http://home.iitk.ac.in/~mohite/TA101.html

22MT103	PRODUCTION TECHNOLOGY LABORATORY	0/0/3/1.5

Nature of Course: Practical

Pre requisites: Nil

Course Objectives:

1. To perform the different manufacturing processes.
2. To expose hands-on training to the students by various exercises using machines like lathe, Shaper, Milling, drilling and grinding machines
3. To impart the knowledge of relative advantages of advanced manufacturing processes over conventional techniques.

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

C103.1	Develop simple metal joints, sand mold, surfaces using welding, foundry and sheet metal operations.	[AP]
C103.2	Practice various operations on a given component using Lathe and drilling machine.	[AP]
C103.3	Construct flat surface on the given component using milling and shaper machines.	[AP]
C103.4	Examine the surface finish in the given components using grinding machines.	[AP]
C103.5	Produce products using 3D printer.	[AP]

S.No	List of Exercises	CO Mapping	BT
1.	Preparation of Butt joint and T- joint by Shielded metal arc welding	C103.1	[AP]
2.	Preparation of Green Sand Mould using Foundry operation.	C103.1	[AP]
3.	Fabrication of Tray and Cone by Sheet Metal Working operation.	C103.1	[AP]
4.	Perform Drilling, reaming and tapping operations on a mild steel flat work piece	C103.2	[AP]
5.	Step Turning and Taper Turning Operation using a Lathe.	C103.2	[AP]
6.	Internal and External Thread Cutting using a Lathe.	C103.2	[AP]
7.	Machining of Hexagon shape from round rod using Milling Machine.	C103.3	[AP]
8.	Machining square from round rod using Shaper.	C103.3	[AP]
9.	Perform plain surface grinding on the work piece using Surface Grinder.	C103.4	[AP]
10.	3D Printing of a Key chain (Basic Shapes)	C103.5	[AP]

Total Hours: 45

Reference Books:

1	Hajra Choudhury, “Elements of Workshop Technology”, Vol. I & II, Media Promotors Pvt. Ltd., Mumbai, 2014.
2	R.S.Khurmi & J.K.Gupta , “A Text book of Workshop Technology : Manufacturing Processes”, Nirja Publishers & Printers Pvt. Ltd, Uttarakhand , 2021
3	Kalpakjian and Schmid, Manufacturing Processes for Engineering materials (5th Edition) - Pearson India, Uttar Pradesh, 2014.

Web References:

1	http://msvs-dei.vlabs.ac.in/msvs-dei/SheetMetal.php
2	http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAM/#
3	www.nptel.ac.in

SEMESTER II

22MT201	APPLIED MECHANICS	3/0/0/3

Nature of Course : Analytical

Pre-Requisites : Nil

Course Objectives:

1. To get insight about the Law of Mechanics, resultant of Forces, equilibrium, the centroid, center of gravity and moment of inertia of composite areas.
2. To understand the mechanical properties of material, the concept of moment and couple and bending behavior of beam for various types of loads.

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

C201.1	Enumerate and predict the effect of forces and to find the centroid, center of gravity and moment of inertia.	[R]
C201.2	Determine the stress and strain induced in uniform and composite sections	[U]
C201.3	Associate the concept of moment and couple in solving shear force and bending moment diagram	[AP]
C201.4	Compute the bending stress in symmetrical sections and torque produced in circular shafts and hollow shaft.	[AP]
C201.5	Calculate the slope, deflection and buckling load of the column.	[AP]

Course Contents:

STATICS OF PARTICLES AND DISTRIBUTED FORCES

System of forces- Resolution and resultant of coplanar concurrent forces-Free body diagram - Equilibrium of a particle in two dimensions– Centroid of common shapes of area -Rectangle, triangle, circle, and semicircle by using standard formula - Centre of gravity of 3D composite bodies by using standard formula-Area moment of inertia –T section- I section- Angle Section-Parallel axis and perpendicular axis theorems-Polar moment of Inertia- Laws of Friction-Ladder Friction. **(15 hours)**

SIMPLE STRESSES, SHEAR AND BENDING MOMENT DIAGRAM

Stress: Tension, compression and shear- Strain: Linear, volumetric and shear- Hooke's Law, Elastic constants and their relations; Factor of safety; Poisson's ratio. Analysis of bars of uniform section and composite sections-Moment of a force- couple –Types of loads and support-Shear force and bending moment diagrams for cantilever, simply supported and overhanging beam with point and uniformly distributed loads. **(15 hours)**

TORSION OF SHAFTS AND DEFLECTION OF BEAM

Theory of simple bending and its equation – Bending stress in symmetrical sections -Torsion equation- Torsion in solid and hollow circular shafts- Evaluation of slope and deflection by Double integration and Macaulay's method for cantilever and simply supported beams - Column-Euler Equation –Introduction to Finite Element Analysis. **(15 hours)**

Total hours: 45

Text Books:

1.	N. Kottiswaran, "Engineering Mechanics Statics and Dynamics", Sri Balaji Publications,2017.
2.	Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016

Reference Books:

1.	F.P. Beer and Jr.E. Johnston, "Vector Mechanics for Engineers statics and Dynamics", Tata McGraw Hill Publishing Company, NewDelhi,11th edition,2017.
2.	S.S. Rattan, "Strength of Materials", Mc Graw Hill Publication, 2016.

Web References:

1	https://ocw.mit.edu/courses/1-050-engineering-mechanics-i-fall-2007/pages/lecture-notes/
2.	https://www.coursera.org/learn/engineering-mechanics-statics

22GE201	UNIVERSAL HUMAN VALUES (Common to all branches)	3/0/0/3

Nature of Course	Descriptive
Pre-Requisites	Interpersonal Communication and Value Sciences

Course Objectives:

1	Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2	Understanding (or developing clarity) of the harmony in the human being ,family, society and nature/existence.
3	Strengthening of self-reflection.
4	Development of commitment and courage to act.
5	Helping the students to appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings.
6	Highlighting plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

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

C201.1	Understand and take responsibilities in life and handle problems to attain sustainable solutions while keeping human relationships and human nature in mind.	[U]
C201.2	Apply responsibilities towards their commitments (human values, human relationship and human society).	[AP]
C201.3	Apply what they have learnt to their own self indifferent day-to-day settings in real life, atleast a beginning would be made in this direction.	[AP]
C201.4	Analyze ethical and unethical practices, and formulate strategies to actualize a harmonious environment wherever they work.	[AN]
C201.5	Understand the harmony in nature and existence, and work out mutually on fulfilling participation in nature.	[U]

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education, Understanding Harmony in the Human Being-Harmony in Myself! 15 Hours

Self-evaluation of the students- Pre-test of UHV**-** Purpose and motivation for the course.Self-Exploration–Its content and process- A look at basic Human Aspirations. Understanding Happiness and Prosperity correctly-Understanding the needs of Self('I') and 'Body'-Understanding the Body as an instrument of 'I'(being the doer, seer and enjoyer)-Understanding the characteristics and activities of 'I' and harmony in 'I' - Understanding theharmony of'I' with the Body- Social activities – Waste Management - Water Conservation-Soil Pollution - Physical Health and related activities - Lectures by eminent persons- Literary activities.

Module 2: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship, Understanding Harmony in the Nature and Existence- Whole existence as Coexistence

15 Hours

Understanding values in human relationship - Understanding the harmony in the society (society being an extension of family): - Visualizing a universal harmonious order in society-Understanding the harmony in Nature.-Understanding Existence as Coexistence of mutually Interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence-Buddy program- Relationships-Homesickness-Managing peer pressure-Projects-Socially responsible engineers-Visit to local areas (orphanages, special children)- Physicalactivities(games).

Module 3: Implications of the above Holistic Understanding of Harmony on Professional Ethics

15 Hours

Natural acceptance of human values- Definitiveness of Ethical Human Conduct- Basis for manistic Education-Humanistic Constitution and Humanistic Universal Order-Competence in professional ethics-Case studies of typical holistic technologies, management models and eco-friendly production systems - Strategy for transition from the present state to Universal Human Order-Sum up: Self-evaluation of the students-Post test of UHV.	
Total Hours:	**45**
Text Books:	
1	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
2	Rajni Setia, Priyanka Sharma, “Human Values”, Genius Publication”, Jaipur, 2019.
Reference Books:	
1	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
2	The Story of My Experiments with Truth –by Mohandas Karamchand Gandhi
3	India Wins Freedom-Maulana Abdul Kalam Azad.
Web References:	
1	https://examupdates.in/professional-ethics-and-human-values/
2	http://hvpe1.blogspot.com/2016/06/notes-human-values-and-professional.html
3	https://www.yourmorals.org/schwartz.2006.basic%20human%20values.pdf
Online Resources:	
1	https://nptel.ac.in/courses/109/104/109104068/
2	https://medium.com/the-mission/the-12-important-life-skills-i-wish-id-learned-in-school-f4593b49445b
3	https://www.thebalancecareers.com/life-skills-list-and-examples-4147222

22MT202	ANALOG AND DIGITAL ELECTRONICS	3/0/0/3

Nature of Course : Theory

Pre Requisites : Nil

Course Objective:

1	To educate the students about an introduction to basic analog and digital electronics
2	To introduce Operational amplifiers and to teach applications of operational amplifier circuits
3	To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits

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

C202.1	Recall and Recognize construction and characteristics of JFETs and MOSFETs and differentiate with BJT	[R]
C202.2	Discuss the functions of Operational Amplifier and its applications.	[U]
C202.3	Identify the importance of canonical forms in the minimization or other optimization of Boolean formulas in general and digital circuits	[U]
C202.4	Apply logic gates to construct combinational and Sequential circuits.	[AP]
C202.5	Examine the Registers, Counters and its applications	[AP]

Course Contents:

SEMICONDUCTOR DEVICES AND OPERATIONAL AMPLIFIERS

Construction & VI Characteristics: Bipolar Junction Transistor, Junction Field Effect Transistors, MOSFETs - Differences between JFETs and MOSFETs - Introduction to inverting and non-inverting Amplifier - Ideal v/s practical Op Amp - Performance Parameters - Astable & Monostable multivibrators - Peak Detector Circuit, Comparator, Integrator and Differentiator - Introduction to IC 555 Timer, ADC & DAC operation. **(15 Hours)**

LOGIC GATES AND COMBINATIONAL CIRCUITS

Review of Basic Logic gates - Boolean Algebra - Sum of Products Method (SOP), Product of Sums Method (POS), K Map representations, Minimization using K Maps - Half adder and Half Subtractor, Full adder and Full Subtractor using gates – Multiplexers and Demultiplexers - Decoders and Encoders - Motion control systems. **(15 Hours)**

SEQUENTIAL CIRCUITS

SR, JK, D and T flip flops - Level triggering and Edge triggering – 4 bit asynchronous and synchronous counters - Types of shift registers, 4 bit Serial in Serial Out, 4 bit Serial In Parallel out, 4 bit Parallel In Parallel Out, Universal Shift Register, Ring counter.

(15 Hours)

Total hours: 45

Text Books:

1.	A.P. Malvino, “Electronic Principles”, Tata McGraw Hill Publications, 2017
2.	M. Morris Mano, Michael D. Ciletti, “Digital Design”, Pearson, New York, 2019

Reference Books:

1.	D. Roy Choudhury and Shail Jain, *“Linear Integrated Circuits”*, New Age International Pvt. Ltd., 2018
2.	A.K. Main & Nakul Maini, “Analog Electronics”, Khanna Book Publishing House, 2018
3.	S. Salivahanan, S. Arivazhagan, *“Digital Circuits & Design”, Oxford University Press, 2018*

Web References:

1	https://nptel.ac.in/courses/108102112
2.	https://nptel.ac.in/courses/108105132
3.	http://www.electrical4u.com/digital-electronics.htm

22MA204	CALCULUS II AND TRANSFORMS (COMMON TO MECH, MCT)	3/1/0/4
Nature of Course	B (100% analytical)	
Pre requisites	-	

Course Objectives:

1	To gain knowledge in integrals, which are needed in engineering applications.
2	To develop logical thinking and analytical skills in evaluating multiple integrals.
3	To familiarize with the concepts of vector calculus needed for problems in all engineering disciplines.
4	To investigate the purpose of using transforms to create a new domain in which it is easier to handle problems.
5	To impart the knowledge of Laplace transform, to find solutions of initial value problems for linear ordinary differential equations.

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

C204.1	Determine the area and volume by applying the techniques of double and triple integrals.	[R]
C204.2	Develop the understanding of integration techniques needed for problems in engineering disciplines.	[U]
C204.3	Apply multiple integral ideas in solving areas, volumes and other practical problems.	[AP]
C204.4	Differentiate and integrate a vector-valued functions to solve real world applications	[AP]
C204.5	Apply Laplace transform methods for solving linear differential equations.	[AP]

Course Contents

MODULE I - MULTIPLE INTEGRALS (20 Hrs)

Definite integrals: Evaluation of definite integrals using Bernoulli's formula –Beta and Gamma function – Double integration in Cartesian coordinates – Area as double integral – Triple integration in Cartesian coordinates –changing the order of integration in Cartesian coordinates - Volume as triple integral – Numerical integration: Trapezoidal rule and Simpson's rule for single and double integrals.

MODULE II - VECTOR CALCULUS (20 Hrs)

Vector differential operator – Gradient and Directional derivatives – Angle between the surfaces – Divergence and Curl – Scalar potential – Equation of the tangent plane and normal line – Irrotational and Solenoidal vector fields –Vector integration: Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds.

MODULE III - LAPLACE TRANSFORMS (20 Hrs)

Convergence of Laplace transform – Transform of some standard functions (concepts of Ramp signal, Sinusoidal signal and Exponential signal)-Unit step function – Unit Impulse function – Properties – Shifting theorem –Transforms of derivatives and integrals –Initial and final value theorem – Transform of periodic functions – Inverse Laplace transform – Partial fraction method – Convolution theorem – Solution of second order linear ordinary differential equations using Laplace Transform.

Total hours	**60**

Text Books:

1.	G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry, 14th Edition, Pearson, Reprint,2018.
2.	Kreyszig. E, "Advanced Engineering Mathematics" Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore 2020.

3.	Grewal. B.S, "Higher Engineering Mathematics", 44th edition, Khanna Publications, Delhi, 2021.
4.	Grewal. B. S, "Numerical methods in Engineering and Science", Khanna Publications, Delhi, 2016.
Reference Books:	
1.	Veerarajan. T, "Engineering Mathematics II",Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2018.
2.	Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, 5th edition, 2018.
3.	N.P.Bali and Dr.ManishGoyal,"A Text book of Engineering Mathematics" 10th edition, Laxmi publications ltd, 2020.
Web References:	
1.	https://ocw.mit.edu/courses/18-02sc-multivariable-calculus-fall-2010/
2.	https://archive.nptel.ac.in/courses/111/107/111107108/
3.	https://archive.nptel.ac.in/courses/111/106/111106139/
Online Resources:	
1.	https://www.coursera.org/learn/integration-calculus
2.	https://www.coursera.org/learn/vector-calculus-engineers
3.	https://www.coursera.org/learn/differential-equations-engineers

22TA101	HERITAGE OF TAMILS	1/0/0/1

Nature of Course:	C (Theory Concept)
Pre requisites:	NIL

Course Objectives:

1	To know various concepts of Tamil Language families.
2	To know about the essentialities of Heritage.
3	To understand the Aram concepts of Tamils and the cultural influence.

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

C101.1	Know about the language families in India, impact of religions and the contribution of Bharathiyar and Bharathidhasan.	[U]
C101.2	Observe the growth of sculpture, making of musical instruments and the role of temples in socio and economic lives.	[U]
C101.3	Understand the significance of folklore and martial arts.	[U]
C101.4	Learn the sangam literature, sangam age and overseas conquest of Cholas.	[U]
C101.5	Understand the contribution of Tamils to Indian Freedom Struggle, role of Siddha medicine and print history of Tamil Books.	[U]

Course Contents:

Language and Literature: Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

Heritage - Rock Art Paintings to Modern Art – Sculpture: Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils. **Folk And Martial Arts:** Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

Thinai Concept Of Tamils - Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas. Contribution of Tamils to Indian national movement and indian culture: Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

Total Hours: 15

Text-cum-Reference Books:

1	தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் – முனைவர் இல. சுந்தரம் . (விகடன் பிரசுரம்).

3	கீழடி – னெனக நதிக்கனரயில் சங்ககால நகர நாகரிகம் (வதால்லியல் Fனற வெளியீடு)
4	வபாருனந – ஆற்றங்கனர நாகரிகம். (வதால்லியல் Fனற வெளியீடு)
5	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author).
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22CS201	DATA STRUCTURES AND ALGORITHMS	3/0/2/4
Nature of Course:	F (Theory Programming)	
Pre requisites:	Problem Solving using C++	

Course Objectives:

1.	To introduce list data structure and its applications.
2.	To impart the importance of stacks and queues in problem solving.
3.	To provide knowledge on Tree and Graph data structures.
4.	To discuss the role of hashing in information storage and retrieval.

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

C201.1	Demonstrate the knowledge of basic data structures such as array and Linked List.	[AP]
C201.2	Solve real world problems efficiently by applying stack and queue data structures.	[AP]
C201.3	Illustrate the applications of tree and trie data structures.	[AP]
C201.4	Evaluate the performance of hashing algorithms in information storage and retrieval.	[A]
C201.5	Employ graph algorithms for solving real time computing problems and analyze them.	[A]

Course Contents:

Module I Linear data structures (15 Hours)

Linked List: Array vs Linked list - Types of linked list - Singly, Doubly and Circular Linked list - Applications of linked list. **Stack:** Array and Linked list implementation of Stack – Applications of Stack - Infix, Prefix and Postfix expressions - Expression Evaluation. **Queue:** Array and Linked list implementation of Queue - Priority Queue - Applications of Queue.

Module II Trees and hashing (15 Hours)

Trees: Binary Tree - Binary Search Tree - Insertion, Deletion, Traversal - Inorder, Preorder, Postorder, Level order traversal. **Tries:** Introduction to Tries, making a trie node, Insert, Search and Remove operation in Tries. **Hashing:** Direct Address Table, open *hashing*-separate chaining, closed *hashing* - linear probing, quadratic probing, double *hashing*- Collision handling.

Module III Graph data structures (15 Hours)

Graphs: Weighted and Directed graphs - Adjacency matrix and list implementation - Traversal – Breadth First Search & Depth First Search. **Graph Algorithms:** Minimum spanning Tree – Prim's and Kruskal's algorithms, Dijkstra's Shortest path algorithm.

Total Hours (Theory):	**45**

Lab Component

S. No.	Lab Exercises
1.	Implementation of Singly, Doubly and Circular Linked List.
2.	Implementation of Stack using Arrays and Linked List.
3.	Implementation of Stack applications
4.	Implementation of Queue using Arrays and Linked List.
5.	Implementation of Priority Queue.
6.	Implementation of Queue applications.
7.	Implementation of Hashing techniques
8.	Implementation of Binary Search Tree.
9.	Implementation of Graph Traversal algorithms
10.	Implementation of Minimum spanning tree algorithms
11.	Implementation of Dijkstra's Shortest path Algorithms.

12.	Implementation of Trie data structure	
	Total Hours (Lab):	**30**
	Total Hours: (45+30)	**75**
Text Books:		
1	Sartaj Sahni, “Data Structures, Algorithms and Applications in C++”, Silicon paper publication 2004.	
2	Anany Levitin, Introduction to the design & analysis of algorithms ,3rd Edition,Pearso Education, 2021.	
3	Michael T. Goodrich, “Data Structures and Algorithms in C++”, 2nd Edition, Wiley Publication 2011.	
Reference Books:		
1	Seymour Lipschutz, “Data Structures by Schaum Series”, 2nd edition, Tata McGraw Hill, 2013.	
2	Narasimha Karumanchi, “Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles”, 5th Edition, CareerMonk,2016.	
3	Debasis Samanta, “Classic data structures”, Prentice Hall of India, 2nd edition, 2014.	
Web References:		
1	https://www.codingninjas.com/courses/c-plus-plus-data-structures-and-algorithms	
2	https://www.edx.org/course/data-structures-algorithms-using-c	
Online Resources:		
1	https://www.programiz.com/dsa l	
2	https://freevideolectures.com/course/2519/c-programming-and-data-structures	
3	https://www.cprogramming.com/algorithms-and-data-structures.html	

22CH101	ENGINEERING CHEMISTRY Common for all B.E/ B.Tech Engineering Courses (Except CSBS & M.Tech CSE)	3/0/2/4

Nature of Course	: E (Theory Skill based)
Pre requisites	: NIL

Course Objectives:

1	To understand the principles and applications of electrochemistry and to learn electroanalytical methods.
2	To learn the effect of corrosion in materials and the methods for prevention of corrosion.
3	To understand the basic concepts, synthesis, and applications of nanomaterials.
4	To explore the synthesis and properties of important engineering plastics and energy sources.
5	To understand the concepts of photophysical and photochemical processes in spectroscopy.

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

C101.1	Recall the principle and working of reference electrodes and conductivity meters as an analyzer.	[R]
C101.2	Apply the various corrosion control techniques in real time industrial environments.	[AP]
C101.3	Interpret the basic concepts and applications of Nano chemistry.	[U]
C101.4	Use the knowledge of various energy sources in storage devices and polymeric products in engineering field.	[AP]
C101.5	Interpret the principle and working of certain analytical techniques.	[U]

Course Contents

Module 1

Electrochemistry and Corrosion: Electrochemistry-Introduction**,** Oxidation and reduction potentials-Free energy and emf, cell potentials, Nernst equation and applications. Reference electrodes-standard hydrogen electrode, saturated calomel electrode, glass electrode-pH measurement. Electrochemical cells-electrolytic cell-reversible and irreversible cells. Water treatment-characteristics of water-hardness-types and estimation of hardness by EDTA method with numerical problems. Importance of corrosion-types–mechanism of dry and wet corrosion-galvanic corrosion-differential aeration corrosion. Corrosion protection-electroplating of Chromium-electroless plating of Nickel. **(15 hours)**

Module 2

Nano-Chemistry and Energy sources: Nano Chemistry-Basics-Comparison of molecules, nanomaterials and bulk materials; Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: Electrochemical deposition and electro spinning. Applications of nanomaterials in medicine. Energy Sources-Fuel Cells-Solid oxide and polymer electrolytes in H_2-O_2 fuel cell. Storage Devices-Batteries- Alkaline-Lead acid, Nickel cadmium and Lithium-ion batteries.

(15 hours)

Module 3

Polymer chemistry and Spectroscopic techniques: Introduction-monomers and polymers-classification of polymers-Degree of Polymerization (Simple problems). Mechanism of addition polymerization (free radical mechanism). Plastics-classification-preparation, properties and uses of Nylon 6,6, Nylon 6, PVC, Bakelite and PET. Moulding methods- moulding of plastics for Car parts, bottle caps (Injection moulding), Pipes, Hoses (Extrusion moulding), Mobile Phone Cases, Battery Trays (Compression moulding) and PET bottles (Blow moulding). Spectroscopy-Beer Lambert's law, principle, instrumentation, and applications of Electronic spectroscopy (UV-visible), Vibrational and rotational spectroscopy (IR) and Flame emission spectroscopy (FES). **(15 hours)**

Field work:

Industrial visit- Moulding and spectroscopic techniques		
Theory:		**45 hours**
Lab Components:		**30 hours**
1	Determination of total, temporary, calcium and magnesium hardness of water sample by EDTA method.	[E]
2	Estimation of alkalinity of water sample.	[E]
3	Estimation of dissolved oxygen in water.	[E]
4	Potentiometry- determination of redox potentials and emf's.	[E]
5	Conductometric titration-mixture of acids vs NaOH..	[E]
6	Determination of strength of strong acid by pH-metry.	[E]
7	Determination of corrosion rate of mild steel in acid medium.	[E]
8	Electroplating of nickel over copper.	[E]
9	Spectrophotometry-Estimation of iron in water.	[E]
10	Determination of single electrode potential of Zinc and Copper by given solution.	[E]
	Total Hours:	**75**
Understanding the concepts by simple Demonstrations/Experiments:		
11	To detect the chlorine content in tap water using simple chemical method.	
12	To know the presence of dissolved oxygen in given water sample using glucose by redox principle.	
13	To illustrate the rate of corrosion in steel nails using acid medium.	
Text Books:		
1	Dara S.S, Umare S.S, "Engineering Chemistry", First revised Edition by S. Chand & Company Ltd., New Delhi 2015.	
2	Jain P. C. & Monica Jain., "Engineering Chemistry", 16th Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2015.	
3	Fundamentals of Molecular Spectroscopy, 4th Edition by C. N. Banwell Publishing McGraw-Hill Book Company (P) Ltd, England, 1994.	
4	Nanochemistry, 2nd Edition by K. Klabunde, G. Sergeev Springer Publisher, 2013.	
Reference Books:		
1	Shikha Agarwal., "Engineering Chemistry and Applications", Cambridge University press, 2016.	
2	Liliya., Bazylak.I., Gennady. E.,Zaikov.,Haghvi.A.K.,"Polymers and Polymeric Composites" CRC Press,2014.	
3	Lefrou., Christine., Fabry.,Pierre.,Poignet.,Jean-claude.,"Electrochemistry - The Basics, with examples" 2012 ., Springer.	
4	Zaki Ahmad, Digby Macdonald, "Principles of Corrosion Engineering and Corrosion Control", Elsevier Science, 2nd Edition 2012.	
5	Introduction to Nano: basics to Nanoscience and Nanotechnology, by Sengupta, Amretashis, Sarkar, Chandan Kumar, Springer Publisher, 2015.	
Web References:		
1	http://www.analyticalinstruments.in/home/index.html	
2	www.springer.com › Home › Chemistry › Electrochemistry	
3	https://www.kth.se/.../electrochem/welcome-to-the-division-of-applied-electrochemistry	
4	www.edx.org/	
5	https://www.ntnu.edu/studies/courses	
6	www.corrosionsource.com/	
Online Resources:		
1	https://ocw.mit.edu/courses/chemistry	

2 3 4 5	nptel.ac.in/courses/105106112/1_introduction/5_corrosion.pdf https://alison.com - Spectroscopic technique, Colorimetry https://ocw.mit.edu/courses/chemistry nptel.ac.in/courses/113108051

22MT203	ANALOG AND DIGITAL ELECTRONICS LABORATORY	0/0/2/1

Nature of Course : Practical

Prerequisites : Nil

Course Objectives:

1. To expose the students to the basic operation of Op-Amp.
2. To help them to develop experimental skills.
3. To expose the students to the basic operation of Op-Amp.

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

C203.1	Interpret the basic electrical and electronics components	[U]
C203.2	Illustrate appropriate design equations/methods to design the given circuit.	[U]
C203.3	Develop and test various types of counters using Flipflop.	[AP]
C203.4	Construct and demonstrate various combinational logic circuits.	[AP]
C203.5	Make use of Flipflop and test various registers.	[AP]

S.No	List of Exercises	CO Mapping	BT
1.	Study of Active and Passive elements (Diodes, BJTs, Low Power JFETs, MOSFETs, Transistors, LED, LCD, R, L, C)	C203.1	[U]
2.	Study and operation of Multi meter (Analog and Digital), Function Generator, Regulated Power Supplies, CRO.	C203.1	[U]
3.	Design an astable multivibrator circuit for three cases of duty cycle (50%, <50%, and >50%) using NE 555 timer IC	C203.2	[AP]
4.	Design of Instrumentation amplifier using Op-amp.	C203.2	[AP]
5.	Construct Voltage to Current and Current to Voltage converters using Op-Amp.	C203.2	[AP]
6.	Design of 8:1 multiplexer using logic gates.	C203.4	[AP]
7.	Realize a J-K Master / Slave Flip-Flop using NAND gates and verify its truth table.	C203.3	[AP]
8.	Design and verify the Truth Table of 3-bit Parity Generator and 4-bit Parity Checker using basic logic gates with an even parity bit.	C203.4	[AP]
9.	Design and implement an asynchronous counter using decade counter IC to count up from 0 to n (n<=9) and demonstrate on a 7-segment display (using IC-7447)	C203.3	[AP]
10.	Implementation of a 3bit PIPO and PISO shift registers using Flipflop.	C203.5	[AP]
		Total Hours:	**45**

Reference Books:

1.	Anil K. Mani, “Digital Electronics: Principles, Devices and Applications”, Wiley, New Jersey, 2019
2.	Ramkant A Gayakwad, “Op-Amps and Linear Integrated Circuit”, Pearson Publication, Revised 4th edition, 2021.

Web References:

1	https://nptel.ac.in/courses/108102095
2	https://nptel.ac.in/courses/117106086

SEMESTER III

22MT301	CONTROL SYSTEMS FOR MECHATRONICS	3/0/0/3

Nature of Course: Analytical

Pre requisites : 22MA204 Calculus II and Transforms

Course Objectives:

1. To impart the basic concepts of control systems components and its feedback control.
2. To Interpret various time domain and frequency domain tools for analysis and design of linear control systems.
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

C301.1	Illustrate the basic components of control systems, mathematical modelling of systems and their representation techniques.	[U]
C301.2	Recall the various time domain for analysis and examine the steady state error.	[R]
C301.3	Employ the various frequency domain tools for analysis and design of linear system.	[AP]
C301.4	Identify the various techniques to determine the transfer function of a system includes compensators and controllers.	[U]
C301.5	Evaluate the stability of systems from transfer function models	[A]

Course Contents:

SYSTEM REPRESENTATION AND MODELING

Introduction and need for Control Systems- Open loop and closed loop systems–Poles and Zeros-Transfer Function –Mathematical Modelling of Mechanical, Electrical systems- Electrical analogous of mechanical systems –Block Diagram reduction –Signal flow graph. **(15 Hours)**

TIME AND FREQUENCY DOMAIN ANALYSIS

Time domain analysis of Invariant systems: Types of test input -First and second order system response for step input-Time domain specifications- Error coefficients- Generalized error series-Steady state error.

P, PI, PID Controller- Procedure for tuning of PID controller using Ziegler Nichols Method - Frequency response: Frequency domain specifications- Bode plots- Polar Plot. **(15 Hours)**

STABILITY ANALYSIS AND COMPENSATOR DESIGN

Stability of systems: Characteristics equation, Location of roots in S plane for stability- Routh Hurwitz- Root loci- Compensator design: Performance criteria of Lag Compensator and Compensator design using bode plot- State Space Model of mechanical translational system-Case Study: Aspects in Modeling and control of simple and inverted Pendulum. **(15 Hours)**

Total hours:	**45**

Text Books:

1.	I.J.Nagrath and M.Gopal, “Control System Engineering”, New Age International Publisher, New Delhi, 2018
2.	Norman S. Nise, “Control Systems Engineering”, Wiley, India, 2018.

Reference Books:

1.	K.Ogata, “Modern Controls Engineering“, Prentice Hall of India Pvt. Ltd., New Delhi, 2015.
2.	B.C. Kuo, “Automatic Control Systems”, Prentice Hall of India Pvt. Ltd., New Delhi, 2014.

Web Resources:

1	https://nptel.ac.in/courses/107106081
2.	https://www.classcentral.com/course/youtube-control-systems-48209/classroom
3.	https://www.cantorsparadise.com/modelling-and-simulation-of-inverted-pendulum

22MT302	ELECTRICAL MACHINES FOR MECHATRONICS	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

1. To acquire the basic knowledge on constructional details, principle of operation, and applications of DC machines.
2. To impart knowledge on constructional details, principle of operation, and applications of AC machines and Special motors
3. To understand the types of Transformers and Concept of Power systems

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

C302.1	Understand the operation of various electrical machines.	[U]
C302.2	Analyze various methods of speed control of motors	[A]
C302.3	Examine the construction and operation of special motors	[AP]
C302.4	Choose appropriate electrical machines suitable for a specific application based on their characteristics.	[AP]
C302.5	Illustrate the basic concepts of power system	[U]

Course Contents:

DC MACHINES

Construction and Operating Principle- Classification- EMF and Torque Equations- Characteristics- Losses and efficiency- Starters and Speed control- Application in Traction system.

(15 Hours)

AC MOTORS AND SPECIAL MACHINES

Three Phase Induction Motors: Principle of operation- Types- Torque-speed characteristics, Single phase induction motors, Synchronous motors: Construction and working, Types, Starting, Construction and working of BLDC motor- Servo motor - Stepper motor - Applications of motors in manufacturing and automation industries. **(15 Hours**)

TRANSFORMERS AND POWER SYSTEMS

Construction & Principle- EMF equation- Types- Ideal and practical transformer- Equivalent circuit- Regulation and efficiency, Autotransformer, Instrument transformers. Basic structure of power system- AC and DC transmission concepts- Introduction to smart grid. **(15 Hours)**

Total hours:	**45**

Text Books:

1	V. K. Mehta and R. Mehta, “Principles of Electrical Machines”, Fourth Revised Reprint, S.Chand Company, 2018
2	Nagrath I.J. and D. P. Kothari, “Electric Machines”, Fifth Edition, Tata McGraw Hill, 2017.

Reference Books:

1	V. K. Mehta and R. Mehta, “Principles of Power System”, Third Revised Reprint, S. ChandCompany, 2018
2	Ahmed Mousa, “The Electric Power System: Generation, Transmission & Distribution MadeSimple”, Second edition, Lulu Publications, 2018

Web Resources:

1	http://nptel.ac.in/courses/108105053/
2	https://www.electrical4u.com/electrical-engineering-articles/electric-motor/
3	https://www.electricaleasy.com/p/electrical-machines.html
4	https://studyelectrical.com/

22MT303	DESIGN AND MODELING OF MECHATRONICS SYSTEMS	3/0/0/3

Nature of Course: : Theory

Pre requisites : -

Course Objectives:

1. To know the basics on mechatronics design, their process and concurrent designs.
2. To provide exposure on performing mechatronic modelling and design.
3. To reduce the product design and development cost through simulation.

Course Outcomes:

Upon completion of the course, students shall have ability to

C303.1	Recall the basic mechatronics system design and their structure	[R]
C303.2	Contrast different mechatronics systems using basic concepts	[U]
C303.3	Examine real time mechatronics products by learning case studies	[AP]
C303.4	Identify the function of each process through simulation and develop products	[U]
C303.5	Analyze mechatronics concept-based products through testing random numbers	[A]

Course Contents:

DESIGN CONCEPTS AND PLC

Key elements of Mechatronics - Mechatronics Design Process - Differences between Traditional and Mechatronics designs, Types of Design - Concurrent design procedure and its concepts, Mechatronics systems for CNC machines, Introduction to PLC - Architecture - Inputs/Outputs - Selection of PLC, SCADA: Introduction - Elements - Architecture. **(15 hours)**

BOND GRAPH AND APPLICATIONS

Introduction to Bond Graphs and its Terminology, Mechatronics design quotient (MDQ) – MDQ Optimization - Application to food industry: Chocolate - Cookies - Natural Drinks, Case Studies: Health Monitoring of a Spacecraft System - Landmine Detection and Removal. (**15 hours)**

SIMULATION AND CASE STUDIES

Introduction - Random Number Generation Techniques - Steps in a Simulation life cycle - Applications. Tests for Random Numbers - KS Test - Chi-square test. Verification and Validation of simulation models. Case Studies: Automotive Control Systems, UAV Quadrotor, pH control system, mobile robot, pick and place robot. **(15 hours)**

Total Hours:	**45**

Text Books:

1. Clarence W. de Silva, “Mechatronic Systems-Devices, design, control, operation and monitoring”, CRC Press, Taylor & Francis Group, 2019.
2. William Bolton., “Mechatronics Electronic Control Systems in Mechanical and Electrical Engineering” Seventh Edition, Pearson Education, 2019

Reference Books:

1. Banks J., Carson J.S. and Nelson B.L. “Discrete – Event System Simulation”, Fifth Edition, Pearson Education, 2013
2. Robert H. Bishop., “The Mechatronics Handbook”, CRC Press, London, 2012
3. Devdas Shetty, Richard A. Kolk, “Mechatronics System Design”, Second Edition, Cengage Learning, 2012.

Web Resources:

1. https://me.engin.umich.edu/research/areas/mechatronics-robotics
2. https://onlinecourses.nptel.ac.in/noc21_me27/preview
3. https://nptel.ac.in/courses/112/103/112103174/

22MT304	THEORY OF MACHINES	3/0/0/3

Nature of Course: Analytical

Pre requisites: 22MT201 Applied Mechanics

Course Objectives:

1. To develop competency in understanding the basic concepts of mechanisms
2. To understand the analysis of kinematics, force analysis and vibration
3. To make the student conversant with friction drives and mechanism for control

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

C304.1	Describe the nomenclature and classification of mechanisms.	[R]
C304.2	Apply kinematics to determine the velocity and acceleration of linkages.	[AP]
C304.3	Devise the diagrams of cam profile and force analysis of mechanisms.	[A]
C304.4	Explain the working principle of mechanisms for control.	[U]
C304.5	Apply the vibration principles in mechanisms.	[AP]

Course Contents:

CONCEPTS OF MECHANISM AND GEARS

Introduction, Mechanisms, terminology and definitions- Mobility - open and closed-chain planar robots - Kutzbach criterion - Grashof's law - Kinematic Inversions of four bar and slider crank chains - Analytical solutions for velocity and acceleration analysis: Four bar Pin-Jointed and single Slider-Crank Mechanisms. Concepts of Coriolis acceleration. Gears terminology and types - Epicyclic spur gear trains. **(15 hours)**

CAM LAYOUT AND FORCE ANALYSIS

Cam - Displacement diagrams - Parabolic, Uniform and Simple harmonic motions - Layout of plate cam profiles (Inline and offset of knife edge follower only). Displacement and velocity analysis of Robots - Review the concepts of static and dynamic force analysis - Static force analysis of front loader mechanism and Dynamic force analysis of landing gear mechanism on small airplanes. **(15 hours)**

VIBRATIONS AND GYROSCOPIC EFFECTS

Introduction to vibration, terminologies - Free damped single degree of freedom vibration - Logarithmic decrement - Critical speed of shafts using Dunkerley's method - Working of block brake - Gyroscopic effects on the movement of air planes and ships. **(15 hours)**

Total hours: 45

Text Books:

1	R.S.Khurmi, J.K.Gupta, "Theory of Machines" S Chand & Company Ltd, 14th Edition, 2020.
2	David H. Myszka, "Machines & Mechanisms: Applied Kinematic Analysis", Pearson Prentice Hall, 4th Edition, 2012.

Reference Books:

1	John J. Uicker, Gordon R. Pennock and Joseph E. Shigley, "Theory of Machines and Mechanisms", Oxford University Press India, 5th Edition, 2016.
2	S.S.Rattan, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 5th Edition, 2019.

Web Resources:

1	https://nptel.ac.in/courses/112/105/112105268/
2	https://nptel.ac.in/courses/112105236
3	https://nptel.ac.in/courses/112/106/112106270/

22MA305	FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS MECH / MCT	3/1/0/4

Nature of Course	B (100% analytical)
Pre requisites	-

Course Objectives:

1	To understand the different possible forms of Fourier series and the frequently needed practical harmonic analysis that an engineer may have to make from discrete data.
2	To acquaint the student with transform techniques which are used in variety of engineering fields.
3	To study the concept of mathematical formulation of certain practical problems in terms of partial differential equations and solving for physical interpretation.
4	To find the numerical solution for partial differential equations.

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

C305.1	Recall the basic integration concepts, partial derivatives and transform techniques	[R]
C305.2	Understand and apply the Fourier series to solve engineering problems	[U]
C305.3	Develop and solve the partial differential equations	[AP]
C305.4	Apply transform techniques in signal processing	[AP]
C305.5	Apply continuous transforms techniques to evaluate definite integrals	[AP]

Course Contents:

MODULE I - FOURIER SERIES **(20 Hrs)**

Dirichlet's conditions – General Fourier Series $(0,2\pi)$ and $(0,2l)$ – Odd and Even Functions $(-\pi, \pi)$ and $(-l, l)$ – Half range sine series and cosine series $(0, \pi)$ and $(0, l)$ – Applications of Fourier Series – One Dimensional Wave Equation.

MODULE II - PARTIAL DIFFERENTIAL EQUATIONS **(20 Hrs)**

Solving PDE by Lagrange's linear equations – Linear homogeneous partial differential equations of second and higher order with constant coefficients – Classifications – Numerical Solution to Partial differential Equations – Elliptic equations – Laplace equation – Liebmann's Iterative Process – Poisson equation – Parabolic Equation (one dimensional heat equation) – Bender-Schmidt's Difference Scheme – Crank-Nicholson's Difference Scheme – Hyperbolic Equation (one dimensional wave equation).

MODULE III- TRANSFORMS **(20 Hrs)**

Complex form of Fourier Transforms – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem and Parseval's Identity (Statement only) – Evaluation of integrals using Parseval's Identity. Z- Transform: Convergence of Z transform – Z-transform of Standard functions – Properties – Solving difference equation– Inverse Z- transform–Convolution theorem (Excluding proof) – Partial fraction method.

Total Hours:	**60 Hrs**

Text Books:

1	Erwin E., "Advanced Engineering Mathematics",John Wiley and Sons (Asia) Limited, Hoboken,2020.
2	Grewal. B.S, "Higher Engineering Mathematics", 44th edition, Khanna Publications, Delhi, 2018.
3	Jain M.K. Iyengar, K & Jain R.K., Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd, Publishers,6th edition, 2016.

Reference Books:	
1	Veerarajan. T, “Transforms and Partial differential equations”, 3rd edition, Tata McGraw-Hill Publishing Company Ltd., reprint, 2016.
2	N.P.Bali ,”A Text book of Engineering Mathematics Sem-III/IV” 13th edition, Laxmi Publications ltd, 2017.
3	Glyn James,” Advanced Modern Engineering Mathematics”, Pearson Education, 4th edition, 2016.
4	P. Kandasamy, K. Thilagavathy and K. Gunavathy, “Numerical Methods”,S.Chand Co. Ltd., New Delhi, 2015.
Web References:	
1	https://www.youtube.com/watch?v=jNC0jxb0OxE
2	https://www.youtube.com/watch?v=iRXXmtcocAQ
3	https://www.youtube.com/watch?v=OGT59INHz3Y
Online Resources:	
1	https://nptel.ac.in/courses/111/106/111106111/
2	https://nptel.ac.in/courses/111/107/111107111/
3	https://nptel.ac.in/courses/111/107/111107107/

22TA201	TAMILS AND TECHNOLOGY	1/0/0/1

Nature of Course:	C (Theory Concept)
Pre requisites:	NIL

Course Objectives:

1	To know about weaving, ceramic, design and construction technologies in sangam age.
2	To know the significance of technologies such as manufacturing, agriculture and irrigation.
3	To understand the development of Scientific Tamils and Tamil Computing.

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

C201.1	Describe about the weaving industry in sangam age and ceramic technology.	[U]
C201.2	Observe the design of houses, sculptures and construction of temples.	[U]
C201.3	Relate the various manufacturing materials and stone types in Silappathikaram.	[U]
C201.4	Understand the significance of agriculture and irrigation technology in ancient period.	[U]
C201.5	Explain the growth of scientific Tamil, Tamil computing and digitization of Tamil books.	[U]

Course Contents:

Weaving and Ceramic Technology: Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries. **Design and Construction Technology:** Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple) - Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

Manufacturing Technology: Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel - Copper and gold - Coins as source of history - Minting of Coins – Beads making-industries Stone beads - Glass beads - Terracotta beads - Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram. **Agriculture and Irrigation Technology:** Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

Scientific Tamil & Tamil Computing: Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

Total Hours:	**15**

Text-cum-Reference Books:

1	தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் – முனைவர் இல. சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – னெக நதிக்கனரயில் சங்ககால நகர நாகரிகம் (வதால்லியல் துனை வெளியீடு)

4	வபாருனந – ஆற்ைங்கனர நாகரிகம். (வதால்லியல் துனை வெளியீடு)
5	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author).
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22IT311	INTRODUCTION TO PYTHON PROGRAMMING	1/0/4/3
Nature of Course	F (Theory Programming)	
Prerequisites	Nil	

Course Objectives:

1.	To understand and execute Python script using types and expressions.
2.	To understand the difference between expressions & statements and tounderstand the concept of assignment semantics.
3.	To utilize high level data types such as lists and dictionaries.
4.	To import and utilize a module and to perform read & write operations on files.

Course Outcomes

Upon completion of the course, students shall have ability to

C311.1	Demonstrate programs using simple python statements and expressions.	[U]
C311.2	Build control flow and string concept in python for solving problems.	[AP]
C311.3	Develop python programs using functions.	[AP]
C311.4	Analyze compound data using python lists, tuples and dictionaries.	[A]
C311.5	Apply python programs using files, exception, modules and packages.	[AP]

COURSE CONTENTS:

DATA, EXPRESSIONS, STATEMENTS: **15 Hours**

Data Types, Variables and Identifiers, Operators and Expression, Conditional Branching Statements, Iterative statements- Nested Loops, Break, Continue, Passstatements, Function - definition and function call, arguments, return statements,Lambda Function and Recursive Function.

STRING, LISTS, FUNCTIONS: **15 Hours**

Strings – Concatenation, Append, Comparing Strings, Iterating Strings, Strings Modules and Functions, Modules – NumPy, Math, List: Operations, Nested list,Cloning, Methods, Looping, Tuple: Operations, Nested Tuple, Tuple assignments, Checking the index, Dictionary: Operations, looping over andNested Dictionary, Built in functions and Methods.

FILES, INHERITANCE: **15 Hours**

Classes and Objects, Inheritance, Polymorphism, File Handling and Exception Handling.

Total Hours **45**

Laboratory Component:

S. No	List of Experiments
1.	Compute the GCD of two numbers.
2.	Find the square root of a number (Newton's method).
3.	Exponentiation (power of a number).
4.	Find the maximum of a list of numbers.
5.	Linear search and Binary search.
6.	Selection sort, Insertion sort.
7.	Merge sort.
8.	First n prime numbers.
9.	Multiply matrices.
10.	Programs that take command line arguments (word count).

11.	Plotting datasets.
12.	File handling and plotting.
	Total Hours **30**

Text Books:	
1.	Allen B. Downey, “Think Python: How to Think Like a Computer Scientist’’, 2nd Edition, Updated for Python 3, Shroff/O’Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/).
2.	Tony Gaddis, “Starting out with Python’’, 4th Edition, Addison Wesley, Pearson, 2017.
Reference Books:	
1.	Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2.	G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3.	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data”, 3rd Edition, MIT Press, 2021.
Web References:	
1.	http://nptel.ac.in/courses/106106145/
2.	https://www.codecademy.com/learn/learn-python
3.	https://www.coursera.org/learn/python-data-analysis#syllabus
Online Resources:	
1.	https://www.programiz.com/python-programming
2.	https://www.fullstackpython.com/best-python-resources
3.	https://www.udemy.com/course/easy-way-to-learn-python-for-beginners-2021/
4.	https://stackify.com/learn-python-tutorials/

22MT305	ELECTRICAL MACHINES FOR MECHATRONICS LABORATORY	0/0/2/1

Nature of Course: Practical

Pre requisites: Nil

Course Objectives:

1. To provide the practical exposure to the student regarding construction and operation of various electrical machines like DC generators, DC Motors, Induction Motors, Special motors and Transformers.
2. To impart the experiment knowledge of various speed control techniques of Electrical machines.
3. To understand the performance characteristics of various Electrical Machines using MATLAB Simulink.

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

C305.1	Apply the load test on DC machines to find efficiency	[AP]
C305.2	Practice speed control techniques of DC machines	[AP]
C305.3	Experiment the transformer and three phase Induction motor at different load conditions	[AP]
C305.4	Simulate the DC machines characteristics using MATLAB Simulink	[AP]
C305.5	Examine the position control technique of special motors	[AP]

S.No	List of Exercises	CO Mapping	BT
1.	Compute the efficiency and performance characteristics of D.C. shunt motor using Load test.	C305.1	[AP]
2.	Simulate the performance characteristics of DC shunt motor using MATLAB Simulink.	C305.4	[AP]
3.	Compute the efficiency and performance characteristics of D.C. series motor using Load test.	C305.1	[AP]
4.	Simulate the performance characteristics of DC series motor using MATLAB Simulink.	C305.4	[AP]
5.	Apply the a) different methods of speed control in D.C. shunt motor b) simulate the speed control techniques using MATLAB simulink.	C305.2 & C305.4	[AP]
6.	Determine the factors affecting losses and efficiency of single-phase transformer.	C305.3	[AP]
7.	Calculate the slip and sketch the torque-speed characteristics of three-phase induction motor.	C305.3	[AP]
8.	Interfacing of BLDC motor with control circuit.	C305.5	[AP]
9.	Experiment on Servo motor position control system.	C305.5	[AP]
10.	Experiment on stepper motor position control system.	C305.5	[AP]

Total Hours: 30

Reference Books:

1	D.P. Kothari, B.S. Umre, “Laboratory Manual for Electrical Machines”, Second Edition, Dream Tech Press, Feb 2020.
2	B. L. Theraja, A. K. Theraja “Textbook of Electrical Technology Volume 1”, S Chand Publishers, July 2014.

Web Resources:

1	http://nptel.ac.in/courses/108105053/
2	https://www.electrical4u.com/electrical-engineering-articles/electric-motor/
3	https://www.electricaleasy.com/p/electrical-machines.html

22MT306	MECHANICS OF MACHINES AND MATERIALS LABORATORY	0/0/2/1

Nature of Course: Practical

Pre requisites: 22MT201 Applied Mechanics

Course Objectives:

1. To develop competency in understanding the basic concepts of mechanisms and materials.
2. To understand and analyze various control mechanisms.
3. To investigate the properties of different components using standard testing methods.

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

C306.1	Experiment the working of various control mechanisms.	[AP]
C306.2	Examine the critical speed of rotating shafts.	[AP]
C306.3	Solve for the natural frequency of bodies using various vibration experiments.	[AP]
C306.4	Determine the moment of inertia of mechanical elements using various apparatus.	[AP]
C306.5	Examine the mechanical properties of the different components.	[AP]

S.No	List of Exercises	CO Mapping	BT
1.	Compare the characteristics of Watt and Proell governors.	C306.1	[AP]
2.	Determination of critical speeds of shaft and analyze it.	C306.2	[AP]
3.	Determination of transverse frequency of beam and compare it theoretically.	C306.3	[AP]
4.	Determination of natural frequency of given spring mass system in free longitudinal vibrations.	C306.3	[AP]
5.	Determination of mass moment of inertia of the disc using Motorized Gyroscope.	C306.1	[AP]
6.	Determine the mass moment of inertia of the object using compound pendulum setup experimentally. Verify the answer theoretically.	C306.4	[AP]
7.	Determination of mass moment of inertia of flywheel axle system.	C306.4	[AP]
8.	Determine the ultimate and yield strength of a mild steel bar using Universal Testing machine.	C306.5	[AP]
9.	Determine the impact strength of components.	C306.5	[AP]
10.	Determine the hardness of components.	C306.5	[AP]

Total Hours: 45

Reference Books:

1	L. Robert Norton, “Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines” McGraw-Hill, 6th Edition, 2020.
2	RS Khurmi and JK Gupta, “Theory of Machines”, S. Chand Publishing, 15th Edition, 2006.
3	Ferdinand P.Beer, E. Russell Johnston, “Mechanics of Materials”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 8th Edition, 2020.

Web References:

1	http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/dynamics-of-machine-lab/experimentlist.html
2	http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/machine_theory/index.php
3	http://mm-nitk.vlabs.ac.in/List%20of%20experiments.html

SEMESTER IV

22MT401	COMPUTER NETWORKS AND CYBER SECURITY	3/0/0/3

Nature of Course: Theory

Pre requisites : Nil

Course Objectives:

1. To understand the concepts of computer networking
2. To describe the different protocols associated with each layer
3. To comprehend the cybersecurity concepts and vulnerabilities

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

C401.1	Describe the fundamentals of computer networks	[U]
C401.2	Illustrate the error detection techniques in Data Link Layer	[AP]
C401.3	Examine various network routing protocols	[AP]
C401.4	Interpret Transport Layer and Application Layer protocols.	[U]
C401.5	Understand Cybersecurity concepts and Vulnerabilities.	[U]

Course Contents:

PHYSICAL AND DATA LINK LAYERS

Data communication Components: Representation of data and its flow, Networks, Types - OSI model - Physical Layer: Transmission Media, Networking Devices: Hubs, Bridges, Switches, Routers and Gateways – Switching: Circuit Switched Networks, Packet Switched Networks - Data Link Layer: Addressing, Error Detection: Parity, CRC, Hamming Code – Protocols: Sliding Window, Stop-and-wait Protocols- Random Access (**15 Hours**)

NETWORK, APPLICATION AND PRESENTATION LAYERS

Network Layer: Internet Protocol: IPv4, IPv6 – ARP, DHCP, ICMP – Distance Vector Routing, Link State Routing, Classless Inter-domain routing. Transport Layer: Process to Process Delivery: User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Congestion Control - Application Layer: Domain Name Space (DNS), Electronic Mail, File Transfer Protocol (FTP), WWW, HTTP. (**15 Hours**)

CONCEPTS OF CYBERSECURITY

Cybersecurity Concepts: Introduction to Cybersecurity, CIA, Risks, Breaches, Threats, Attacks, Exploits, Need of Cyber Security, Cyber Crime – Types, Cybersecurity Vulnerabilities & Safe Guards, Internet Security -Fundamentals of cryptography

(**15 Hours**)

Total hours:	**45**

Text Books:

1.	Behrouz A. Forouzan, “Data Communications and Networking” 5th Edition, McGraw Hill Education, 2017
2.	Andrew S. Tanenbaum, Nickolas Feamster, “Computer Networks”, Pearson Education, 2019

Reference Books:

1.	Charles J. Brooks, Christopher Grow, Philip A. Craig, Jr., Donald Short, “Cybersecurity Essentials”, Wiley, 2018
2.	Linda Lavender, “Principles of Cybersecurity”, Goodheart-Willcox Company, Incorporated, 2018

Web References:

1	https://nptel.ac.in/courses/106105183
2.	https://onlinecourses.swayam2.ac.in/nou19_cs08/preview
3.	https://www.edx.org/learn/computer-networking
4.	https://in.coursera.org/specializations/intro-cyber-security
5.	https://www.futurelearn.com/courses/introduction-to-cyber-security

22MT402	BASICS OF DIGITAL SIGNAL PROCESSING	3/0/0/3

Nature of Course : Analytical

Pre Requisites : -

Course Objectives:

1. 1. To study the concept of DFT and FFT computation
2. To design digital filters using IIR and FIR techniques
3. To study the importance of multi-rate signal processing and its application.

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

C402.1	Examine the signals and transformation techniques such as DFT, DTFT and their properties.	[R]
C402.2	Explain the functions of FFT in time domain and frequency domain.	[U]
C402.3	Illustrate the design of digital filter using finite impulse response by various techniques.	[A]
C402.4	Apply Infinite Impulse Response techniques in designing digital filters.	[AP]
C402.5	Interpret the principles of multi-rate signal processing applications.	[AP]

Course Contents:

SIGNAL TRANSFORMATION TECHNIQUES

Introduction to Signals and Systems- Discrete Fourier Transform (DFT) and its properties-Relation between Discrete-Time Fourier Transform (DTFT) and Discrete Fourier Transform (DFT)- Fast Fourier Transform (FFT) computations: Radix-2 Decimation in Time (DIT) and Decimation in Frequency (DIF) algorithms -Linear and Circular Convolution-Overlap-Add and Save methods. (**15 Hours)**

DIGITAL FILTERS

Design of Infinite Impulse Response (IIR) digital filters using impulse invariance technique and bilinear transform method – Realization of IIR: Direct, Cascade and Parallel forms- Design of Finite Impulse Response (FIR) digital filters using windowing (Rectangular, Hamming, Hanning and Blackman Windows) and Frequency sampling method - Realization of FIR filters: Transversal and Linear phase structures**. (15 Hours)**

MULTIRATE SIGNAL PROCESSING AND APPLICATIONS

Introduction - Sampling Theorem, Decimation, Interpolation, Sampling rate conversion-Quantization of signals- Applications of multi-rate signal processing -Architecture of TMS 320C54XX Digital Signal processor-On-board DSP Technologies applied to Robotics Applications. **(15 Hours)**

Total Hours:	**45**

Text Books:

1.	A.Anand kumar, “Digital Signal Processing” PHI learning Second edition 2015
2.	S. Salivahanan, “Digital Signal Processing”, McGraw Hill, Fourth Edition, 2019.

Reference Books:

1.	Rameshbabu, “Digital Signal Processing” Scitech Publications (India) Pvt.Ltd. 6th Edition 2015.
2.	V.Udayashankara, “Modern Digital signal Processing”, PHI Learning Private Limited, Third edition 2017.
3.	Devdas Shetty, Richard A. Kolk, “Mechatronics System Design”, Second Edition, Cengage Learning, 2012.

Web References:

1.	https://nptel.ac.in/courses/117/102/117102060/
2.	https://www.tutorialspoint.com/digital_signal_processing/
3.	https://www.udemy.com/course/signal-processing/
4.	https://nptel.ac.in/courses/108106136

22MT403	MICROCONTROLLER AND ITS APPLICATIONS	3/0/0/3

Nature of Course: Theory

Pre requisites : Nil

Course Objectives:

1. To impart the concepts of 8051 and PIC Microcontroller.
2. To understand the concepts of ARM architecture.
3. To familiarize the architecture of MSP430 and quantum micro controllers.

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

C403.1	Interpret the features of 8051 Micro-controllers	[AP]
C403.2	Identify the operation of PIC Microcontroller.	[U]
C403.3	Utilize the features of Raspberry Pi based on ARM processor.	[A]
C403.4	Examine the functions of MSP430	[R]
C403.5	Understand the basics of Quantum Computing	[U]

Course Contents:

INTRODUCTION TO MICROCONTROLLERS

Overview of 8051 Microcontroller, Architecture, I/O Ports, Memory Organization, Addressing Modes, Instruction set and Opcode of 8051 - PIC Microcontroller: PIC 10, PIC12, PIC16, PIC18 series comparison, features and selection - PIC18FXX architecture - registers, memory Organization and types - Brief summary of Peripheral support, Overview of instruction set, MPLAB IDE & C18 Compiler - Programming of RPM meter using Assembly and C. **(15 hours)**

ARM CONTROLLER

ARM Architecture - ARM programmer's model, Data processing instructions, Data transfer instructions, Control flow instructions, 3 and 5 stage pipeline, Thumb Programmers Model, Thumb Instruction Set, IOT and Raspberry-Pi Based Smart Irrigation System interfaced with soil sensor. **(15 hours)**

MSP430 MICROCONTROLLER

Functional block diagram - Central Processing Unit – Addressing modes – Instruction set - Timer: Watch dog timer, Basic Timer1, Timer A - IBMQ Quantum Computing: Quantum Computer Architecture - Introduction to Elementary quantum mechanics - Spin, Qubit - Quantum Gates - CNOT gate . **(15 hours)**

Total hours:	**45**

Text Books:

1.	Steve Furber, “ARM system-on-chip architecture”, Pearson Edition, 2016.
2.	John H. Davies, “MSP430 Microcontroller Basics”, Elsevier Ltd, 2008.

Reference Books:

1. 1.	Mazidi, “PIC Microcontroller & Embedded System” 3rd Edition, Pearson, 2016
2. 4.	Dr. Umesh Dutta, Dr. Kamal Kishor Jha, Vikas Sharma, “8051 Microcontroller Fundamentals and Programming: Project Based Learning Approach”, 2022.
3. 5.	Danny Causey, Muhammad Ali Mazidi, Rolin McKinlay, PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18, MicroDigitalEd, 2016

Web Resources:

1	https://circuitdigest.com/microcontroller-projects/getting-started-with-msp430-using- code-composer-studio
2.	https://nptel.ac.in/courses/117104072
3.	https://www.instructables.com/id/IOT-Based-Surveillance-Camera-Raspberry-Pi-Pan- Til/
4.	https://nptel.ac.in/courses/106106232

22MA402	PROBABILITY AND COMPUTATIONAL METHODS (MECH, MCT & EEE)	3/1/0/4

Nature of Course	B (100% Analytical)
Pre requisites	-

Course Objectives:

1.	To define the concept of probability and its features.
2.	To have a well – founded knowledge of standard distributions which can be used to describe real life phenomena.
3.	To learn the concept of testing hypothesis using statistical analysis.
4.	To study the concept of fitting a curve of best fit to the given numerical data and to calculate the deviation of the expected value from the observed value.
5.	To study the various numerical methods to fit the polynomial by interpolation formulas.

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

C402.1	Recall the concept of probability.	[R]
C402.2	Understand to handle situations involving random variables and Standard distributions.	[U]
C402.3	Apply measures of central tendency to analyze statistical data and to find the correlation and regression between the given data.	[AP]
C402.4	Develop the inferences for engineering problems using testing of hypothesis.	[AP]
C402.5	Apply numerical methods to fit the polynomial by interpolation formulas.	[AP]

Course Contents

MODULE I - PROBABILITY **(20 Hrs)**

Sample space – Axioms of Probability – Events – Conditional probability – Total Probability – Baye's Theorem (Statement only). One dimensional Random Variable – Discrete random variable Probability mass function – Discrete distributions – Binomial distribution – Poisson distribution – Continuous Random Variable – Probability density function – Continuous distribution: Uniform distribution – Normal distribution.

MODULE II - STATISTICS **(20 Hrs)**

Measures of Central tendency: Mean Median and Mode. Correlation (Karl Pearson's) – Rank correlation (Spearman's) – Linear regression. Testing of Hypothesis – Small Samples– Student's t-Test for single mean, difference of means – F test – Chi square test for goodness of fit and independence of attributes – Analysis of Variance – One way classification.

MODULE III - NUMERICAL METHODS **(20 Hrs)**

Curve Fitting – Empirical laws – Linear law – Laws reducible to Linear law – Method of group averages - straight line and parabola – Principle of Least squares - Fitting straight line,Parabola and exponential curve. Interpolation – Interpolation with equal intervals – Newton's Forward and Backward difference formula – Interpolation with unequal intervals – Newton's Divided difference formula – Lagrange's interpolation formula.

Total hours	**60**

Text Books:

1.	Peebles Jr. P.Z., Probability Random Variables and Random Signal Principles, Tata McGraw-Hill Publishers, Fourth Edition, New Delhi, 2016

2.	Gupta, S.C., & Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand & sons, 12th edition , 2020
3.	Grewal B.S., Numerical methods in Engineering and Science, 12th edition, Stylus Publishing, 2018.
Reference Books:	
1.	Ross, S,"A First Course in Probability, Ninth edition", Pearson Education, Delhi, 2018.
2.	Richard A. Johnson, Irwin Miller, John Freund, Miller & Freund's,"Probability and Statistics for Engineers",Ninth edition,2016.
3.	Steven Chapra, "Applied Numerical Methods with MATLAB for engineers and scientists", 4th edition, 2017.
Web References:	
1.	http://nptel.ac.in/courses/111104079/
2.	http://www.nptelvideos.in/2012/12/probability-random-variables.html
3.	http://freevideolectures.com/Course/2311/Digital-Communication/4
Online Resources:	
1.	https://www.coursera.org/learn/probability-intro
2.	https://www.coursera.org/lecture/wharton-introduction-spreadsheets-models/3-1-random-variables-and-probability-distributions-Y3bCF

22MT404	SENSORS, MEASUREMENTS AND INSTRUMENTATION	3/0/2/4

Nature of Course: Theory

Pre requisites : Nil

Course Objectives:

1. To observe the basic concept conventional transducers and its characteristics
2. To understand various sensors and transducers for measuring mechanical quantities
3. To familiarize the basics of Virtual Instruments

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

C404.1	Choose different types of sensors and Transducers in various applications	[AP]
C404.2	Recite a transducer for a specific measurement application	[R]
C404.3	Identify the suitable measurement techniques for unknown parameters	[U]
C404.4	Apply instrumentation protocols for measurement system.	[AP]
C404.5	Illustrate the basic concepts of Virtual Instrumentation	[AP]

Course Contents:

CLASSIFICATION OF SENSORS

Introduction -Hall effect sensors, Tactile, Proximity, Capacitive, Inductive, Fiber optic, Thermal, Chemical, Inertial Rotary, Magnetic, Radiation, Magnetic nano Sensor, Smart Sensors, Measurement of vehicle speed with radar sensors, Introduction to flexible sensors and sensor fusion. (**15 Hours)**

MEASUREMENT SYSTEMS

Terminologies - Performance characteristics – Errors - Calibration and Standards, Form Measurements: Optical Flat – Thread Gauge - Gear Measurements – Optical Projector, Angular Velocity Measurement: Stroboscopic methods – Encoders, Decoders and Resolvers - Vibrometer and Accelerometer – Densitometers, Laser Interferometer, Data Display and Recording Systems. Production Floor temperature and humidity loggers. Case Study: Automated Turning Operation. **(15 Hours)**

INSTRUMENTATION

Field Instrumentation protocols, Robotic Instrumentation, Safety and Security Instrumentation. HART Protocol, Instrumentation Protocol: Standards Grounding/shielding and noise - EIA-232&485 interface standard –Current loop and EIA-485 converters, Introduction to Virtual Instrumentation using LabVIEW- Comparison with traditional Instrument, Components of DAQ, DAQ Assistant, DAQ hardware and software. **(15 Hours)**

Total hours: 45

Laboratory Component:

S. No	List of Experiments	
1.	Displacement measurement using capacitive sensor and weight using load cell	[AP]
2.	Piezo Electric accelerometer for vibration measurement	[AP]
3.	Measurement of pressure using Bourdon Gauge	[AP]
4.	Measurement of temperature using Thermistor/RTD and Thermocouple sensor	[AP]
5.	Measure and control the speed of motor using stroboscope	[AP]
6.	a) Measurement of flow-rate using Rotameter b) Water level measurement using ultrasonic sensor	[AP]
7.	Measure the strain applied in the cantilever beam using strain sensor	[AP]
8.	Measure the torque developed using torque sensor	[AP]
9.	Programming for measurement of displacement using LVDT sensor using DAQ.	[AP]

10.	Programming for measurement of real time temperature using LM35 sensor using DAQ	[AP]
	Total Hours	**30**

Text Books:	
1.	John P. Bentley, Principles of Measurement Systems, Pearson Education, 6th Edition, 2018.
2.	Samir Mekid, Metrology and Instrumentation Practical Applications for Engineering and Manufacturing, 1st Edition 2022.
Reference Books:	
1.	Murthy D. V. S, Transducers and Instrumentation, Prentice Hall, 2nd Edition,2018
2.	S. Sumathi and P. Surekha, “LabVIEW based Advanced Instrumentation Systems” Springer-Verlag Berlin Heidelberg, 2015.
Web References:	
1	https://www.sciencedirect.com/science/article/pii/B9780123819604000127
2.	https://www.sciencedirect.com/science/article/pii/B9780123819604000139
3.	https://www.sciencedirect.com/topics/engineering/sensor-fusion

22MT405	MICROCONTROLLER LABORATORY FOR MECHATRONICS	0/0/2/1

Nature of Course: Practical

Pre-requisites: Nil

Course Objectives:

1. To provide a practical understanding on the programming concept of microcontrollers.
2. To experiment with the interfacing of hardware units with microcontrollers.
3. To expose hands-on training to the students by various exercises using Microcontrollers like 8051, PIC Microcontroller and Raspberry Pi

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

C405.1	Experiment the Arithmetic operations using 8051 microcontrollers.	[AP]
C405.2	Apply the instruction set and programming concepts for interfacing peripherals.	[AP]
C405.3	Apply the programming concepts for interfacing hardware units with AVR microcontroller.	[AP]
C405.4	Develop applications using PIC Microcontrollers.	[AP]
C405.5	Employ Raspberry Pi - ARM Processor for various applications.	[AP]

S.No	List of Exercises	CO Mapping	BT
1.	Write an ALP to perform 16 Bit Addition and Subtraction using 8051 Microcontroller	C405.1	[AP]
2.	Interfacing stepper motor with 8051 microcontrollers.	C405.2	[AP]
3.	Interface with A/D and D/A converters.	C405.2	[AP]
4.	Establishing LED blinking with practical AVR microcontroller	C405.3	[AP]
5.	Interfacing stepper motor with AVR microcontroller.	C405.3	[AP]
6.	Interfacing serial communication using AVR Microcontroller.	C405.3	[AP]
7.	Basic programming in PIC microcontroller.	C405.4	[AP]
8.	Interfacing Programming with PIC Microcontroller.	C405.4	[AP]
9.	Programming for LED blinking using Raspberry Pi ARM	C405.5	[AP]
10	Establishing temperature measurement with Raspberry Pi ARM.	C405.5	[AP]
			Total Hours: 30

Reference Books:

1. Muhammad Ali Mazidi, Sarmad Naimi, and Sepehr Naimi," AVR Microcontroller and Embedded Systems: Using Assembly and C", Pearson New International Edition,2017
2. Thakur, M. "NodeMCU ESP8266 Communication Methods and Protocols: Programming with Arduino IDE." Amazon Digital Services LLC 2018)
3. Richardson, Matt, and Shawn Wallace, "Getting Started with Raspberry Pi: Electronic Projects with Python", Scratch, and Linux. Maker Media, Inc., 2014.

22MT406	BASICS OF DIGITAL SIGNAL PROCESSING LABORATORY	0/0/2/1

Nature of Course: Practical

Pre requisites: Nil

Course Objectives:

1. To perform basic signal processing operations using software programming tool.
2. To implement FFT and digital filter design in MATLAB programming.
3. To study sampling theorem and demonstrate decimation and interpolation.

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

C406.1	Illustrate various signals and system in continuous and discrete form.	[AP]
C406.2	Apply DFT and FFT algorithms in DIF and DIT analysis.	[AP]
C406.3	Simulate linear and circular convolution technique.	[AP]
C406.4	Compute IIR and FIR filters using various techniques.	[AP]
C406.5	Determine multi-rate signal processing in application to real time processing.	[AP]

S. No	List of Exercises	CO Mapping	BT
1.	Generation of basic Continuous Time and Discrete Time Signals.	C406.1	[AP]
2.	Computation of N-point DFT.	C406.2	[AP]
3.	Design and simulation of Linear and Circular Convolution.	C406.3	[AP]
4.	Computation of FFT -DIF algorithm.	C406.2	[AP]
5.	Computation of FFT-DIT algorithm.	C406.2	[AP]
6.	Design and simulation of Infinite Impulse Response (IIR) using Impulse Invariant transformation.	C406.4	[AP]
7.	Design and simulation of Finite Impulse Response (FIR) Using windowing techniques.	C406.4	[AP]
8.	Design and simulation of Sampling Theorem.	C406.5	[AP]
9.	Design and simulation of Decimation and Interpolation.	C406.5	[AP]
10.	Simulation and Processing of time-series signals.	C406.5	[AP]

Total Hours: 30

Reference Books:

1	Uday Kumar S, “Digital Signal Processing with DSP lab manual”, Pristine publishing house, 3rd edition, 2017.
2	Jose Unpingco, “Python for Signal Processing: Featuring IPython Notebooks”, Springer 2016.

Web References:

1	https://www.udemy.com/course/digital-signal-processing-with-matlab-applications/
2	https://www.udemy.com/course/signal-processing/
3	https://onlinecourses.nptel.ac.in/noc19_ee50/preview

SEMESTER V

22MT501	MACHINE DESIGN	3/0/0/3

Nature of Course : Analytical

Pre requisites : Nil

Course Objectives:

1. To analyse the various machine elements subjected to the design stresses.
2. To design various joints, shafts and springs.
3. To understand the selection of bearings and power transmission elements.

(*Use of PSG Design Databook is permitted)

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

C501.1	Interpret the design of mechanical components based on failure modes.	[U]
C501.2	Examine welded and threaded joints.	[AP]
C501.3	Evaluate the dimensions of couplings, helical and leaf springs.	[A]
C501.4	Select deep groove ball bearings and journal bearings	[U]
C501.5	Establish dimensions of various mechanical power transmission elements.	[AP]

Course Contents

DESIGN OF COMPONENTS AND JOINTS

Design Process and Procedure - Stresses - Static, residual - Factors of safety - Theories of failure – Stress concentration factors - Goodman, Soderberg equation-based design- Limits, Fits and Tolerances- Design of axially loaded Transverse and Parallel fillet welded joints – Design of axial loaded threaded joints. **(15 Hours)**

DESIGN OF SHAFTS, BEARINGS AND SPRINGS

Design of Solid and Hollow shafts based on strength – Design of flanged coupling and Bushed pin coupling - Design of Journal Bearings – selection of Deep groove ball bearings – Oil Seals (Theory only) - Design of helical and leaf springs. **(15 Hours**)

DESIGN OF POWER TRANSMISSION ELEMENTS

Design and selection of V belts and pulleys - Design and selection of roller chains and sprockets - Component design of spur, helical, bevel and worm gears based on wear strength. Ball screw selection (Theory only). **(15 Hours)**

Total hours:	**45**

Text Books:

1	Bhandari V.B, “Design of Machine Elements”, 5th Edition, Tata McGraw-Hill education, 2020.
2	Joseph Edward Shigley and Richard G. Budynas, J.Keith Nisbett, “Mechanical Engineering Design”, 11th Edition, Tata McGraw-Hill education, , 2020.

Reference Books:

1	Robert L Norton, "Machine Design - An Integrated Approach, 5th Edition,Pearson Education", New Delhi, 2013.
2	Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Component Design”, 7th Edition, Wiley, 2019.

Web Resources:

1	https://archive.nptel.ac.in/courses/112/105/112105124/
2	http://www.nptelvideos.com/course.php?id=791
3	https://www.me.iitb.ac.in/~ramesh/courses/ME423/me423.html

22MT502	ROBOTIC SYSTEMS	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1. To acquire the concepts and techniques in robot manipulator control and robot dynamics.
2. To impart knowledge on design and implementation of robot applications and their relationship to other automated technologies.
3. To understand the basics of machine vision and its application in robotics

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

C502.1	Understand the basic concepts of Robotics and Robot components.	[U]
C502.2	Choose appropriate the concept of end effectors in robotics and basic robot programming techniques	[AP]
C502.3	Analyze the robot kinematic position and dynamic equations	[A]
C502.4	Explain the concept of Robotic Operating system.	[AP]
C502.5	Illustrate the basic concepts of wheeled mobile robotics.	[U]

Course Contents:

ROBOT COMPONENTS

Introduction-Laws of robotics- Robot Anatomy- Configuration of Robot- Work Volume- Robot Drive Systems- Control System- Precision of Movement- Robot Application. Robot end effectors-Types of end effectors-Mechanical Grippers-Types of gripper mechanisms-Tools as end effectors- Lead through Programming. **(15 Hours)**

ROBOT DYNAMICS AND KINEMATICS

Introduction- Lagrangian Mechanics- Effective moment of Inertia- Dynamic Equations for multiple DOF Robots. Basics of trajectory planning. Robot kinematics: Introduction to Manipulator Kinematics- Position representation- Forward and Reverse transformation of 2DOF arm- 3DOF arm in 2D- Homogeneous transformations and robot kinematics- DH Representation of forward kinematic equations of robot. **(15 Hours**)

ROBOT OPERATING SYSTEM AND MOBILE ROBOTS

Introduction - difference from other meta-operating systems–services – Robot Operating System (ROS) framework Introduction to Wheeled Mobile Robots – Locomotion - Motion control - Perception - Sensors for mobile robots: wheel sensor, heading sensor, accelerometers, inertial measurement - Localization - localization-based navigation. Case study- Mobile robot in military application. **(15 Hours)**

Total hours:	**45**

Text Books:

1	M.P.Groover, "Industrial robotics- Technology, programming and Applications", McGraw-Hill, 2017
2	Saeed B. Niku, "Introduction to Robotics: Analysis, Systems, Applications", 2nd edition, Pearson Education India, 2015.

Reference Books:

1	King Sun Fu, Rafael C. González, C. S. George Lee, "Robotics: control, sensing, vision, and intelligence", Tata Mcgraw-Hill Publication, 2016.
2	Robin R Murphy, “Introduction to Al Robotics”, Fourth Edition, MIT Press, 2016.
3	Roland Siegwart, IllahR.Nourbakhsh, "Introduction to Autonomous Mobile Robots", 2nd Edition, 2011

Web Resources:

1	https://onlinecourses.nptel.ac.in/noc23_me51/preview

2	https://www.robotbooks.com/
3	http://nptel.ac.in/courses/112101099/
4	https://www.toptal.com/robotics/introduction-to-robot-operating-system

22MT503	POWER ELECTRONICS AND DRIVES	3/0/0/3

Nature of Course: Theory

Pre requisites : 22MT202-Analog and Digital Electronics
22MT302 Electrical Machines For Mechatronics

Course Objectives:

1. To learn the principles of operation, characteristics and applications of power semiconductor devices.
2. To understand the principles of operation of basic power electronic converters.
3. To understand the basics of electrical drives.

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

C503.1	Compare the characteristics of power semi-conductor devices and the working principles of various power converters.	[U]
C503.2	Inspect power electronic converters to verify their proper functioning.	[A]
C503.3	Identify the types of choppers and its control strategies.	[AP]
C503.4	Examine the functions of various motor drives.	[AP]
C503.5	Choose appropriate power converter circuits and electrical drives through their acquired knowledge.	[AP]

Course Contents:

DEVICES AND CONTROLLED RECTIFIERS

Characteristics of Power Diode, Thyristor, TRIAC, MOSFET -Thyristor Protection, Single-phase diode rectifier- Phase Controlled Rectifiers (single-phase), Dual Converters (single-phase),Case study: Single phase rectifier in traction application. **(15 Hours)**

CHOPPERS, INVERTERS AND CONTROLLERS

Principle of DC-to-DC Converter operation (chopper operation), Control Strategies, Step-up Choppers, Step down choppers, Types of Chopper Circuits, Case study: Application of choppers in electronic throttle control- **Inverters**- Three Phase Bridge Inverters, Pulse-width Modulated Inverters, **AC Voltage Controllers**- Single-Phase Voltage Controller with RL Loads. **(15 Hours**)

Electrical Drives

Introduction - Choice -Types - Classes of duty, Closed-Loop (current-limit, torque and speed) Control of Drives, Brushless DC Motor Drives, Stepper Motor Drives, Servo Motor Drives, Variable Frequency Drives-Case study: Control of stepper motor for SCARA **(15 Hours)**

Total hours: 45

Text Books:

1	P.S. Bimbhra, “Power Electronics”, Khanna Publishers, 6th Edition, 2018
2	D P Kothari and Rakesh Singh Lodhi “Electric Drives”, Wiley India Publishers,5th Edition,2020.

Reference Books:

1	Muhammad H. Rashid, “Power Electronics: Circuits, Devices & Applications”, Pearson, 4th Edition, 2014
2	Austin Hughes, William Drury, “Electric Motors and Drives”, Elsevier,4th Edition, 2013

Web Resources:

1	https://nptel.ac.in/courses/108/101/108101126/
2	https://www.coursera.org/learn/power-electronics

22MT504	ARTIFICIAL INTELLIGENCE FOR ROBOTICS	3/0/2/4

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1.	To study the idea of intelligent agents and search methods.
2.	To understand about various robotic paradigms.
3.	To gain idea about localization, planning and natural language processing

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

C504.1	Understand the history of AI and intelligent agents.	[U]
C504.2	Examine the various search strategies in AI	[A]
C504.3	Explain suitable robotic paradigms and architectures	[U]
C504.4	Choose appropriate path planning and localization methodologies	[AP]
C504.5	Identify language models in natural language processing	[AP]

Course Contents:

INTELLIGENT AGENTS AND SEARCHING STRATEGIES

Introduction to AI: Foundations, History - Intelligent Agents - Agents and Environments, Structure of agents - Problem solving agents - Problem formulation – Search Algorithms - Uninformed search strategies: Breadth-first search, Depth-first search, Iterative deepening search, Uniform-cost search – Informed search strategies: Best-first search, Greedy best-first search, A* search, IDA* – Heuristic functions **(15 Hours)**

ROBOTIC PARADIGMS

Overview of the Three Paradigms - Hierarchical Paradigm: attributes – representative architectures - Reactive paradigm: attributes - subsumption architecture - potential field methodologies - Designing a reactive implementation: a primitive move-to-goal behavior, an abstract follow-corridor behavior - Designing a Reactive Behavioral System - The Hybrid Deliberative/Reactive Paradigm- Attributes - Architectural Aspects- Managerial Architectures- State-Hierarchy Architectures Model-Oriented Architectures **(15 Hours)**

NAVIGATION AND NATURAL LANGUAGE PROCESSING

Topological Path Planning: Landmarks and gateways - relational methods – associative methods - case study – Metric Path Planning: Configuration space – Cspace representations – Graph based planers – Wavefront based planers - Localization and Map making: Sonar sensor model – Bayesian – Localization – Exploration – Learning and Natural language: Forms of learning – NLP - Language models – Natural language for communications - Speech recognition. **(15 Hours)**

Total hours	**45**

Laboratory Component:

S. No.	List of Experiments		
1	Implement basic search strategies: 8-Puzzle, 8 – Queens problem	C504.2	[AP]
2	Implement A* algorithm.	C504.2	[AP]
3	Solve Depth First Search and Breadth First Search in Prolog	C504.2	[AP]
4	Implement the Traveling Salesman Problem	C504.4	[AP]
5	Implement a four-wheels mobile robot.	C504.3	[AP]
6	Implement obstacle avoidance and path planning in the mobile robot using AI based algorithms	C504.4	[AP]
7	Develop AI based algorithm for connected cars to avoid traffic congestion and reduce travel times.	C504.3	[AP]
8	Develop AI based algorithm for healthcare robot to read and store	C504.3	[AP]

	the vitals of a patient and predict ill-health.		
9	Write a python program to implement a simple Chatbot.	C504.5	[AP]
10	a) Write a program to POS (Parts of Speech) tagging for the sentence using natural language toolkit. b) Write a python program to remove stop words for a given passage from a text file using NLTK.	C504.5	[AP]
	Total Hours	**30**	

Text Books:	
1	Murphy RR, 'Introduction to AI Robotics', Second Edition, MIT Press, Cambridge, London, 2019.
2	Stuart Russel and Peter Norvig, 'Artificial Intelligence: A Modern Approach', Fourth Edition, Pearson Education Limited, UK, 2022
Reference Books:	
1	Francis X. Govers, "Artificial Intelligence for Robotics", Packt, 2018.
2.	Elaine Rich, Kevin Knight, SB Nair, "Artificial Intelligence", Third Edition, McGraw Hill, 2017
Web References:	
1	https://www.coursera.org/learn/introduction-to-ai
2	http://nptel.ac.in/courses/106105077
3	https://www.coursera.org/learn/ai-for-everyone

22MT505	POWER ELECTRONICS AND DRIVES LABORATORY	0/0/2/1

Nature of Course: Practical

Pre-requisites: Nil

Course Objectives:

1. To become familiar with MATLAB simulation and to simulate various Power converters.
2. To experimentally learn and verify the characteristics of Power Semiconductor devices and circuits.
3. To become familiar with the operation of various power electronic converters

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

C505.1	Experiment with various power electronic converters.	[AP]
C505.2	Articulate the design aspects of power electronic converters for various applications.	[AP]
C505.3	Design and analyze the performance of DC choppers.	[AP]
C505.4	Simulate power electronic converter circuits.	[AP]
C505.5	Simulate electrical drives for various applications.	[AP]

S.No	List of Exercises	CO Mapping	BT
1.	Introduction to MATLAB simulink	C505.4	[AP]
2.	Hardware implementation of Gate firing circuits for SCR.	C505.1	[AP]
3.	Design a single-phase half-controlled and fully controlled converter and obtain the output voltage waveforms across R and RL loads.	C505.2	[AP]
4.	Design a single-phase AC Voltage controller and obtain the output voltage waveforms across R and RL loads.	C505.2	[AP]
5.	Analyse the operation of series inverter and parallel inverter.	C505.1	[AP]
6.	Design step up and step - down choppers, and compare their output voltages.	C505.3	[AP]
7.	Analyse the performance of voltage and current commutated choppers.	C505.3	[AP]
8.	Design and simulate the 180 degrees/120-degree modes of three-phase inverter.	C505.4	[AP]
9.	Design and Simulate speed control of converter fed DC motor drive.	C505.5	[AP]
10.	Design and Simulate position control of converter fed Stepper Motor drive.	C505.5	[AP]

Total Hours: 30

Reference Books:

1	P.S. Bimbhra, “Power Electronics”, Khanna Publishers, 6th Edition, 2018
2	Farzin Asadi, “Simulation of Power Electronics Circuits with MATLAB®/Simulink®: Design, Analyze, and Prototype Power Electronics”, Apress, 1st edition, 2022

Web Resources:

1	https://www.mathworks.com/academia/books/power-electronic-converters-iyer.html
2	https://electrical-engineering-portal.com/academy/courses/matlab-simulink-course-power-electronics-simulations

22MT506	ROBOTIC SYSTEMS LABORATORY	0/0/2/1

Nature of Course: Practical

Pre requisites: Nil

Course Objectives:

1. To familiarize the concepts and techniques in robots, manipulator control via teach pendant.
2. To understand rapid programming and create programs to perform certain tasks.
3. To understand the basics of machine vision using LabVIEW and its application in robotics.

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

C506.1	Apply the basics and classification of robots.	[AP]
C506.2	Apply the concepts of Rapid programming and create programs to perform industrial tasks	[AP]
C506.3	Apply the concept and techniques of a simple mobile robots	[AP]
C506.4	Apply the basics of path planning in robots	[AP]
C506.5	Apply the concepts and techniques of industrial robots to manipulator control via the Teach pendant.	[AP]

S.No	List of Exercises	CO Mapping	BT
1.	Using the Robot Studio Software simulate the following experiments a) Write your short name using six axis ABB robot b) Simulate the pick and place operation using six axis ABB robot	C506.1	[AP]
2.	Simulate the pick and place operation in a six axis robot using V Rep software.	C506.2	[AP]
3.	Simulate the path following mobile robot using V Rep software.	C506.3	[AP]
4.	Open loop and PID control system for a simple mobile robot using MATLAB	C506.3	[AP]
5.	Trajectory planning for Robot Manipulators using MATLAB	C506.4	[AP]
6.	Simple, rapid programming using Teach pendant.Pendant	C506.1	[AP]
7.	Teach Work object and TCP setting to ABB six axis robot using Teach pendant	C506.1	[AP]
8.	Teach the ABB six axis robot a) To identify the given components are Metal or Non - metal using Teach pendant b) Machine tending operation of ABB six axis robot using Teach pendant	C506.5	[AP]
9.	Teach the ABB six axis robot a) welding simulation of ABB six axis robot using Teach pendant b) Painting simulation of ABB six axis robot using Teach pendant	C506.5	[AP]
10	Teach the ABB six axis robot a) Matrix palletizing operation of ABB six axis robot using Teach pendant with single suction cup b) Cartoon palletizing operation of ABB six axis robot using Teach pendant with multi suction cup	C506.5	[AP]

Total Hours: 30

Reference Books:

1	Lentin Joseph, Jonathan Cacace, “Mastering ROS for Robotics Programming”, Packt Publishing, Oct 2021.
2	J. Norberto Pires “Industrial Robots Programming”, Springer, Oct 2010.

Web Resources:

<table>
<tr><td>22MT507</td><td>MINI PROJECT</td><td>0/0/2/1</td></tr>
<tr><td colspan="3">Course Outcomes:
Upon completion of the course, students shall have ability to</td></tr>
<tr><td>C507.1</td><td>Identify the real-time problem in thrust areas</td><td>[U]</td></tr>
<tr><td>C507.2</td><td>Compare and contrast the several existing solutions for the problems identified.</td><td>[AP]</td></tr>
<tr><td>C507.3</td><td>Design the proposed model using software tools.</td><td>[A]</td></tr>
<tr><td>C507.4</td><td>Develop and fabricate the proposed model.</td><td>[AP]</td></tr>
<tr><td>C507.5</td><td>Report and present the work carried out.</td><td>[A]</td></tr>
<tr><td>Week</td><td colspan="2">Guidelines</td></tr>
<tr><td>0</td><td colspan="2">Students can do the project either individually or in a group of maximum 4 members.
Students shall form their batch in the middle of 5th semester.
Head of the department / Students shall fix guide who is appropriate to their field of interest.
On discussion with their guides students shall identify a project title based on Mechatronics Engineering solution to societal problems or Re-engineer any of the automated systems.
The identified projects need to address any Research Problems or to develop a product or to provide technical solution to the real-world problems.</td></tr>
<tr><td>1
2</td><td colspan="2">(i) An extensive literature review pertaining to the problem identified shall be done by the students
(ii) Students shall file all referred literatures in hard copy</td></tr>
<tr><td>3</td><td colspan="2">(i) Students shall make the software modelling of the proposed project and tentative budget of the project
(ii) Students shall get approval of PPT and project diary from their project guide at least one day before the review</td></tr>
<tr><td>4</td><td colspan="2">ZEROTH REVIEW – Approval of the project based on literature review and feasibility
(i) Marks will be awarded based on selection of project title, presentation by individual batch members, feasibility of the project, literature review and dress code
(ii) A hardcopy of all referred literatures shall be submitted</td></tr>
<tr><td>5
6
7</td><td colspan="2">(i) Students shall do design calculations and prepare the assembly and part drawings
(ii) Design calculations should be verified by the respective project guide and a design expert in the department. Further, the final approval should be obtained from project co-ordinator
(iii) Students shall get approval of their PPT, partial project report with front page, introduction, literature review, design calculation chapters, journal paper, project diary from their project guide at least one day before the review</td></tr>
<tr><td>8</td><td colspan="2">FIRST REVIEW – Verification of design and bill of materials of the project.
(i) Marks will be awarded based on design calculation, CAD modelling, bill of materials, contribution, dress code and presentation by individual batch members
(ii) Students shall submit hardcopy of their partial project report corrected and approved by their project guide
(iii) They shall also submit hardcopy of journal paper prepared and verified by their guide.</td></tr>
<tr><td>9</td><td colspan="2">Students shall procure the hardware components required for the project.</td></tr>
</table>

10 11 12	(i) (ii)	Fabrication of the approved project shall be carried out by students at the college premises only. Students shall update their work progress and get their project diary duly filled and attested by the guide
13 14	(i) (ii)	Students shall present a paper in International Conference/publish a journal paper on their project in scopus / web of science journals Students shall get approval of their PPT, project report, project diary from their project guide at least one day before the review
15	**SECOND REVIEW** – Demonstration of completed mini projects (i) (ii)	Marks will be awarded based on completion of project, working model, project report, presentation by individual batch members, submission of international conference/journal paper and dress code Students shall get approval of PPT, International conference/journal paper and work progress in project diary from project guide
16	**End Semester Project VIVA-VOCE Examination** (i) (ii)	The viva – voce examination evaluates project presentation by individual batch members, demonstration of the project, project diary, project report, dress code and the components decided by external examiners. 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:

(i) Project report should be in prescribed format.
(ii) Students those who are absent for any review will not get any marks for that review
(iii) Students should be punctual to the reviews as per the time schedule
(iv) Students shall follow formal dress code. Boys should come with clean shaved face
(v) Students must follow strictly the instructions given then and there by the department

Assessment Components		
S.No.	**Category**	**Marks**
1	Zeroth Review	**10**
2	First Review	**15**
3	Second Review	**20**
4	Journal / International Conference/ Patent Publication	**15**
5	Viva Voce	**40**
Total		**100**

SEMESTER VI

22MT601	AUTOTRONICS AND VEHICLE INTELLIGENCE	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1.	To interpret the basic electronic engine control used in automobiles
2.	To select appropriate sensors and actuators for engines
3.	To learn and illustrate electronic fuel injection, ignition system and advanced control system in automobiles

Course Outcomes:

Upon completion of the course, students shall have ability to

C601.1	Describe the role of electronic control in vehicles.	[R]
C601.2	Illustrate various roles of sensors and actuators in automobiles.	[U]
C601.3	Explain various electronic injection and ignition systems.	[AP]
C601.4	Discuss various chassis and safety system operation and applications.	[U]
C601.5	Infer the operation of various engine control systems.	[U]

Course Contents:

AUTOMOTIVE SYSTEM AND SENSORS

Introduction to Automotive electronics – Emission norms -Engine components and their functions, Drive train and suspension systems, ABS and steering systems, Fuel supply systems and components. Vehicle Interoceptive sensors: Knock sensors, oxygen sensors, crankshaft angular, position sensor, temperature sensor, speed sensor, Pressure sensor, Mass air flow sensor, Manifold Absolute Pressure Sensors, crash sensor, Coolant level sensors, Brake fluid level sensor. **(15 Hours)**

AUTOMOTIVE CONTROL AND COMFORT SYSTEMS

Starting System -Charging System - Batteries - Electronic Engine Control system– Electronic Fuel Control System - Analysis of Intake Manifold Pressure-Ignition system- Electronic spark timing control, Automatic Transmission System - Variable Valve timing control - Integrated engine control system - Vehicle motion control-Active suspension system – Traction control system Electronic steering control-Electronic stability program. In-vehicle Networks. Onboard diagnostics. **(15 Hours**)

EV AND ADVANCED SYSTEMS

Electric Vehicle - batteries- electric motor and controller, regenerative braking Control of hybrid vehicles - Advanced Driver Assistance Systems (ADAS): Lane Departure, Active Cruise Control, Blind Spot Detection, Parking Assist, Autonomous Emergency Braking, Night Vision, Traffic Sign Recognition, Intelligent High beam Assistant, Tire Pressure Monitoring, Adaptive Lighting, Driver Drowsiness Detection, Hill Decent Control. Connected and Autonomous Vehicles (CAVs) **(15 Hours)**

Total hours: 45

Text Books:

1	B.William Ribbens, '' Understanding Automotive Electronics: An engineering Perspective", 8th Edition, Butterworth- Heinemann, Woburn, 2017.
2	Tom Denton, "Automobile Electrical and Electronic Systems", 5th Edition, Taylor and Francis group, 2018.

Reference Books:

1	Denton T Electric and hybrid vehicles, 2nd edition, Routledge,2020.
2	Denton. T, "Automated driving and driver assistance systems. Routledge,2019

Web Resources:

1	https://www.dieselnet.com/standards/in/

2	https://onlinecourses.nptel.ac.in/noc23_de01/preview
3	https://en.wikipedia.org/wiki/Bharat_Stage_emission_standards
4	https://www.eulermotors.com/en/charging-network

22MT602	INDUSTRIAL MANAGEMENT AND PROFESSIONAL ETHICS	3/0/0/3

Nature of Course : Theory

Pre Requisites : Nil

Course Objectives:

1. To understand the basic principles of management and the types of organization.
2. To understand the inventory and production planning analysis through various approaches
3. To understand ethics and its procedure in all aspects

Course Outcomes:

Upon completion of the course, students shall have ability to

C602.1	Enumerate the role of management in achieving the organizational Goals	[R]
C602.2	Classify the layout of plants and to provide the optimum inventory for the production.	[U]
C602.3	Establish the Quality function deployment and Six sigma	[AP]
C602.4	Develop work ethics and computer ethics in organizations	[AP]
C602.5	Understand IPR, copyright and trademark procedure	[U]

Course Contents:

PRINCIPLES OF MANAGEMENT

Management- Definition- Scientific Management- Significance and Features of Scientific Management-Functions of Management-Planning-Organizing-Staffing-Departmentalization-Centralization-Decentralization-Staffing-selection and training-Performance Appraisal - Directing- Controlling-Coordinating-Management by Objective- Case study: Management as a Science and Management as an Art **(15 hours)**

INVENTORY MANAGEMENT AND QUALITY CONTROL

Materials Management- Significance of Inventory-Functions of Inventory- ABC Analysis- V-E-D Analysis- Enterprise Resource Planning (ERP) -Production Planning and Control- Functions of Production Planning- Facility Planning – Muther's Principle of Facility Layout- Types of Plant Layout- Statistical Quality Control- Quality function Deployment (QFD) – Introduction to six sigma. **(15 hours)**

ENGINEERING ETHICS AND RIGHTS

Moral and values- Work Ethics- Engineering Ethics- Kohlberg's Theory- Gilligan's Theory- Consensus and Controversy- Theories about right action- Uses of Ethical theories- Occupational Crimes-Professional rights- Employee Rights- Intellectual Property Rights–Copyrights and its Infringement- Trademark and its Infringement-Environmental Ethics- Computer Ethics- Ten Commandments of Computer Ethics-Engineering as Experimentation- Rights of Engineers. **(15 hours)**

Total :45

Text Books:

1	N.V.S.Raju, "Industrial Engineering and Management", Cengage, Delhi, 1 st edition, 2013.
2	Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, Fourth edition, 2017.

Reference Books:

1	Stephen P.Robbins, Timothy A.Judge, Katherine E.Breward, "Essentials of Organizational Behaviour", Canada,Pearson Publication, 2022.
2	George Reynolds. "Ethics In Information Technology",Cengage,5th Edition, Noida,2015

Web References:

1	https://www.managementstudyguide.com/
2	https://www.sciencedirect.com/topics/computer-science/computer-ethics

22MT603	HYDRAULICS AND PNEUMATICS SYSTEMS	3/0/0/3

Nature of Course :Theory

Pre requisites : Nil

Course Objectives:

1. To understand the concepts of hydraulics and pneumatics.
2. To develop a measurable degree of competence in the design, construction and operation of hydraulic circuits.
3. To apply the pneumatic principles to design various sequential circuits.

Course Outcomes:

Upon completion of the course, students shall have ability to

C603.1	Understand the basic concept of hydraulics and pneumatics and working of pumps.	[U]
C603.2	Summarize the working principle of hydraulic actuators and control components.	[U]
C603.3	Understand different types of hydraulic circuits and systems.	[U]
C603.4	Explain the basic pneumatic components and working of different pneumatic circuits.	[U]
C603.5	Design the pneumatic circuit according to the given sequence using cascade and step counter method.	[AP]

Course Contents:

FLUID POWER PRINCIPLES AND COMPONENTS

Introduction to Hydraulics and pneumatics - Advantages and Applications - Types of fluids - Pascal's Law and its application- Principles of flow, Pumping Theory – Pump Classification, Construction, Working, Advantages, Disadvantages, Selection criterion of Linear, Rotary - Fixed and Variable displacement pumps – Properties of air – Perfect Gas Laws - Symbols of hydraulic and pneumatic elements. **(15 Hours)**

HYDRAULICS ELEMENTS AND CIRCUITS

Hydraulic system design and typical Industrial applications - Sizing and selection of power pack elements – actuators – intensifiers – valves(pressure, flow and directional control valves) –hydraulic pumps and motors - accumulators - deceleration circuit, regenerative circuits, speed control circuits, sequencing circuits, synchronizing circuits, fail safe circuits - Introduction to digital hydraulics. **(15 Hours**)

PNEUMATIC AND ELECTRO-PNEUMATIC CIRCUITS

Compressors - Filter, Regulator, Lubricator, Muffler, Air control valves, Actuators. Pneumatic Circuits: Speed control, Quick exhaust, Air-Oil-reservoir circuit - Design of pneumatic circuit by cascade method and step counter method – Introduction to Electro hydraulics and pneumatics & PLC - Applications of fluid power in excavators & pick and place robot. **(15 Hours)**

Total hours:	**45**

Text books:

1	Anthony Esposito, "Fluid Power with Applications", Pearson Education, South Asia, Seventh edition, 2016.
2	Srinivasan.R, "Hydraulic and Pneumatic controls", McGraw Hill Education Pvt. Ltd, Third edition, 2019.

Reference books:

1	S.R.Majumdar, "Pneumatic System Principle and Maintenance" Tata McGraw-hill. New Delhi,2017
2	J.Michael, Pinches and G.John Ashby, "Power Hydraulics", Prentice Hall, New Delhi,2018

Web Resources:

1	https://www.mdpi.com/1996-1073/14/24/8589
2	https://archive.nptel.ac.in/courses/112/106/112106300/
3	https://whyps.com/applications-of-hydraulics-and-pneumatics

22MT604	HYDRAULICS AND PNEUMATICS LABORATORY	0/0/2/1

Nature of Course: Practical

Pre requisites: Nil

Course Objectives:

1. To understand the basics of hydraulics and pneumatics.
2. To develop a degree of competence in the design, construction and operation of fluid power circuits.
3. To construct electrohydraulic and electropneumatic circuits used in industries.

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

C604.1	Understand the basic components of hydraulic and pneumatics.	[U]
C604.2	Apply the basic principles of hydraulics and design the different types of Industrial hydraulic circuits and systems.	[AP]
C604.3	Design and simulate the sequential pneumatic circuits for various industrial applications.	[AP]
C604.4	Design Pneumatic circuits using basic logical elements.	[AP]
C604.5	Develop the electro-pneumatic circuits based on the given sequence.	[AP]

S.No	List of Exercises	CO Mapping	BT
1.	Study of pneumatic and hydraulic components.	C604.1	[U]
2.	Simulation and actuation of hydraulic linear & rotary actuator.	C604.2	[AP]
3.	Simulation and actuation of speed control in hydraulic actuator.	C604.2	[AP]
4.	Simulation and actuation of an accumulator circuit.	C604.2	[AP]
5.	Simulation and actuation of counter balancing circuit.	C604.2	[AP]
6.	Simulation and actuation of regenerative circuit.	C604.2	[AP]
7.	Simulation and actuation of single and double acting pneumatic cylinder, parallel and series circuit.	C604.3	[AP]
8.	Simulation and actuation of pneumatic logical circuits using Shuttle valve & two pressure valve.	C604.4	[AP]
9.	Simulation and actuation of metering in and metering out pneumatic circuit.	C604.3	[AP]
10.	Simulation and actuation of sequential pneumatic circuit (2 & 3 cylinder circuit).	C604.3	[AP]
11.	Simulation and actuation of pneumatic circuit using cascading method (2 & 3 cylinder circuit).	C604.3	[AP]
12.	Simulation and actuation of sequential circuits using electropneumatics circuits.	C604.5	[AP]

Total Hours: 30

Reference Books:

1 .	Andrew Parr, “Hydraulics and Pneumatics – A technicians and Engineers guide”, Third Edition, Butterworth-Heinemann, 2018.
2 .	Majumdar, S.R., “Oil Hydraulics Systems- Principles and Maintenance”, Tata Mc Graw Hill, 2017.

Web Resources:

1	https://pc-coep.vlabs.ac.in/
2	https://www.festo.com/us/en/e/technical-education/digital-learning-id_31239/
3	https://www.coursera.org/learn/fluid-power

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**

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**

PROFESSIONAL ELECTIVES

2MT901	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	Describe different robot configuration for various applications	[R]
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 modeling mobile robots	[AP]
C901.5	Apply various algorithms in path planning and navigation	[AP]

Course Contents:

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 Maneuverability-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/

22MT902	AGRICULTURAL ROBOTICS AND AUTOMATION	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1.	To learn about Farming related Machines, traction and testing.
2.	To familiarize the concept of weed management.
3.	To learn about machinery selection.

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

C902.1	Recognize the areas in the agricultural process where robotics can be applied.	[U]
C902.2	Interpret the sensor and system for a required specific process in agricultural applications.	[AP]
C902.3	Apply mechanics to the design of various robot parameters.	[AP]
C902.4	Convert various mechanisms into robots by providing actuation at specific links and joints of the mechanism.	[U]
C902.5	Examine and select suitable robotic systems for specific agricultural tasks.	[AP]

INTRODUCTION AND PRECISION AGRICULTURE

History of Mechanized Agriculture - Farming Operations and Related Machines - Tillage, Planting Cultivation, and Harvesting, Agricultural Automation - Agricultural Vehicle Robot - Sensors – types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks

(15 Hours)

TRACTION, TESTING AND SOIL TILLAGE

Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction models, Traction predictor spreadsheet, Soil Compaction, Traction Aids, Tractor Testing - Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements, Hitching of Tillage Implements

(15 Hours)

WEED MANAGEMENT AND MACHINERY SELECTION

Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation- Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers, Machinery Selection. Case studies: Drones for agricultural purposes and health prediction of crops - Flower picking and fruit plucking robots.

(15 Hours)

Total hours: 45

Text Books:

1	Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, "Engineering Principles of Agricultural Machines", ASABE Publication, 2012.
2	Myer Kutz , "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2019.

Reference Books:

1	Qin Zhang, Francis J. Pierce, "Agricultural Automation Fundamentals and Practices", CRC Press, 2016.
2	Guangnan Chen, "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2021.

Web Resources:

1	https://www.ieee-ras.org/agricultural-robotics-automation
2	https://builtin.com/robotics/farming-agricultural-robots

22MT903	BIO - MECHATRONICS	3/0/0/3

Nature of Course : Theory

Pre requisites : Nil

1. To understand the principle, design and application of various human measurement and assisted devices for the human functional system.
2. To familiarize on the Bio – Mechatronics devices and their functions.
3. To acquire the basic knowledge on wearable Bionics devices.

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

C903.1	Observe basic knowledge about the Bionics and Bio Mechatronics Devices	[R]
C903.2	Summarize various Mechatronics concepts in patient monitoring and rehabilitation system.	[U]
C903.3	Apply the basic concept of prosthetics in rehabilitation robots	[AP]
C903.4	Examine appropriate Mechatronics device for assisting devices	[AP]
C903.5	Retell the wearable bionic devices and rehabilitation robots for different applications.	[R]

Course Contents:

BIONIC SYSTEMS AND MEASUREMENTS

Fundamentals of Biological systems and Mechanisms- Cardiovascular, Musculoskeletal, Central Nervous Systems and Orthopedic systems, Human ergonomics, Rehabilitation. Smart actuators for biological applications - Heart rate - Heart sound -Pulmonary function measurements -spirometer -finger-tip oximeter - ESR, GSR measurements. **(15 Hours)**

PROSTHETICS AND ASSISTING DEVICES

Introduction to Prosthetics, Passive Prosthetics – walking dynamics, Knee and foot prosthesis, Active prosthesis.

Bioelectric Potentials, Bio-medical signals, Bionic Eyes, hearing aids and Cochlear Implants, Assisting Devices – Sonar based systems, Respiratory aids, Pacemakers, Tactile devices for visually challenged. **(15 Hours**)

WEARABLE BIONIC DEVICES

Artificial Kidney, Wireless capsule endoscope, Exoskeleton rehabilitation system, Wearable hand rehabilitation, Therapeutic Exercise and rehabilitation Robots. Introduction to organ on chips. Case studies - Orthopedic Surgery, Cardiac Surgery. **(15 Hours)**

Total hours: 45

Text Books:

1	Raymond Tong Kaiyu. “Bio-mechatronics in Medicine and Healthcare” Pan Stanford Publishing, CRC Press, 2015
2	Hu Xiaoling, Intelligent Biomechatronics in Neuro rehabilitation, Academic Press, 2019.

Reference Books:

1	Ahmad Azar, Control Systems Design of Bio-Robotics and Bio-Mechatronics with Advanced Applications, Academic Press, 2019.
2	Raymond Tong Kaiyu. “Bio-mechatronics in Medicine and Healthcare” Pan Stanford Publishing, CRC Press, 2017.

Web Resources:

1	https://www.mechatronic.me/2021/02/what-is-biomimetics-bionics.html
2	https://www.azorobotics.com/Article.aspx?ArticleID=477
3	https://www.dlr.de/rm/en/desktopdefault.aspx/tabid-3793/

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

Course Contents

INTRODUCTION TO ROS

Introduction – file system level, Computational graph level, Community level. Creating ROS package Working with ROS Servies, creating launch files- 3D robot Modelling in ROS - Visualizing using Rviz. **(5 hours)**

SIMULATION AND NAVIGATION

Simulating Robots Using Ros and V-REP, Robotic arm suing V -REP and ROS – Differential Wheeled robot in V – REP - ROS Movelt and Navigation Stack -- Understanding ROS Navigation Stack, building map using SLAM. **(5 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 **(5 hours)**

Total hours: 15

Laboratory Component:

S no	List of Experiment s
1.	Create ROS Workspaces and Packages
2.	Publish/subscribe communication paradigms
3.	3D robot Modelling Using URDF
4.	Simulating robot Arm using Gazebo & PID Tunning
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 interface

Total hours: 30

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 References:	
1	http://wiki.ros.org/ROS/Tutorials
2	https://www.udemy.com/course/ros-essentials/

22MT905	MICROROBOTICS	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1. To acquire the basic knowledge on constructional details, principle of operation, and applications of Microrobots.
2. To impart knowledge on constructional details, principle of operation, and applications of Micro Actuators and Micro Sensors
3. To understand the types of machining used to make Microrobots

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

C905.1	Describe micro system technology and microrobots.	[U]
C905.2	Explain the physics and machining involved in microrobots	[R]
C905.3	Describe various actuators and sensors used in microrobots	[U]
C905.4	Discuss appropriate design criteria suitable for micromachining and micro assembly	[AP]
C905.5	Illustrate real time applications of microrobotics	[U]

Course Contents:

Module I – Basics of Microrobots

Introduction- Scale effect- Perception- Design of micro actuators and fabrication technology- Repeatability and dexterity of micro robots- Surface forces - Contact forces - forces for micromanipulation. **(15 Hours)**

Module II - Actuators and Sensors

Design Principles of Actuators- Electrostatic Actuators- Thermal-Based Actuators - Shape Memory Alloys - Piezoelectric Actuators - Sensors in Micro robotics - Terminology - Sensing Technologies for Displacements. Electromagnetic Sensors - Optical-Based Displacement Sensors - Motion Tracking with Microscopes **(15 Hours**)

Module III - Micromachining

Manufacturing Requirements for Micro robots - Surface Micromachining and Lithography Based Processes - High-Aspect Ratio Micromachining- Design Selection Criteria - Silicon surface machining processes- Case Study: Water Drop Gripper: Gripping with Capillary Forces - Smart Pills. **(15 Hours)**

Total hours: 45

Text Books:

1	Yves Bellouard, Microrobotics Methods and Applications, CRC Press, Massachusetts, 2019.
2	Nicolas Chaillet, Stephane Regnier, “Microrobotics for Micromanipulation”, Wiley, 2013.

Reference Books:

1	Vikas Choudhry, Krzystof, “MEMS: Fundamental Technology and Applications”, CRC Press, 2017.
2	Kenneth K. W. Kwan, Alfonso H. W. Ngan, “Stimuli-responsive Actuating Materials for Micro-robotics”, Elsevier, 2024.

Web Resources:

1	https://builtin.com/robotics/microrobotics
2	https://www.robotpark.com/academy/all-types-of-robots/micro-robots-microbotics/
3	https://microbotlabs.com/project-lab.html

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/

22MT907	PRODUCT DESIGN AND MANUFACTURING	3/0/0/3

Nature of Course: Theory

Prerequisites : Nil

Course Objectives:

1.	To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development.
2.	To apply the principles of product architecture and the importance of industrial design principles and DFM principles for new product development.
3.	To expose the different Prototyping techniques to develop a robust design and importance to patent a developed new product.

Course Outcomes:

Upon completion of the course, students shall have ability to

C907.1	Apply the principles of generic development process; product planning; customer need analysis for new product design and development	[AP]
C907.2	Set product specifications and generate, select, screen, test concepts for new product design and development.	[U]
C907.3	Understand the principles of product architecture and design for manufacturing in new product development.	[U]
C907.4	Understand the concept of industrial design	[U]
C907.5	Apply the adopt Prototyping techniques to develop a robust design and document a new product for patent.	[AP]

Course Contents:

PRODUCT DESIGN AND SPECIFICATIONS

Product design - Morphology of design - Characteristics of Successful Product development – Product Planning Process - Process of Identifying Customer Needs - Establish Target and Final product specifications – Activities of Concept Generation - Concept Screening and Scoring - Concept Testing Methodologies. **(15 Hours)**

PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN

Product Architecture – Implications and establishing the architecture – Delayed Differentiation – Platform Planning – Related system level design issues - Need and impact of industrial design - Industrial design process - management of the industrial design process - assessing the quality of industrial design. **(15 Hours)**

DESIGN FOR MANUFACTURE, PROTOTYPING AND ROBUST DESIGN

DFM Definition - Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors - Prototype basics - Principles of prototyping – Prototyping technologies - Planning for prototypes –Robust Design and process. **(15 Hours)**

Total hours: 45

Text Books:

1	Karl T. Ulrich and Steven D. Eppinger. “Product Design and Development” Tata McGraw-Hill Publishing Company Limited, 7th Edition, 2020.
2	Kenneth Crow, "Concurrent Engineering/Integrated Product Development". DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book

Reference Books:

1	Kevin N Otto, Kristin L Wood, “Product Design – Techniques in Reverse Engineering and New Product Development”, Pearson Education, Inc, 2016.
2	A.K. Chitale, R.C. Gupta, “Product Design and Manufacturing”, Prentice Hall of India Private Limited, New Delhi, 6th Revised Edition, 2014.

Web Resources:

1	https://nap.nationalacademies.org/read/10526/chapter/4
2	https://onlinecourses.nptel.ac.in/noc21_me66/preview
3	https://onlinecourses.nptel.ac.in/noc21_me83/preview
4	https://www.pmi.org/learning/library/modeling-ippd-design-team-8530

22MT908	ROBOTS AND SYSTEMS IN SMART MANUFACTURING	3/0/0/3

Nature of Course: Theory

Pre requisites : NIL

Course Objectives:

1	To impart knowledge in the basics of robotic anatomy, robot interfaces and its integrated system for successful implementation of smart factories.
2	To empower the students in gaining concepts about robot system in the field of automation
3	To gain insight to develop robot cell assembly

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

C908.1	Describe the robot motion control through sensor integration	[R]
C908.2	Able to select robots according to the industrial application.	[U]
C908.3	Build the robot cell using GRASP to integrate robots with the industry environment.	[AP]
C908.4	Discover the concept of flexible automation and flexible machining cell.	[U]
C908.5	Understand the concept of robot assembly cell	[U]

Course Contents:

ROBOT CONFIGURATIONS AND SYSTEMS

Overview of Robotic Components and Configurations- Robot Classifications- Robot coordinate systems- Work envelopes- Types of Robot Controls-Motion control of Robots- End effector and Grippers- Gripper design for pick and place operation-Robot Sensors –Design and Control of sensor integrated Dexterous robot hand-Specifications of Robots **(15 hours)**

FLEXIBLE AUTOMATION AND SMART MANUFACTURING SYSTEM

Flexible Automation and Machining Cell – Robot Assembly- Types - Robots in smart manufacturing- Robotic Assembly Cell and Design – GRASP- primitives- Modelling Robot cell using GRASP- Smart manufacturing system- Significance and benefits - Smart Manufacturing Technologies- Weld Robots- Smart Factories in real world - Architecture and Technologies

(15 hours)

ROBOTICS APPLICATIONS

Robots for Material Handling Operation- Rail Mounted Robots for Machine loading and Unloading- Basic Components of a Robotic Arc welding System-Teaching and Programming the Robot for Automated Single Pass Welding- Sensors based Robot Welding- Spray Painting Robots-Joystick Cum Teleoperated Robots in Nuclear plants-Robotic application under Computer Integrated Manufacturing Environment- Introduction to Robot Vision System and application in inspection

(15 hours)

Total hours: 45

Text Books:

1	S.R.Deb and.S Deb, “Engineering Robotics Technology and Flexible Automation”, Mc Graw Hill Education, Second edition.2017.
2	Richard D.Klafter, Thomas A.Chnielewski, Michael Negin, “Robotic Engineering, An integrated Approach” Pearson Education, U.S.A, 2019.

Reference Books:

1	Saeed B.Niku, “Introduction to Robotics Analysis, Systems, Applications” .Pearson education, second impression, 2017.
2	Alasdair Gilchrist, “Industry 4.0 the Industrial Internet of Things”, first edition, Apress, 2016.

Web References:

1	https://onlinecourses.nptel.ac.in/noc21_me76/preview
2	https://archive.nptel.ac.in/courses/112/105/112105249/

22MT909	CNC MACHINES AND PART PROGRAMMING	3/0/0/3

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1. Understand the construction of modern CNC machine tool structures.
2. Discover the various support system available for CNC machine tools.
3. Prepare the part programming methods using standard coding system and APT language.

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

C909.1	Understand the principle of CNC and its hardware basics.	[U]
C909.2	Explain the different types of tooling and work holding devices.	[U]
C909.3	Recognize the type of CNC machining & turning centers and their capabilities.	[R]
C909.4	Write part programs for milling and drilling operations in machining centers.	[AP]
C909.5	Develop ISO code part programs for turning & thread cutting and APT program for end mill operations.	[AP]

Course Contents:

CNC BASICS AND HARDWARE

Introduction- Numerical Control - Numerical control modes-numerical control elements- NC machine tools – Structure of CNC machine tools – Spindle design-drives-Actuation systems – feedback devices – Axes-standards. **(15 Hours)**

CNC TOOLING, MACHINE TOOLS AND CONTROL SYSTEM

Cutting tool materials-turning tool geometry – Milling tooling systems – tool presetting – Automatic tool changers – work holding – cutting process parameter selection – CNC machining centers-CNC turning centers- High speed machine tools – support systems- Touch trigger probes. **(15 Hours)**

CNC PROGRAMING

Part programming fundamentals-manual part programming methods- preparatory functions-miscellaneous functions- program number- tool length compensation- canned cycles-cutter radius compensation – ISO Part program of machining parts - turning center axes system – motion commands- thread cutting - APT language structure and commands – Complete part programming in APT**.** **(15 Hours)**

Total hours: 45

Text Books:

1. P. N. Rao**,** “CAD/CAM: Principles and Applications”, 3rd Edition, McGraw Hill Education, 2017
2. Vikram Sharma, Vikrant Sharma and Om Ji Shukla, “ Principles and Practices of CAD/CAM”, 1st Edition, CRC Press, Taylor & Francis Group, 2024.

Reference Books:

1. P Radhakrishnan, “ Computer Numerical Control Machines and Computer Aided Manufacture”, 2nd Edition, New Academic Science Limited, 2019.
2. Peter Smid, “ Programming Handbook, 3rd Edition, Industrial Press, Inc., 2020.

Web Resources:

1. https://nptel.ac.in/courses/112105211
2. http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAM/exp2/index.html
3. https://www.classcentral.com/subject/cnc-programming

22MT910	ADDITIVE MANUFACTURING PROCESSES	3/0/0/3

Nature of Course: Theory

Pre requisites : Nil

Course Objectives:

To introduce the development of Additive Manufacturing (AM), various business opportunities and applications

To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.

To cultivate knowledge on choosing AM processes, devices and materials to suit particular engineering requirements

Course Outcomes:

Upon completion of the course, students shall have ability to

C910.1	Recognize the development of AM technology and its propagation into various businesses opportunities.	[R]
C910.2	Associate knowledge on process of transforming a concept into the final product in AM technology.	[U]
C910.3	Illustrate the vat polymerization and direct energy deposition processes and its applications.	[U]
C910.4	Extend the knowledge on process and applications of powder bed fusion and material extrusion processes.	[U]
C910.5	Explain the advantages, limitations, applications of sheet lamination processes.	[AP]

Course Contents:

INTRODUCTION AND 3D PRINTING ESSENTIALS

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing - Electronics Printing. CAD Modelling for 3D printing: 3D Scanning and digitization - data handling & reduction Methods, AM Software: data formats and standardization, Slicing, Process-path generation. Business Opportunities and Future Directions. **(15 hours)**

VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION

Photo polymerization: Stereolithography Apparatus (SLA)- Materials - Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP)Technology. Laser Engineered Net Shaping (LENS)- Process - Material Delivery -Materials -Benefits - Applications. **(15 hours)**

POWDER FUSION, EXTRUSION AND SHEET LAMINATION

Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism -Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations. Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials-Application and Limitation. **(15 hours)**

Total hours:	**45**

Text Books:

1	Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing”, 3rd Edition, Springer, 2021.
2	Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: 3D Printing and Additive manufacturing Principles and Applications” ,5th Edition, World Scientific, 2019.

Reference Books:

1	Kaushik Kumar, DivyaZindani, J.PauloDavim , “Rapid Prototyping, Rapid Tooling and Reverse Engineering”, De Gruyter Publisher ,2020.

2	Sunpreetsingh, Chander Prakash and Seeram Ramakrishna, "Additive Manufacturing: Knowledge for the beginners", World Scientific, 2020.
3	Richard Leach and Simone Carmignato , "Precision Metal Additive Manufacturing", CRC press, 2020.
Web References:	
1	https://archive.nptel.ac.in/courses/112/103/112103306/
2	https://learn-xpro.mit.edu/additive-manufacturing
3	http:// www. sciencedirect.com/science/article/pii/S1742706119307172
4	https://www.coursera.org/courses?query=additive%20manufacturing

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

22MT913	ADVANCED DRIVER ASSISTANCE SYSTEMS	3/0/0/3

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1. To provide detailed explanations about the various driver assistance systems.
2. Introduce the fundamental aspects of Autonomous Vehicles.
3. Gain Knowledge about the Sensing Technology and Connectivity Aspects involved in driverless cars.

Course Outcomes:

Upon completion of the course, students shall have ability to

C913.1	Describe the evolution of Autonomous vehicles	[R]
C913.2	Interpret the different type of sensing mechanisms involved in Autonomous Vehicles	[U]
C913.3	Examine the driver assistance systems employed in today's automotive industry	[AP]
C913.4	Interpret the different levels of automation involved in an Autonomous Vehicle	[U]
C913.5	Discover the various accident prevention systems for Autonomous Vehicles	[AP]

Course Contents:

AUTONOMOUS GROUND VEHICLES

Introduction - Autonomy Levels. Overview of driver assistance systems - Driving behavior, driving safety - active and passive safety systems – Integration of ADAS technology into vehicle electronics - Applications of ADAS. **Sensors for autonomous vehicles:** Evolution – Sensor technology - Basics of radar - Ultrasonic sonar – LIDAR- MIC - Camera and illumination technology. **(15 hours)**

DRIVING VISION SYSTEMS

Computer vision techniques as pattern recognition, feature extraction, learning, tracking, 3D vision to assist the driving activity - Night Vision - Blind Spot Monitoring. **Driving assistance systems for maneuvering**: Automatic Parking - Autonomous valet parking - Navigation System - Lane Assist and Lane Keeping - Adaptive cruise control - Glare - Free High Beam and Pixel Light - Adaptive light control - Automatic Emergency Braking. **(15 Hours)**

MOTION PLANNING FOR AUTONOMOUS VEHICLES

Driverless Car Technology-Different Levels of Automation -Localization - Path Planning - Controllers to Actuate a Vehicle - PID Controllers -Model Predictive Controllers. **Accident prevention systems:** Crosswind Stabilization - Tyre pressure monitoring system - Driver drowsiness detection - Driver monitoring system - Collision avoidance system - Connected vehicles - Role of Sensor Data Fusion. **(15 Hours)**

Total hours: 45

Text Books:

1	Konrad Reif, Brakes, Brake Control and Driver Assistance Systems, 1st edition, Springer Vieweg, 2014
2	Hong Cheng, "Autonomous Intelligent Vehicles: Theory, Algorithms and Implementation", Springer, 2011.

Reference Books:

1	Shaoshan Liu, Liyun Li, Creating Autonomous Vehicle Systems, Morgan and Claypool Publishers, 2017.
2	Robert Bosch, Automotive Electronics Handbook, John Wiley and Sons, 2004.

Web Resources:

1	https://www.coursera.org/learn/intro-self-driving-cars
2	https://www.phi.science/products/agv-autonomous-ground-vehicles-specialization
3	https://in.mathworks.com/academia/student-competitions/igvc.html
4	https://www.science.gov/topicpages/a/autonomous+ground+vehicle.html

22MT914	VEHICLE ERGONOMICS	3/0/0/3

Nature of Course: Theory

Pre requisites: Nil

Course Objectives:

1. To provide basic concepts about Ergonomics and their implementation in design.
2. To illustrate the application of ergonomic principles in automobile design.
3. To familiarize with the knowledge on the styling, design of the vehicle entry and exit and visibility inside the vehicle.

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

C914.1	Recall the concepts of automotive ergonomics.	[R]
C914.2	Apply the basic techniques of ergonomics on vehicle design.	[AP]
C914.3	Infer anthropometric data in automotive design, ensuring user-friendly spatial arrangements.	[U]
C914.4	Apply vehicle design for optimal user comfort and safety.	[AP]
C914.5	Understand the importance of optimizing vehicle design using ergonomic principles: AHP, manikin, entry/exit, visibility, cockpit, and loading.	[U]

Course Contents:

FUNDAMENTALS OF ERGONOMICS

Introduction - principles – applications - Dimension Determination, Anthropometry - Need, Data collection methodology, Different postural considerations - Measuring Procedures Subject and Sampling size selection, Measurement of Hands/Feet/Full posture, Applying Anthropometry data, Application of percentile curves. Recent developments in ergonomics and styling. **(15 hours)**

AUTOMOTIVE ERGONOMICS

Passenger Compartment, Floor Pan, Vehicle interior ergonomics, ergonomics system design Technical requirements, Force Analysis, Seating and position – Economic Commission for Europe (ECE) Regulations, Human Factors, Navigation systems, pedal positioning Crash tests, forces in rollover, head on impact. **(15 hours)**

VEHICLE DESIGN

Accelerator Heel Point (AHP), Manikin positioning of 2-D pattern, car entry/exit, Sight - All round visibility, View of Instruments, Mirror design, Logical formation of cockpit, Boot lid packaging, Loading/Unloading analysis. Case study (Physical ergonomic evaluation of any vehicle workstation starts with assessing key human factor issues). **(15 hours)**

Total hours: 45

Text Books:

1	Vivek D Bhise, “Ergonomics in the Automotive Design Process”, CRC Press; 1st edition 2016.
2	I.A.R. Galer, “Applied Ergonomics”, Butterworth-Heinemann Ltd, 2nd edition, 1987.

Reference Books:

1	R. Bridge, “Introduction to Human Factors and Ergonomics”, Boca Raton: CRC Press, 4th Edition, 2017.
2	J. Brian Peacock, Waldemar Karwowski, “Automotive ergonomics”, Taylor & Francis ltd, 1993.
3	Julian Happian-Smith, “An introduction to modern vehicle design”, Butterworth Heinmenn,2001.

Web Resources:

1.https://www.dsource.in/course/basic-ergonomics-automotive-design

2.https://onlinecourses.swayam2.ac.in/aic20_ed03/preview

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

22MT916	ELECTRIC AND HYBRID VEHICLES	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1.	To acquire the basic knowledge on Electric Hybrid Vehicles
2.	To impart knowledge on Architecture, dynamic equations and characteristics for vehicles
3.	To understand the types of converters, Drives and Energy Management Strategies

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

C916.1	Understand the architecture of electric hybrid vehicles.	[U]
C916.2	Analyze dynamic equations and characteristics for vehicles.	[A]
C916.3	Explain the train topologies and fuel efficiency analysis for electric hybrid vehicles.	[AP]
C916.4	Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.	[AP]
C916.5	Identify the various energy management strategies and choose proper communication systems.	[U]

Course Contents:

ELECTRIC HYBRID VEHICLES

Introduction - Economic and Environmental Impact of Electric Hybrid Vehicle (EHV)-Motion and dynamic equations for vehicles - Vehicle Power Plant and Transmission Characteristics -. Impact of modern drive trains on energy supplies Electric Vehicles. **(15 Hours**)

ARCHITECTURE OF DRIVE TRAINS

Basic Architecture of Hybrid Drive Trains and Analysis of Series Drive Train - Power Flow in HEVs- Torque Coupling and Analysis of Parallel DriveTrain - Basic Architecture of Electric Drive Trains- Train topologies – Fuel efficiency Analysis. **(15 Hours**)

DRIVES AND ENERGY STORAGE

DC-DC Converters and DC-AC Inverters for EHV Applications - Induction motor drives control and applications in EHVs - Permanent magnet motor drives control and applications in EHVs- Battery Parameters – Different types of batteries – Lead Acid- Nickel Metal Hydride – Lithium ion Sodium based- Metal Air. Battery Modelling – Equivalent circuits, Energy Management Strategies- Communication and Supporting System. **(15 Hours)**

Total hours:	**45**

Text Books:

1	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2017.
2	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design,CRC Press, 2017.

Reference Books:

1	James Larminie, John Lowry, Electric Vehicle Technology Explained,Wiley, 2018
2	Electrical and Plug-in Hybrid Vehicle Networks Optimization and Control Emanuele Crisostomi, Robert Shorten, Sonja StGdli & Fabian Wirth © 2018 Taylor & Francis Group

Web Resources:

1	https://archive.nptel.ac.in/courses/108/103/108103009/

22MT917	AUTOMOBILE ENGINEERING	3/0/0/3

Nature of Course: Theory

Pre requisites : NIL

Course Objectives:

1	To understand automobile types, engine components, fuel injection systems, ignition systems, and turbocharging technologies.
2	To learn clutch types, gearboxes, steering mechanisms, suspension systems, braking systems, and traction control technologies
3	To study the use of alternative fuels in automobiles, engine modifications, and performance characteristics of SI and CI engines.

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

C917.1	Recall the various parts of the automobile, their functions and materials.	[R]
C917.2	Discuss the engine auxiliary systems.	[U]
C917.3	Distinguish the working of different types of transmission systems.	[U]
C917.4	Explain the Steering, Brakes and Suspension Systems.	[U]
C917.5	Predict possible alternate sources of energy for IC Engines.	[AP]

Course Contents:

VEHICLE STRUCTURE & AUXILIARY SYSTEMS

Types of automobiles, vehicle construction and different layouts, chassis, frame and body, IC engines –components-functions and materials, variable valve timing (VVT). Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system and capacitive discharge ignition system), Turbochargers (WGT & VGT).

(15 hours)

DRIVE AND CONTROL SYSTEMS

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle. Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control. **(15 hours)**

ALTERNATIVE ENERGY SOURCES

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell. **(15 hours)**

Total hours: 45

Text Books:

1	Dr.Kirpal Singh, “Automobile Engineering Vol.1 & 2”, Standard Publishers and Distributors Pvt Ltd, 14th Edition, 2021.
2	S.Srinivasan, “Automotive Mechanics”, McGraw Hill Education; 2nd edition,2017.

Reference Books:

1	Tom Denton, “Automobile Electrical and Electronic Systems”. Butterworth-Heinemann,4th Edition, 2017.
2	Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals” CRC Pr I Llc; 3rd edition, 2021.

Web References:

1	NPTEL, Fundamentals of Automotive Systems, https://nptel.ac.in/courses/107106088
2	Coursera, Electric Vehicles and Mobility, https://www.coursera.org/learn/electric-vehicles-mobility

22MT918	BATTERY MANAGEMENT SYSTEM	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1. To introduce the various Battery Management System parts.
2. To understand basic information about batteries.
3. To measure different battery parameters & charge of the battery.
4. To estimate state of health of the battery.

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

C918.1	Review various Battery Management System parts.	[R]
C918.2	Discuss the basic information about batteries and demonstrate Lithium-Ion Battery Fundamentals.	[U]
C918.3	Illustrate Battery pack design and cloud-based charging.	[AP]
C918.4	Detail the need of Battery Modelling software/simulation frameworks.	[AP]
C918.5	Estimate the state of health of the battery and discuss battery fault detection.	[U]

Course Contents:

ESSENTIALS OF BATTERY MANAGEMENT SYSTEMS

Introduction to Battery: Characteristics general operational mechanism of batteries, battery voltage. Battery Management Systems (BMS); Comparison of BMS in a low-end and high-end. Lithium -Ion Battery Fundamentals, Operation, Construction, Chemistry, Safety Longevity, Performance and Integration. **(15 Hours)**

BATTERY TERMS AND MODELLING METHODS

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model. Peak power definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance Cloud based and Local Smart charging. Battery Modelling Methods: Equivalent Circuit Models Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model PNGV model. State space Models Introduction. Battery Modelling software/simulation frameworks **(15 Hours)**

BATTERY PARAMETER ESTIMATION

State-of-Charge (SOC) Estimation Algorithms, Challenges -SOC Corrections-State-of-Health (SOH) Estimation Algorithms- Mechanisms of Failure, Predictive SOH Models- Impedance Detection-Passive Methods, Active Methods-Capacity Estimation, Self-Discharge Detection Parameter Estimation-Dual-Loop, System, Remaining Useful Life Estimation-Fault Detection-Overview. **(15 Hours)**

Total hours:	**45**

Text Books:

1	H. J. Bergveld, “Battery Management Systems : design by modelling” University Press Facilities, Eindhoven,2002.
2	Gregory L. Plett, “Battery Management Systems: Battery Modeling”, Artech house, 2015.

Reference Books:

1	Plett, Gregory L. Battery management systems, Volumel &II Artech House, 2015.
2	Phillip Weicker, “A Systems Approach to Lithium-Ion Battery Management”, artech house, 2014.

Web Resources:

1	https://onlinecourses.nptel.ac.in/noc21_mm34/preview
2	https://www.coursera.org/learn/battery-management-systems
3	https://www.infineon.com/cms/en/applications/solutions/battery-management-system/
4	https://www.synopsys.com/blogs/chip-design/what-is-a-battery-management-system-bms.html.

22MT919	INTRODUCTION TO MACHINE LEARNING	3/0/0/3

Nature of Course : Theory

Pre Requisites : Nil

Course Objectives:

1	To understand the basic concepts and techniques of machine learning.
2	To become acquainted with supervised and unsupervised learning methods in Machine Learning
3	To understand the underlying mathematical relationships of various algorithms

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

C919.1	Recall the basic concepts of various learning methods	[R]
C919.2	Understand the working of neural networks	[U]
C919.3	Analyze the working of various algorithms used for supervised learning	[A]
C919.4	Illustrate the different algorithms used for unsupervised learning	[AP]
C919.5	Apply reinforcement learning for robotic applications	[AP]

Course Contents:

MACHINE LEARNING MODELS AND NEURAL NETWORKS

Machine Learning: Introduction, Types, Applications, Tools and Issues – Preparing to Model – Modelling and Evaluation – Basics of Feature Engineering – Basics of Neural Networks – Backpropagation - Minimization of cost function and Gradient Descent - Application of Neural Networks in manufacturing and process control applications. **(15 Hours)**

SUPERVISED LEARNING

Supervised Learning: Regression: Linear regression - Logistic regression – Discriminant Analysis - Bias-Variance tradeoff - Cross-validation- Decision Tree – Support Vector Machines – Bayesian Classification - Hidden Markov Model – Obstacle avoidance, Navigation and path planning of a mobile robot **(15 Hours)**

UNSUPERVISED LEARNING

Unsupervised Learning: K-Means clustering, Hierarchical clustering – Expectation Maximization Algorithm - Dimensionality Reduction - Principal Component Analysis - Restricted Boltzmann Machine - Sparse Representation – Reinforcement Learning: Markov Decision Process - Temporal Difference Learning - Function Approximation - Introduction to Convolutional Networks and Deep Learning. **(15 Hours)**

Total hours: 45

Text Books:

1	Kevin P. Murphy, "Machine Learning – A Probabilistic Perspective", The MIT Press, 2020.
2	Ethem Alpaydin , "Introduction to Machine Learning", The MIT Press, 2004.

Reference Books:

1	Tom M Mitchell , "Machine Learning", Mc Graw Hill, 2017.
2	Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2012.

Web References:

1	onlinecourses.nptel.ac.in/noc21_cs24/preview
2	https://www.coursera.org/learn/machine-learning
3	https://www.datacamp.com/tracks/machine-learning-with-python
4	http://scikit-learn.org/stable/tutorial/basic/tutorial.html

22MT920	AI FOR PERCEPTION PLANNING AND CONTROL	3/0/0/3

Nature of Course: Theory

Pre requisites : Nil

Course Objectives:

1. To explore the fundamentals of intelligent agents and apply various search strategies.
2. To realize perception and automated planning in AI agents
3. To implement reinforcement learning based planning and control in robotic applications

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

C920.1	Outline foundational concepts of AI and their evolution	[U]
C920.2	Implement search algorithms for intelligent agents	[AP]
C920.3	Model perception and planning in AI agents	[U]
C920.4	Illustrate perception, planning, and control in robotics	[U]
C920.5	Describe the applications of reinforcement learning for planning and control tasks	[AP]

Course Contents:

INTELLIGENT AGENTS

Foundations and History of AI – Risks and benefits of AI – Intelligent Agents: Agents and Environments – Nature of Environments – Structure of Agents – Search Algorithms: Uninformed search strategies: Breadth-First Search, Depth-First Search, Uniform-Cost Search – Informed search strategies: Best First Algorithm, A* Algorithm

(15 Hours)

PERCEPTION AND AUTOMATED PLANNING

Perception in AI Agents – Types of perception – Role of perceptions – Types of Planning in AI - Classical Planning: Definition – Algorithms – Heuristics – Hierarchical Planning – Planning and Acting in Nondeterministic domains – Time, Schedules and Resources

(15 Hours)

ROBOTIC PERCEPTION, PLANNING AND CONTROL

Robotic perception – Planning and Control – Planning uncertain movements – Reinforcement learning in Robotics – Alternative Robotic Frameworks – Application domains - Deep reinforcement learning in planning and control of autonomous ground robots and aerial robots

(15 Hours)

Total hours:	**45**

Text Books:

1.	Stuart Russel and Peter Norvig, 'Artificial Intelligence: A Modern Approach', Fourth Edition, Pearson Education Limited, UK, 2022
2.	Murphy RR, 'Introduction to AI Robotics', Second Edition, MIT Press, Cambridge, London, 2019.

Reference Books:

1.	K M Lynch, F C Park, "Modern Robotics: Mechanics, Planning and Control", Cambridge University Press, 2017
2.	R S Sutton, A G Barton, "Reinforcement Learning: An Introduction", Second Edition, The MIT Press, 2018

Web Resources:

1	https://www.coursera.org/learn/introduction-to-ai
2.	https://arxiv.org/pdf/2209.07042
3.	https://errin.eu/calls/ai-advanced-and-collective-perception-and-decision-making-ccam-applications-ccam-partnership

2MT921	CONDITION MONITORING AND FAULT DIAGNOSTICS	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1.	To acquire the basics of various condition monitoring methods.
2.	To Identify the selection of condition monitoring sensors for various applications.
3.	To study various sensors for fault diagnostics monitoring applications.

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

C921.1	Understand the basics of various condition monitoring methods.	[U]
C921.2	Infer suitable condition monitoring sensors for various applications.	[R]
C921.3	Interpret various sensors for fault diagnostics monitoring applications.	[AP]
C921.4	Illustrate about various failure analysis, maintenance and machine learning.	[U]
C921.5	Apply different fault diagnosis methods for various applications.	[AP]

Course Contents:

CONDITION MONITORING TECHNIQUES

Condition Monitoring in manufacturing industries; Noise monitoring, Wear and debris Analysis, Thermography, Cracks monitoring, Ultrasonic techniques - Case studies. Vibration, Acoustic emission and vibro-acoustics signal analysis; intelligent fault detection system **(15 Hours)**

SENSORS FOR FAULT DIAGNOSTICS

Introduction - Contaminant monitoring sensors- Corrosion monitoring sensors - Force monitoring sensors - Gas leakage monitoring sensors- Air pollution monitoring sensors - Liquid contamination monitoring sensors - Non-destructive testing techniques - Optical examination - Temperature sensing. **(15 Hours**)

FAILURE ANALYSIS AND MAINTENANCE

Maintenance Principles, Failure mode analysis - Equipment downtime analysis – Breakdown analysis - condition based maintenance, Vibration, Acoustic emission and vibrio-acoustics signal analysis; intelligent fault detection system. Case studies**:** Condition Monitoring, fault diagnostics and troubleshooting of CNC machines. **(15 Hours)**

Total hours: 45

Text Books:

1	W.H. Tang, Q.H. Wu ,"Condition Monitoring and Assessment of Power Transformers Using Computational Intelligence", Springer, 2011.
2	Muhammad Irfan, "Advanced Condition Monitoring and Fault Diagnosis of Electric Machines" IGI Global Scientific Publishers, New York, 2019

Reference Books:

1	R. A. Collacott, "Mechanical Fault Diagnosis and condition monitoring", Springer, 2011. Chapman and Hall London A Halstead Press Book John Wiley & Sons, New York

Web Resources:

1	https://onlinecourses.nptel.ac.in/noc22_me60/preview
2	https://onlinecourses.swayam2.ac.in/nou21_me10/preview

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	Recall the concepts of neural networks and fuzzy logic.	[R]
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	Describe the basic concepts of Genetic Alogrithm	[R]
C922.5	Illustrate the applications of Genetic Alogrithm	[AP]

Course Contents:

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 Algorithm. 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

22MT923	HAPTICS	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1.	To identify the terminologies of haptic devices.
2.	To understand the structure of haptic system and to aware of the teleoperation for various applications.
3.	To acquire knowledge on modeling for haptic system development relevant to human haptics.

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

C923.1	Examine the haptic technology and its concepts in various haptic systems	[R]
C923.2	Classify the elements of haptic system and teleoperation in detail.	[U]
C923.3	Illustrate various rendering and stability analyses of kinesthetic haptic devices in real-time.	[AP]
C923.4	Articulate the various sensors and control elements for haptics devices.	[AP]
C923.5	Infer the design and use the devices in human haptic applications.	[U]

Course Contents:

INTRODUCTION TO HAPTICS

Definition - Importance of Touch - Tactile Proprioception - Tactual Stereo Genesis - Kinesthetic Interfaces - Tactile Interfaces - Human Haptics - overview of existing applications - Basics of Force Feedback Devices - Kinesthetic Vs. Tactile Haptic Devices - Configurations of Kinesthetic Devices -Types of Kinesthetic Devices. **(15 Hours)**

KINESTHETIC HAPTIC DEVICES AND TELEOPERATION

Mechatronics in Haptics System - Haptic Kinematics - Haptic Dynamics - Existing Kinesthetic Devices - Haptic Device Static Rendering - Haptic Device Dynamic Rendering - Control of Haptic Devices - Stability Analysis of Haptic Devices - Stability Analysis of the Rendered Model - Passivity of the Rendered Model. Types of Sensors - Measurement of Haptic Parameters - Types of Actuators - Types of Transmission - Admittance Type Kinesthetic Device - Admittance Control - Comparison of Impedance and Admittance Type Devices - Genesis of Tele-Operation - Tele-Operation Controllers -Tele-Operator Transparency - Stability Analysis of Tele-operator - Tracking and Transparency - Surface Haptic - Exogenous Force Inputs. **(15 Hours)**

HUMAN HAPTICS AND ITS PLATFORM

Introduction - Types of Haptic Sensing - Active vs. Passive Touch – Mechanoreception- Mechanoreceptive Afferents - Kinesthetic Sensing - Force Sensing and Proprioception Introduction to Psychophysics - Measurement Thresholds - Laws of Psychophysics - Weber's Law - Fechner's Law - Fitt's Law - Psychophysical Methods of Limit, Constant Stimuli and Adjustment - Introduction to Virtual Reality Modelling Language (VRML) – Open Haptic Platform - OpenGL- Virtual Environment Manager - Modelling of Simple Haptic System.

(15 Hours)

Total Hours	**45**

Text Books:

1	Hannaford B and Okamura A. M “Haptics: Handbook of Robotics”, Springer, pp. 718735, 2008.
2	Eckehard Steinbach et al, “Haptic Communications”, Vol. 100, 4:937-956, 2012

Reference Books:

1	Kenneth Salisbury, Francois Conti and Federico Barbagli, “Haptic Rendering: IEEE Computer Graphics and Applications, v24 n2 (200403): 24-32, 2004.

2	MacLean K. E, “Haptic Interaction Design for Everyday Interfaces: Reviews of Human Factors and Ergonomics”, 4:149194, 2008

Web Resources:	
1	http://nptel.ac.in/courses/108105053/
2	https://nptel.ac.in/courses/121106013
3	https://online.stanford.edu/courses/soe-yhapatics-introduction-haptics
4	https://www.sciencedirect.com/science/article/abs/pii/S2214785317303188

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 system.
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	Employ embedded system in various applications	[AP]

Course Contents:

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	Examine RPA, its applications and implementations	[R]
C926.2	Describe the different types of variables, Control Flow and data manipulation techniques	[U]
C926.3	Identify and understand Image, Text and Data Tables Automation	[U]
C926.4	Develop concepts to handle the User Events and various types of Exceptions and strategies	[AP]
C926.5	Interpret for the Deployment of the Robot and to maintain the connection	[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 packages. **(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-ll”, Taylor and

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.	www.nptel.ac.in/syllabus/112106152

22MT929	DIGITAL TWIN AND INDUSTRY 5.0	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1.	To understand the basics concepts in digital twin
2.	To Introduce the concepts in digital twin in a discrete and Process Industry
3.	To obtain the knowledge in industry 5.0

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

C929.1	Relate the basics concepts in digital twin	[R]
C929.2	Understand the concepts in digital twin in a discrete Industry	[U]
C929.3	Illustrate the concepts in digital twin in a process Industry	[U]
C929.4	Relate the knowledge in industry 5.0 with various applications	[R]
C929.5	Apply the advantages in industry 5.0 with various applications	[AP]

Course Contents:

INTRODUCTION

Digital twin – Definition, types of Industry and its key requirements, Importance, Application of Digital Twin in process, product, service industries, History of Digital Twin, DTT role in industry innovation, Technologies/tools enabling Digital Twin – Virtual CAD Models – control Parameters- Real time systems – control Parameters – Handshaking Through Internet – cyber physical systems – Advantages of Digital Twin. **(15 Hours)**

DIGITAL TWIN IN DISCRETE AND PROCESS INDUSTRY

Discrete Industry: Basics, Trends, Control system requirements - Digital Twin of a Product - Digital Thread - Data collection & analysis for product & production improvements- Automation simulation, Digital Enterprise.

Process Industry: Basics, Trends, Control system requirements – Digital Twin of a plant - Digital Thread- Data collection and analysis for process improvements, process safety, Automation simulation, Digital Enterprise. **(15 Hours**)

INDUSTRY 5.0

Industrial Revolutions, Industry 5.0 – Definition, principles, Application of Industry 5.0 in process & discrete industries, Benefits of Industry 5.0, challenges in Industry 5.0, Smart manufacturing, Internet of Things 5.0, Industrial Gateways, Basics of Communication requirements – cognitive systems 5.0 **(15 Hours)**

Total hours: 45

Text Books:

1	Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2018.
2	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019.
3	Ulrich Sendler, “The Internet of Things, Industries 4.0 Unleashed”, Springer., Germany, 2018

Reference Books:

1	Uthayan Elangovan, Industry 5.0: The Future of the Industrial Economy, CRC Press, 2022.
2	Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, Apress., United States, 2015

3.	Christoph Jan Bartodziej, "The Concept Industry 4.0 an Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gambler., Germany, 2017
4.	Ibrahim Garbie, "Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0", Springer., Switzerland, 2016.
Web Resources:	
1	https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/industry-50_en
2	https://www.sap.com/india/insights/industry-5-0.html
3	https://journalofcloudcomputing.springeropen.com/articles/10.1186/s13677-022-00314- 5

22MT930	INTERNET OF THINGS FOR MECHATRONICS	3/0/0/3

Nature of Course : Theory

Pre requisites : Nil

1. To understand the basics of Internet of Things (IoT)
2. To study about IoT Protocols.
3. To know about different applications of IoT.

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

C930.1	Recall the basic architecture and design methodology of Internet of Things (IoT).	[R]
C930.2	Examine and organize the data for IoT applications.	[AP]
C930.3	Illustrate various Protocols for IoT applications.	[U]
C930.4	Infer the privacy and security issues in IoT.	[U]
C930.5	Articulate the various IoT applications in real-world scenario.	[AP]

Course Contents:

IOT PROTOCOLS

Overview of Internet of Things (IoT), Design principles for connected devices, IoT levels, Web Connectivity, Data acquiring, Organizing, Processing and analytics, Data Collection, storage and computing using a cloud platform -Introduction to cloud computing **(15 Hours)**

PRINCIPLES FOR CONNECTED DEVICES

Sensors, Participatory Sensing, RFID and Wireless Sensor Networks**.** 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. **(15 Hours**)

DEVELOPMENT STRATEGIES

Prototyping and designing the software for IoT Application: Devices, Gateways, Internet, IoT Privacy, Security and Vulnerabilities Solutions, Introduction to Internet of Medical Things (IoMT), Internet of Robotics Things (IoRT), Internet of Vehicles (IoV) and Industrial Internet of Things (IIoT). Case study: Internet of Things in Hospitals. **(15 Hours)**

Total hours: 45

Text Books:

1	Raj Kamal, “Internet of Things” McGraw Hill, 2017.
2	Arshadeep Bahga, Vijay Madisetti, “Internet of Things: A Hands-On Approach”, Published by Arshdeep Bahga& Vijay Madisetti, 2016.

Reference Books:

1	Samuel Greengard, “The Internet of Things”, Second Edition, MIT Press, 2021.
2	Michael Miller, “The Internet of Things”, Pearson Education, 2017.
3	Reis, Catarina I., and Marisa da Silva Maximiano, eds. Internet of Things and advanced application in healthcare, 1st edition, IGI Global, 2016.

Web Resources:

1	https://www.biz4intellia.com/blog/iot-applications-in-automotive-industry/
2	https://nptel.ac.in/courses/108108098
3	https://www.i-scoop.eu/
4	https://www.frontiersin.org/articles/10.3389/frobt.2020.00104/full

22MT931	AVIONICS	3/0/0/3

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1.	To introduce the basic of avionics and its need for civil and military aircrafts
2.	To impart knowledge about the avionic architecture and various avionics data buses
3.	To gain more knowledge on various avionics subsystems
4.	To understand the concepts of navigation systems and auto pilot system

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

C931.1	Enumerate the basic concepts of Avionics Systems to the engineers	[R]
C931.2	Illustrate the working of avionics systems in an aircraft.	[U]
C931.3	Interpret the architecture of digital avionics and data buses	[U[
C931.4	Examine the cockpit control and display technologies	[A P]
C931.5	Explain the implementation of Navigation systems and Auto Pilot process.	[U]

Course Contents:

INTRODUCTION TO AVIONICS & AIR DATA

Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to digital computer and memories.Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Mach warning, Altitude warning

(15 Hours)

DIGITAL AVIONICS ARCHITECTURE AND CONTROL

Avionics system architecture – data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629. Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.

(15 Hours)

NAVIGATION SYSTEMS and AUTO PILOT

Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS. Auto pilot – Basic principles, Longitudinal and lateral auto pilot. **(15 Hours)**

Total hours: 45

Text Books:

1	Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., USA, 2022.
2	Collinson.R.P.G. "Introduction to Avionics", Chapman and Hall, 2020

Reference Books:

1	Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England,2019.
2	Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 2020

Web Resources:

1	https://www.researchgate.net/publication/283567145_Summary_of_Avionics_Technologies
2	https://www.aviationtoday.com/2024/10/02/the-nexus-of-avionics-artificial-intelligence-and-aircraft-values/
3	https://www.aviationtoday.com/2021/12/28/10-read-avionics-international-articles-2021/

22MT932	DRONE TECHNOLOGIES	3/0/0/3

Nature of Course : Theory

Pre requisites : **Nil**

Course Objectives:

1. To introduce the state-of-the art drone technologies and components.
2. To discuss the methodologies of design and control of drones
3. To enable the students to understand the applications of drones

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

C932.1	Observe the types of drones and its anatomy	[R]
C932.2	Illustrate the salient features and societal impact of drones	[U]
C932.3	Summarize the design objectives and control parameters of drones	[U]
C932.4	Discover the rules for drone usage and for securing the drones	[AP]
C932.5	Examine the various applications of drones	[AP]

Course Contents:

INTRODUCTION

History and Trends - Classification of Drones – Forces acting on a drone – Anatomy of a drone – Components of drone – Evolution of drones – Salient features and important codes with public awareness – Safety and precautionary points - Societal impact of commercial drones – Drone in Enterprises - Advantages and disadvantages of drones **(15 Hours)**

DESIGN AND CONTROL

Classification of various categories of air drones – Flight performance analysis – Dynamics and design objectives of drones – Design methods and challenges – Guidance, Navigation and control of drones – Categorization of UAVs – Specification of drones – Drone monitoring equipment – Collison avoidance and obstacle detection – Flight controllers – Gyroscope stabilization – Inertial Measurement Unit – Operating Systems in Drone – Intelligent flight system

(**15 Hours**)

GUIDELINES AND APPLICATIONS

India Policy Guideline for drones – Drone Rules – Securing drones: Machine learning for drone security -Applications: Military drones – Land mine detection and illegal migration surveillance - Drone technology in agriculture: Soil fertility management, Irrigation and water management, Crop disease identification, Pest control management - Drone-enabled smart healthcare system – IoT applications for smart cities - Drone delivery **(15 Hours)**

Total	**45**

Text Books:

1	SN Mohanty, JVR Ravindra, G Surya Narayana, CR Pattnaik, YM Sirajudeen, “Drone Technology: Future Trends and Practical Applications”, Scrivener Publishing, Wiley, USA, 2023.
2	Terry Kilby and Belinda Kilby, “Make: Getting Started with Drones “,Maker Media, Inc, 2016

Reference Books:

1	David McGriffy,’Make: Drones: Teach an Arduino to Fly’, 2016, Maker Media, United States of America.
2	Syed Omar Faruk Towaha,’Building Smart Drones with Esp8266 and Arduino’, 2018, Packt Publishing, UK.
3	Adam Juniper - The Complete Guide to Drones Extended 2nd Edition, 2018
4	Ruben Antuna Herrero,” Industrial Engineering Drone Design”, 2012

Web Resources:

1	https://dojofordrones.com/build-a-drone/
2	https://www.udemy.com/course/learn-how-to-build-a-drone-from-scratch/
3	https://egazette.gov.in/WriteReadData/2021/229221.pdf

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

22MT934	UNMANNED AERIAL VEHICLES	3/0/0/3

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	Recall 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.	[AP]
C934.5	Compute the different techniques used to achieve the control and stability of UAV systems.	[AP]

Course Contents:

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 Systems‖, 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 : -

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	**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 system with good surface finish.
4.	To select the appropriate element involved in the design and packages of 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 process in the production unit.	[R]
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]

Course Contents:

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)**

NANOFINISHING TECHNIQUES

Magnetic Abrasive Finishing (MAF), Magnetorheological Finishing (MRF), Elastic Emission Machining (EEM) - Chemical Mechanical Polishing (CMP). Production of carbon nano tubes: 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/

22MT941	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	Identify the importance of measurements in engineering and the factors affecting measurements.	[R]
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	[AP]
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, Geometric Dimensioning and Tolerances - Calibration - Limits, fits and gauges - Linear and Angular measuring instruments - 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

Vision measurement system - Introduction to Coordinating measuring machine: Non-contact Type. 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/

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

22MT951	AUTOMATION IN PRODUCTION SYSTEMS AND MANAGEMENT	3/0/0/3

Nature of Course : Theory

Pre requisites :

Course Objectives:

1.	To provide a comprehensive understanding of automation and its role in production systems.
2.	To provide a comprehensive understanding of automation and its role in production systems.
3.	To explore strategies for managing automation implementation projects.

Course Outcomes:

Upon completion of the course, students shall have ability to

C951.1	Explain the core principles and levels of industrial automation.	[U]
C951.2	Identify and describe the components of an automated production system.	[U]
C951.3	Evaluate automation solutions in terms of efficiency, cost, and scalability	[AP]
C951.4	Develop automation implementation plans including technical and management considerations.	[U]
C951.5	Interpret industrial case studies and apply automation strategies in real-world scenarios.	[AP]

Course Contents:

Fundamentals of Automation

Definition, types, and scope of automation - Advantages and limitations of automation - Basic elements: sensors, actuators, controllers - Types of control systems: open loop and closed loop - Industrial safety and standards. **(15 Hours)**

Automation Technologies and Systems

Introduction to Programmable Logic Controllers (PLC) - SCADA and Distributed Control Systems (DCS) - Robotics in automation: types, configurations, programming - Automated Material Handling Systems (AMHS) - Flexible Manufacturing Systems (FMS) and their integration **(15 Hours**)

Production Management and Automation Strategy

Automation in production and operations management - Implementation strategy and project planning - Economic analysis of automation (ROI, payback, cost-benefit) - Human factors, ergonomics, and organizational changes - Case studies on successful industrial automation **(15 Hours)**

Total hours: 45

Text Books:

1	Mikell P. Groover “Automation, Production Systems, and Computer-Integrated Manufacturing”, Fourth edition, Pearson Education, 2016.
2	Frank Lamb “Industrial Automation: Hands On” McGraw-Hill Education, 2016.

Reference Books:

1	K.L.S. Sharma – Overview of Industrial Process Automation, Elsevier,2016.
2	Peter Harriott – Process Control, Tata McGraw-Hill,2017.

Web Resources:

1	https://onlinecourses.nptel.ac.in/noc21_mg92/preview
2	https://www.zebra.com/ap/en/industry.html
3	https://blog.anynines.com/posts/web-application-automation-management/
4	https://archive.nptel.ac.in/courses/110/105/110105155/

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

EMERGING ELECTIVES

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

22MT007	DESIGN THINKING AND ENTREPRENEUR DEVELOPMENT	3/0/0/3

Nature of Course: Theory

Pre requisites : Nil

Course Objectives:

1 To promote the fundamental concept of innovation and design thinking.
2 To explain the concept of design thinking for product and service development.
3 To discuss the various methods of new product development.

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

C007.1	Explain the design thinking process.	[U]
C007.2	Develop design ideas through different tools.	[AP]
C007.3	Infer the role of innovation in the digital era.	[U]
C007.4	Explain the basic concepts of entrepreneurship and skills needed for entrepreneurial management.	[U]
C007.5	Explain the types, characteristics of entrepreneurship and its role in economic development	[AP]

Course Contents:

ESSENTIALS OF DESIGN THINKING

Principles of Design and Design Thinking Process - Five stages: Empathize, defining, ideating, prototyping, and testing - Selection criteria of Immersion tools, Analysis and Synthesis tools, Ideation tools and Prototyping tool - Design thinking benefits and limitations - Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization, creative culture, strategy and organization - Design thinking for Startups.
- Case studies on FMCG. **(15 Hours)**

PRODUCT DEVELOPMENT

Innovation Management – Need in an organization -Types of innovation and Models of Innovation- Frugal Innovation - Innovation for growth - Data driven innovation - Integrating design and Technology - Collaborative ideation and innovation - Transforming business - Management of research and development – TRIZ methodology. **(15 Hours)**

ENTREPRENEURSHIP

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur - Entrepreneurial Process and Lifecycle - Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth - Global Entrepreneurship and International Expansion - Entrepreneurship Ecosystems. **(15 Hours)**

Total hours: 45

Text Books:

1	Pavan Soni,"Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving", Penguin Books India Private Limited, 1st edition, 2021.
2	Innovation Management & New Product Development by Paul Trott, Pearson Publishers, 6th edition, 2017.
3	Hisrich R D, Peters M P, Shepherd D A, Sinha S, "Entrepreneurship", 11th Edition, Tata McGraw-Hill, 2020

Reference Books:

1	Ulrich, Karl T., Eppinger, Steve D., and Yang, Maria C, "Product Design and Development" McGraw-Hill Education, 7th edition, 2016.
2	Idris Mootee, "Design Thinking for Strategic Innovation", Wiley Publishers,1st edition, 2014.

Web References:

1	https://nptel.ac.in/courses/110106124
2	https://www.mindtheproduct.com/understanding-design-thinking-lean-agile-work-together/
3	https://www.icmrindia.org/casestudies/catalogue/Operations/OPER076.htm

22MT008	BRAIN COMPUTER INTERFACE AND APPLICATIONS	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1. To understand the anatomy of brain and the basic concepts of brain computer interface (BCI)
2. To study the various types of BCI
3. To understand the applications and ethics of BCI

Course Outcomes:

Upon completion of the course, students shall have ability to

C008.1	Recall the basics of neuroscience and brain stimulation	[U]
C008.2	Build a brain computer interface	[U]
C008.3	Interpret the major types of BCI	[AP]
C008.4	Employ the various medical and nonmedical applications of BCI	[AP]
C008.5	Apply the ethics of BCI	[AP]

Course Contents:

RECORDING AND STIMULATING THE BRAIN

Basic Neuroscience: Neurons, Synapse , Spike Generation, Synaptic Plasticity, Brain organization, Anatomy and Function - Recording signals from the brain - Stimulating the Brain - Simultaneous recording and stimulation - Building a Brain Computer Interface (BCI) - Useful brain responses. **(15 Hours)**

MAJOR TYPES OF BCI

Invasive BCI: Two Major Paradigms in Invasive Brain-Computer Interfacing - Invasive BCIs in Humans, Semi-invasive BCI: ECoG BCIs in Humans- BCIs Based on Peripheral Nerve Signals; Non-Invasive BCI: Electroencephalographic (EEG) BCIs - BCIs that stimulate: Sensory Restoration, Motor Restoration, Sensory Augmentation - Bidirectional and Recurrent BCIs: Cursor Control with Direct Cortical Instruction via Stimulation, Bidirectional BCI Control of a Mini-Robot **(15 Hours)**

APPLICATIONS AND ETHICS

Medical Applications: Sensory, Motor and Cognitive Restoration, Rehabilitation, Restoring Communication with Menus, Cursors, and Spellers, Brain-Controlled Wheelchairs - Nonmedical Applications: Web Browsing and Navigating Virtual Worlds, Robotic Avatars, Lie Detection and Applications in Law, Applications in Space, Gaming and Entertainment, Brain-Controlled Art - Ethics of BCI. **(15 Hours)**

Total hours: 45

Text Books:

1. Rajesh P. N. Rao, "Brain-Computer Interfacing: An introduction",Cambridge University Press, 2019.
2. Vaibhav Gandhi, "Brain computer interfacing for Assistive Robots", Academic Press, Elsevier, 2015
3. Narayan Panigrahi, Saraju P. Mohanty, "Brain Computer Interface EEG Signal Processing", CRC Press, 2022.

Reference Books:

1. G Dornhege, JDR Millan, T Hinterberger et al. "Towards Brain Computer Interfacing", MIT Press, 2017
2. Aboul Ella Hassanien, Ahmad Taher Azar, "Brain- Computer Interfaces current trends and applications", Springer, 2016
3. Chang S. Nam, Anton Nijholt, Fabien Lotte, "Brain–Computer Interfaces Handbook Technological and Theoretical Advances", CRC Press, 2018

Web Resources:

1. https://www.researchgate.net/publication/343532808_A_Review_on_Brain-Computer_Interface_BCI_Spellers_P300_Speller

2	https://nptel.ac.in/courses/108108167
3	https://nexusacademicpublishers.com/uploads/portals/Brain-Computer_Interface.pdf
4	https://dl.acm.org/doi/pdf/10.1145/3594806.3594810

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 Roboticsǁ, Springer, 2015
2.	Aleksandar Lazinica, —Mobile Robots Towards New Applicationsǁ, Advanced Robotic Systems International, 2015
3.	Bruno Siciliano, Oussama Khatib, —Springer Handbook of Roboticsǁ, 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/

22MT010	COGNITIVE ROBOTICS	3/0/0/3

Nature of Course: Theory

Pre-Requisites : Nil

Course Objectives:

1. To provide brief introduction to about robot cognition and perception
2. To understand the concepts of path planning algorithms.
3. To understand robot programming packages used in localization and mapping.

Course Outcomes:

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

C010.1	Define the basics of robot cognition and perception.	[R]
C010.2	Describe the different methods of map building program.	[R]
C010.3	Explain the operation of Autonomous Navigation Imaging system.	[AP]
C010.4	Discuss the various robot programming packages for display applications.	[U]
C010.5	Explain the aspects of Imaging Techniques used in Robotic Applications.	[AP]

Course Contents:

CYBERNETIC VIEW OF ROBOT COGNITION AND PERCEPTION

Introduction to the Model of Cognition – Visual Perception - Visual Recognition - Machine Learning - Soft Computing Tools and Robot Cognition. Map building: Introduction - Constructing a 2D World Map- Execution of the Map Building Program. (**15 hours)**

PATH PLANNING AND NAVIGATION

Path Planning, and Navigation using a Genetic Algorithm Roadmaps: Visibility maps – Deformation Retracts - Retract like structure –simultaneous localization and mapping (SLAM):
- Particle Methods - three types of robot intelligence paradigms - Relation of Paradigms-A Complete Program for Autonomous Navigation system- Introduction to human - Robot interaction (**15 hours)**

ROBOT PROGRAMMING

Robot programming packages: Robot Parameter Display - Program for Bot Speak - Program for Sonar Reading Display - Program for Wandering within the Workspace - Program for Tele- operation - Imaging Geometry: Introduction – necessity for 3D Reconstruction – Building Perception –Image capture Program, building 3D perception using a Kalman Filter- Kuramoto model. Case study: cognitive robotic system of Humanoid robots. **(15 hours)**

Total Hours | **45**

Text Books:

1	Patnaik S “Robot Cognition and Navigation: an experiment with mobile robots”, Springer Science & Business Media,2010.
2	Choset, H., Lynch, K. M., Hutchinson, S., Kantor, G. A., & Burgard, W “Principles of robot motion: theory, algorithms, and implementations”. MIT press.2016

Reference Books:

1	Jefferies, M. E., & Yeap, W. K. “Robot and cognitive approaches to spatial mapping. In Robotics and Cognitive Approaches to Spatial Mapping”, Springer, Berlin, Heidelberg,2009
2	Laxmidhar, B., & Indrani, K., “Intelligent Systems and Control Principals andApplications”, Oxford University Press,2010.
3	Hooman Samani , "Cognitive Robotics", 1st Edition, CRC Press, 2020.

Web References:

1	https://ocw.mit.edu/courses/16-412j-cognitive-robotics-spring-2016/
2	https://www.cs.cmu.edu/afs/cs/academic/class/15494-s12/Lectures.html
3	https://www.youtube.com/watch?v=8orItG9eYiY&list=PLFW6lRTa1g80VlXbS8XfvhzW992uc34kK&ab_channel=IITKanpurJuly2018
4	https://freevideolectures.com/course/3762/cognitive-robotics-mit16412j

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-HLl7iXCQToXuvFz70wVWzrWUAmIPhxS6eNn06ETsB1aQ
4. https://www.tm-robot.com/en/robot-vision-system/

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	Recall the basic concepts of Robotics and Robot components.	[R]
C001.2	Explain the concept of sensors used in robotics applications.	[U]
C001.3	Employ the concept of end effectors.	[U]
C001.4	Apply the concept of image processing & its real time application in robotics.	[AP]
C001.5	Illustrate basic robot programming techniques.	[U]

Course Contents:

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/

22MT002	BASICS OF AUTOMATION SYSTEMS	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

Course Objectives:

1. To impart knowledge about automation and its concepts.
2. To learn about mechatronics engineering applications in automation fields
3. To understand and illustrate mechatronics application techniques over conventional and unconventional techniques.

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

C002.1	Infer the role of sensors and actuators in various mechatronics applications	[R]
C002.2	Define the role of automation in various fields using PLC	[U]
C002.3	Apply various mechatronics concepts in engineering fields	[AP]
C002.4	Describe the advanced applications of mechatronics	[U]
C002.5	Explain the concepts of Autotronics in vehicles.	[AP]

Course Contents:

AUTOMATION

Automation – Industrial automation – requirements – types and components- Sensors and Transducers: Introduction-Generalized Measurement System-Elements-Active and Passive Sensors PLC: Introduction-Architecture-Inputs and Outputs-Programming Methods-Types of PLC-Applications in manufacturing industries: car assembly. **(15 Hours)**

MOTION CONTROL DEVICES

Hydraulic and pneumatic actuators-Electrical actuators- Micro actuators -Drives: Types, Selection factors and Applications. Mechatronic Design process - Robots: Pick and Place Robot- Sophia Robot. **(15 Hours**)

INTEGRATED SYSTEMS

Home automation using Industry 4.0. Autotronics: Adaptive cruise control -Bosch Motronic Engine Management System - windscreen wiper mechanism-Digital Speedometer-Automatic Dim and Bright Control-Air Bag deployment control. Electrocardiograph (ECG) function and CT scanner. **(15 Hours)**

Total hours: 45

Text Books:

1	Jon Stenerson, “Industrial Automation and Process Control”, 4th edition, Prentice Hall, 2018.
2	Appukuttan.K.K, “Introduction to Mechatronics”, 5th Edition, Oxford University Press, New Delhi, 2013

Reference Books:

1	Dobrivoje Popovic and Vijay Bhatkar, “Distributed control for Industrial Automation”, Marcel Dekker Inc, 5th edition, 2017.
2	Devdas Shetty, Richard.A.Folk “Mechatronics System Design”, 2nd Edition, Cengage Learning, USA, 2012

Web Resources:

1	https://elearn.nptel.ac.in/shop/nptel/mechatronics/
2	https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_expert_systems.htm
3	https://www.bosch.com/stories/history-of-artificial-intelligence/
4	https://www.simform.com/home-automation-using-internet-of-things/

22MT003	SMART SENSORS FOR IoT	3/0/0/3

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1. To learn the measurement techniques and various types of sensors.
2. To acquire the basic knowledge on applications of smart and advanced sensors.
3. To impart knowledge on IoT, Cloud computing & its applications.

Course Outcomes:

Upon completion of the course, students shall have ability to

C003.1	Infer the basics of sensors technology with its characteristics.	[U]
C003.2	Describe the various transducers used to measure various physical parameters.	[R]
C003.3	Employ the sensors in smart systems.	[AP]
C003.4	Recognize the basic concepts of IoT & Cloud computing	[R]
C003.5	Illustrate the core technologies behind IoT & Cloud computing applications.	[AP]

Course Contents:

MEASUREMENT

Basics of Measurement - Main technical requirement and trends - Units and standards - Performance Measures of Sensors - Classification of Sensors - Static and Dynamic Characteristics of Transducers – Sensor Calibration Techniques - Errors & its Classification - Sensor Output Signal Types. **(15 Hours)**

SENSORS

Motion sensors – Potentiometers, Resolver, Encoders - Semiconductor sensor - Acoustic sensors - Film sensor, MEMS & Nano sensors, LASER sensors - Humidity Sensor: Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor - GPS, Bluetooth - Laser Range Sensor (LIDAR). **(15 Hours**)

IoT AND CLOUD

Internet of things (IoT): Hardware and software requirements, Characteristics, architecture - Domain Specific IoTs Applications: Smart Home Automation, Smart Sustainable Cities and Smart Buildings, Smart Energy Management system, Environment, Agriculture, IoT for Defense. Cloud Computing: Introduction - Characteristics, Models – Cloud based services & Applications for Energy systems, Transportation systems, Education & Mobile communication. **(15 Hours)**

Total	**45**

Text Books:

1	Jacob Fraden, “Hand Book of Modern Sensors: Physics, Designs and Application” Fourth edition, Springer, 2010.
2	Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014

Reference Books:

1	IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017
2	Arshdeep Bahga, Vijay Madisetti, “Cloud Computing: A Hands-On Approach”, Universities Press, 2014

Web Resources:

1	https://archive.nptel.ac.in/courses/108/108/108108147/
2	https://archive.nptel.ac.in/courses/106/105/106105166/

22MT004	BASICS OF UNMANNED AERIAL VEHICLES	3/0/0/3

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1. To introduce the various types of frame design used for the drones.
2. To understand the basic working principle behind the electronic components.
3. To identify various functional modules of the controllers.

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

C004.1	Explain the types and characteristics of drones and their applications	[U]
C004.2	Illustrate the concepts of aerodynamics of flight vehicle.	[U]
C004.3	Identify and understand various components, sensors and payload of drone	[R]
C004.4	Interpret the rules and regulations of drones	[AP]
C004.5	Observe the different types of certifications in drone	[U]

Course Contents:

DRONES

History of Drones - DIY drones - Commercial drone and kits - Basic Components and Categories – Principles of Flight – Flight Maneuvers, Choosing an Airframe, Assembling Drone, frame, Motors and Props, Quadcopter Propulsors - Case study: Building a Follow Me Drone **(15 Hours)**

FLIGHT DYNAMICS:

Flight dynamics, Multirotor Aerodynamics, Inertial Measurement Unit (IMU)/ Atitude and Heading Reference System (AHRS) - Circuit Board and Motor Controller - Construction and Tuning - Power system - Brushless Motors and Electronics Seed controller, Flight Controller and Radios. Case study: Building a Mission Control Drone. (**15 Hours**)

DRONE CERTIFICATION:

GPS - Magnetometer – Accessories - Software, Comparison with other aerial vehicles, SONAR, and LIDAR - Failure Modes and Fault Tolerance - International Rules, Regulations, Standards & Practices, Type Certification of Drones, Registration, Remote Pilot Certificate, Drone Insurance. Case study: Building Prototype Drones – Racing Drones. **(15 Hours)**

Total hours:	**45**

Text Books:

1	John Baichtal, ‘Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs’, 2016, Que Publishing, United States of America.
2	David McGriffy,’Make: Drones: Teach an Arduino to Fly’, 2016, Maker Media, United States of America.

Reference Books:

1	Syed Omar Faruk Towaha, ‘Building Smart Drones with Esp8266 and Arduino’, 2018, Packt Publishing, UK.
2	Donald Norris, ‘Build Your Own Quadcopter: Power Up Your Designs with the Parallax Elev-8’, 2014, McGraw-Hill, new Delhi.

Web Resources:

1	https://dojofordrones.com/build-a-drone/
2	https://www.udemy.com/course/learn-how-to-build-a-drone-from-scratch/
3	https://www.civilaviation.gov.in/sites/default/files/Draft_Drones_Rules_14_Jul_2021.pdf

22MT005	FUNDAMENTALS OF ARDUINO AND RASPBERRY Pi	3/0/0/3

Nature of Course : Theory

Pre requisites :Nil

1. To educate the students on the fundamentals of Arduino & Raspberry pi boards
2. To make the students to understand the basic principles of interfacing I/O devices with controllers
3. To facilitate the students with the knowledge of readily available Arduino prototyping shields
4. To encourage the students in building real time embedded applications

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

C005.1	Understand the features, architecture and functionality of Arduino Uno & Raspberry pi.	[U]
C005.2	Identify the different supporting Arduino Shields and its applications	[AP]
C005.3	Analyse the interface of I/O devices with Arduino	[A]
C005.4	Illustrate the fundamentals of Raspberry pi and its usage in building real time Applications	[AP]
C005.5	Interface peripherals with Raspberry pi	[U]

Course Contents:

ARDUNIO

Introduction to Arduino – Arduino Uno- ATMEGA328 architecture, General Purpose and Status Register, Data Memory –. Arduino Programming Structure, Arithmetic and logical Instructions, Serial Interfaces – USART, SPI and TWI, Timer/Counter, Interrupts, Watchdog Timer. **(15 Hours)**

INTERFACING WITH ARDUNIO

Interfacing I/O Devices with Arduino: IDE programming - Light Emitting Diode, Push Button/Switch, Sensors - Fire, Passive Infrared, Ultrasonic, Temperature, Humidity sensors.
Actuators – Servo Motor, Stepper Motor. **(15 Hours)**

RASPBERRY PI

Introduction to Raspberry Pi- Architecture – Features-Operating systems- Interfacing Hardware-GPIO pin Connections- Sending and Receiving Signals Using GPIO Pins- Analog & Digital Outputs. Case studies – Autonomous Rover & Web-Controlled Rover. **(15 Hours)**

Total hours: 45

Text Books:

1	J. M. Hughes,"Arduino: A technical Reference – A Handbook for technicians, Engineers and Makers",O'Reilly Media.,2016.
2	Simon Monk, "Programming the Raspberry Pi, Getting started with python", Second Edition, McGraw-Hill Education, 2018.

Reference Books:

1	Michael Margolis and Nicholas Weldin, "Arduino Cookbook" First Edition, O Reily Media, 2016.
2	Rajesh Singh, Anita Gehlot, Bhupendra Singh and Sushabhan Choudhury, "Arduino – based Embedded Systems: Interfacing, Simulation and LabVIEW GUI", CRC Press, 2018
3.	Derek Molloy,"Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux, Wiley Publications; 1st edition (1 July 2016)

Web Resources:

1	https://archive.nptel.ac.in/courses/106/105/106105166/
2	https://www.coursera.org/specializations/iot
3	https://www.udemy.com/course/arduino-programming-and-interfacing/

MANDATORY COURSES

22MC101	INDUCTION PROGRAMME (FOR ALL BRANCHES OF B.E / B.TECH/ M.TECH PROGRAMMES)	1/0/0/0

Nature of Course	Induction Programme
Pre requisites	Nil

Course Objectives:

1.	To have broad understanding of society and relationships
2.	To nurture the character and fulfil one's responsibility as an engineer, a citizen and a human being
3.	To incorporate meta skills and values

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

C101.1	Explore academic interest and activities	[AP]
C101.2	Work for excellence	[AP]
C101.3	Promote bonding and give a broader view of life and character	[AP]

Course Contents:

PHYSICAL ACTIVITY: Research over the past years has shown Yoga to have stress-relieving powers on students, paving the way for improved academic performance with the practice of asanas, meditation and breathing exercises. To prove these words Yoga classes has been planned in this module.(CO mapping: C101.1, C101.2, C101.3)

CREATIVE ARTS (students can select any one of their choice): Cultural development supports students to understand, feel comfortable with, value and appreciate the potential enrichment of cultural diversity. They should challenge discrimination, whether based on cultural or racial difference. Students should experience cultural traditions embedded in arts, crafts, language, literature, theatre, song, music, dance, sport, Science, technology and travel. Students should develop an appreciation of beauty both in experiencing artistic expression and by exploring their own creative powers. To inculcate those skills they are given a chance to exhibit their talents through painting, sculpture, pottery, music, dance, craft making and so on. .(CO mapping: C101.1, C101.2, C101.3)

UNIVERSAL HUMAN VALUES: Moral development involves supporting students to make considered choices around their behaviour and the values that provide a framework for how they choose to live. Moral development is also learning about society's values, understanding the reasons for them, how they are derived and change; and how disagreements are resolved. Students must consider the consequences of personal and societal decisions on the wider community – local and global- and on the environment and future generations. To acquire this the students are exposed to training to enhance their soft skills. .(CO mapping: C101.1, C101.2, C101.3)

LITERARY AND PROFICIENCY MODULES: Social development helps students to work effectively together, developing the inter-personal skills required to relate positively with their peers and people of all ages. Students must also understand how to participate productively in a diverse and plural society and learn about, and how to effectively engage with societal

institutions and processes. They should understand that a person may have different roles and responsibilities within society. To reach this the following aspects are given in the form of Reading, writing, speaking – debate, role play etc. Communication and computer skills. (CO mapping: C101.1, C101.2, C101.3)

LECTURES BY EMINENT PEOPLE: Teaching with Lectures It is essential to see lectures as a means of helping students learn to think about the key concepts of a particular subject, rather than primarily as a means of transferring knowledge from instructor to student. During the induction period students will attend to Guest lectures by subject experts.(CO mapping: C101.1, C101.2, C101.3)

VISIT TO LOCAL AREAS: Traveling is in fact a way of learning to learn. You are out of your comfort zone and so you must learn to be able to adapt to a new learning environment in a very short time. It also helps in your overall learning as well. In the induction period students will be taken to different places near college to learn new things. Eg.Meditation centre/orphanage/Hospital.(CO mapping: C101.1, C101.2, C101.3)

FAMILIARIZATION TO DEPARTMENT/BRANCH INNOVATION: Hod's of different branches will present about their department followed by department visit to view various facilities available at their department, new innovations from students and faculties etc. .(CO mapping: C101.1, C101.2, C101.3)

22MC102	ENVIRONMENTAL SCIENCES	2 /0 /0 /0

Nature of Course	:C (Theory Concept)
Pre requisites	:Basics in Environmental Studies

Course Objectives:

1	To learn the integrated themes on various natural resources.
2	To gain knowledge on the type of pollution and its control methods.
3	To have an awareness about the current environmental issues and the social problems.

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

C102.1	Recall and play an important role in transferring a healthy environment for future generation.	[R]
C102.2	Illustrate the importance of natural resources and conservation of biodiversity.	[U]
C102.3	Interpret and analyze the impact of engineering solutions in a global and societal context.	[U]
C102.4	Apply the gained knowledge to overcome pollution problems.	[AP]
C102.5	Apply the gained knowledge in various environmental issues and sustainable development.	[AP]

Course Contents:

Natural Resources:
Introduction-Forest resources: Use and abuse, case study-Major activities in forest-Water resources-over utilization of water, dams-benefits and problems. Mineral resources-Use and exploitation, environmental effects of mining- case study–Food resources- World food problems, case study. Energy resources -Renewable and non-renewable energy sources Land resources-Soil erosion and desertification – Role of an individual in conservation of natural resources.

Environmental Pollutions:
Definition – causes, effects and control measures of: a. Air pollution - Acid rain - Greenhouse effect-Global warming- Ozone layer depletion – case study- Bhopal gas tragedy. Water pollution c. Soil pollution - Solid waste management-Recycling of plastics-Pyrolysis method- causes, effects and control measures of municipal solid wastes d. Noise pollution. e. Nuclear hazards-case study-Chernobyl nuclear disaster-Role of an individual in prevention of pollution.

Social issues and the Environment:
Sustainable development-water conservation, rain water harvesting, E-Waste Management – Environmental ethics: 12 Principles of green chemistry-Scheme of labelling of environmental friendly products (Eco mark) – Emission standards – ISO 14001 standard.

Total Hours:	**30**

Text Books:

1	AnubhaKaushik and C P Kaushik “Perspectives in Environmental Studies”4th Edition, Newage International (P) Limited, Publisher Reprint 2014. New Delhi
2	Rajagopalan, R, “Environmental Studies-From Crisis to Cure”, Oxford University Press 2015.

Reference Books:

1	Tyler Miller, Jr., “Environmental Science”, Brooks/Cole a part of Cengage Learning, 2014.
2	William Cunningham and Mary Cunningham, “Environmental Science”, 13th Edition, McGraw Hill,2015.

3	Gilbert M. Masters, “Introduction to Environmental Engineering and Science”, Third Edition, Pearson Education, 2014.
Web References:	
1	http://nptel.ac.in/courses/104103020/20
2	http://nptel.ac.in/courses/120108002
3	http://nptel.ac.in/courses/122106030
4	http://nptel.ac.in/courses/120108004/
5	http://nptel.ac.in/courses/122102006/20
Online Resources:	
1	https://www.edx.org/course/subject/environmental-studies
2	www.environmentalscience.org

22MC103	SOFT SKILLS	2/0/0/0

Nature of Course: Theory Concept

Pre Requisites : Technical Communication Skills

Course Objectives:

1	To develop the students competency level and their capabilities.
2	To teach the students to be effective in workplace and social environments.
3	To create self confidence among the students and to resolve stress and conflict within themselves.
4	To help the students to enhance their career skills by increasing their productivity and performances.
5	To concentrate more on conversation skills, presentation skills, verbal ability, critical and creative thinking.

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

C103.1	Remember the principles of soft skills required for their profession.	[R]
C103.2	Understand the importance of Interpersonal communication Skills among individuals, groups and cultures.	[U]
C103.3	Apply verbal and non-verbal communication skills in corporate environment.	[AP]
C103.4	Analyse and apply creativity skills, critical thinking skills and problem-solving skills.	[AN]
C103.5	Articulate oral and written messages in an appropriate and persuasive manner to suit specific purposes, audiences and contexts at work place.	[AP]
C103.6	Apply good teamwork skills and Leadership Skills	[AP]

Course Contents:

Module 1: Professional Communication Skills

Introduction to the Soft Skills, Performance Evaluation 1 – Significance of Soft Skills - Understanding the basic Communication Principles –Listening Skills- Listening Exercises Speaking Skills- How to start and Sustain a Conversation- Speaking in Groups- Understanding self and Personal Branding, attitude, types of attitudes, Positive Attitude, Self Confidence and Self-Motivation - Personal Application/Action Taken. Advanced Writing Skills-Principles of Business Writing- E mails- Writing Reports- Types of Reports- Strategies for Report Writing-Personal Application/Action Taken. Verbal Ability- Analogy- Classification- Odd One Out-Idioms and Phrases- Sentence Correction- Empathy and its importance in career -Personal Application/Action Taken.

(10 Hours)

Module 2: Interpersonal Communication

Nonverbal Communication- Individual, Groups and Cultures- Body Language- Attire and Etiquettes- Interpersonal Skills- dealing with diverse People- Networking- Emotional Intelligence and its importance. Personal Application/Action Taken. Developing Creativity-Critical Thinking and Problem-Solving Skills- Making the Right Choice- Never Give Up- Begin to Grow- Personal Application/Action Taken. Interviews- Facing Job Interviews - Planning and Preparing- Effective Resume along with Covering Letter- Planning and Preparing- Personal Application/Action Taken. Self-Discipline - Self Presentation - Personal Application/Action Taken.

(10 Hours)

Module 3: Teamwork and Leadership Skills

Industry Expectations- Universal Hiring Rule- Personal Application/Action Taken. Importance of Human Values-Importance of Team Work- Developing Key Traits in Motivation, Persuasion, Negotiation and Leadership Skills- Being an Effective Team Player- Personal Application/Action

Taken. Planning- Prioritization - Delegation- Conflict Management-Decision and its necessity in crucial situations- Group Discussion- Personal Application/Action Taken. Essential Skills in working Strategies- Presentation and Interaction Skills- What to Present and How- Being Assertive- Multimedia Presentation-Making Effective Presentations. Interview Skills- Do's and Don'ts - Body Language – Answering the Common Questions of Interview- Performance Evaluation 2- Mock Interview **(10 Hours)**	
Total Hours:	**30**
Text Books:	
1	Penrose, "Business Communication for managers: An advanced approach", Cengage learning.
2	H.E. Sales, "Professional Communication in Engineering", Palgrave Macmillan 2009.
3	W. P. Scott, Bertil Billing, "Communication for Professional Engineers", Thomas Telford, 1998.
Reference Books:	
1	Peter Davson-Galle, "Reason and Professional Ethics", Ashgate Publishing, Ltd., 2009.
2	William B. Gudykunst, "Cross Cultural and Inter Cultural Communication", Sage Publications India Pvt Ltd, New Delhi, 2003.
3	Joep Cornelissen, "Corporate Communications: Theory and Practice", Sage Publications India Pvt Ltd, New Delhi, 2004.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc16_hs15/preview
2	https://www.getinternship.switchidea.com/NTAT/syllabus/InterpersonalCommunication
3	https://smude.edu.in/smude/programs/bca/soft-skills.html
4	https://swayam.gov.in/course/4047-developing-soft-skills-and-personality
5	https://www.clearias.com/interpersonal-skills-including-communication-skills-for-csat/
6	https://www.bizlibrary.com/soft-skills-training/

22MC104	MANAGEMENT ORGANIZATIONAL BEHAVIOUR	2/0/0/0
Nature of Course	Theory Concept	
Pre requisites	Nil	
Course Objectives:		
1.	The objective of the course is to provide basic knowledge about management to familiarize the students with the management principles and organizational behavior.	
2.	The course is designed to enable the students to adapt & apply theoretical concepts in business	
3.	To know about the role of manager in the area of management.	
4.	To create and implement team building strategies for organization building.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C104.1	Identify and understand different management principles techniques in business environment.	[U]
C104.2	Apply management fundamentals and planning to solve organization problems and make effective decisions.	[AP]
C104.3	Understand and analyze the changes within an individual will change the group as well as the organization	[A]
C104.4	Understand and analyze the leadership style and organization theories to create a productive environment to workforce.	[A]
C104.5	Analyze the organizational climate and change management strategies and tactics	[A]
C104.6	Apply the empowerment strategy and tactics for productivity	[AP]

Course Contents:

Module 1: Fundamentals of Management, Planning and Decision Making (10 Hours)

Introduction to Management- Concept and functions- Thought Managerial roles and styles- Principles of Management - Levels of Management- Theories of Management - Classical, Scientific, Administrative, Behavioral, Management Sciences Theories. Organizational planning - Vision, Mission and goals, Types of plans, steps in planning process, Approaches to planning, Planning in Dynamic Environment. Decision making process, types of decisions, decision making styles, Behavioural influences on decision making - Group decision making - Vroom's Participative decision-making model.

Module 2: Individual, interpersonal and group behavior (10 Hours)

Definition, need and importance of Organizational behavior –Learning-Nature -Importance of Learning- Introduction and theories Motivation: Content and process theories-Leadership: Styles and Theories - Perception-Personality – Attitudes- Definition, need and importance -Nature and scope-Importance of Groups and Teams- Role relationships and conflict-Group dynamics- Work values. Organization Theories: Maslow's needs hierarchy theory, two factor theory of motivation, McGregor's theory, ERG theory, McClelland's needs theory, Valance Theory.

Module 3: Organizational Development (10 Hours)

Organizational culture: Elements - Organizational climate– Factors affecting organizational climate-Organizational Commitment, Organizational schange- Importance- Stability Vs Change-Proactive Vs Reaction change- Change process– Resistance to change- Managing changes-Managing International Workforce – Productivity- Alternative change management approaches and cultural contingencies - power to manage effectively; Empowerment and Participation

strategies and tactics.	
Total Hours:	**30 Hrs**
Text Books:	
1.	Nelson, Quick, Khandelwal, "Organizational Behavior", 2nd Edition, Cengage Learning, 2016.
2.	Williams, Tripathy, "Principles of Management", Cengage Learning, 2016.
3.	Aswathappa, K, "Organizational Behavior", 12th Edition, Himalaya Publication, 2016.
4.	Stephen Robbins, Timothy A. Judge, "Organizational Behavior", 16th Edition, Prentice Hall India Pvt. Ltd, 2014.
Reference Books:	
1.	Chandrani Singh, Aditi Khatri, "Principles and Practices of Management and Organizational Behavior", Sage Publications, 2016.
2.	Richard L. Daft, "Understanding the Theory and Design of Organizations", 11th Edition, Cengage Learning, 2013.
3.	John M Ivancevich and Robert Konopaske, "Organizational Behavior and Management", McGraw-Hill Education, 2013.
4.	UdaiPareek, Sushama Khanna, "Organization Behavior", 3rd Edition, Oxford Publishing, 2012.
Web References:	
1.	https://iedunote.com/fundamental-concepts-of-organizational-behavior
2.	https://nscpolteksby.ac.id/ebook/
3.	https://ebooks.lpude.in/management/mba/term_1/DMGT402_MANAGEMENT PRACTICES_AND_ORGANIZATIONAL_BEHAVIOUR.pdf
4.	https://www.studocu.com/in/document/vellore-institute-of-technology/organizational-behaviour/lecture-notes/ob-notes/3208134/view
Online Resources:	
1.	https://nptel.ac.in/syllabus/110105034/
2.	https://nptel.ac.in/courses/110/105/110105033/
3.	https://freevideolectures.com/course/3502/organizational-behaviour-i
4.	https://nptel.ac.in/courses/110/106/110106145/

22MC105	GENERAL APTITUDE	2/0/0/0

Nature of Course: Problem analytical

Pre Requisites : Basic Mathematical calculations

Course Objectives:

1	To ensure that students learn to think critically about mathematical models for relationships between different quantities and use those models effectively to solve problems and reach conclusions about them.
2	To impart skills that enable students to effectively use and interpret data, formulas, and graphs in the workplace.
3	To instills confidence in facing technical aptitude questions interviewed by recruiters

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

C105.1	To teach the basics of Quantitative Techniques in a graded manner.	[R]
C105.2	Understand the verbal and non-verbal nature of problems in reality and know the shortcut methods of solving it.	[U]
C105.3	Solve problems using their general mental ability.	[AP]
C105.4	To give intense focus on improving and increasing the ability of solving real problems.	[AP]
C105.5	Think critically about mathematical models for relating different quantities to reach conclusion.	[AP]
C105.6	Enable effective use of data interpretation, formulas, graphs and assumptions.	[AP]

Course Contents:

Module 1: Number Theory and Statistics

Number Systems– HCF and LCM of Numbers – Decimal Fractions – Simplification – Square Root and Cube Root of a number – Surds and Indices – Problems on numbers – Percentage – Ratio and Proportion – Divisibility – Mixtures – Averages- Polynomials – Solving Equations and Inequalities – Discard's rule of signs – Problems on ages – Chain rule – Time and Work – Time and Distance – Problems on Trains – Problems on Boats and Streams- Measures of central tendency – Mean, Median and Mode – Variance and Standard deviation Logarithms – Profit and Loss – Simple Interest – Compound Interest. **(14 Hours)**

Module 2: Logic and Decision Making

Analogy – Classification – Series completion – Coding and Decoding – Blood Relations – Puzzle Test – Direction Sense test – Logical Venn Diagrams - Number Ranking and Time Sequence Test – Decision Making – Assertion and Reason– Inserting the missing one – Logical Sequence of words – Syllogisms. **(8 Hours)**

Module 3: Reasoning

Logic – Statement and Arguments – Statements and Assumptions – Statements and Course of Action – Statements and Conclusions – Deriving conclusions from passages – Functions – Different kinds of functions – Miscellaneous sets- Series – Analogy – Classifications – Analytical Reasoning – Problems on Cubes and Dice – Mirror Images – Water Images – Rule Detection.

(8 Hours)

Total Hours: 30

Text Books:

1	Aggarwal R. S, "Quantitative Aptitude" Revised Edition, S. Chand Publication.

2	Abhijit Guha, “Quantitative Aptitude” 5th Edition, McGraw Hill Education.
Reference Books:	
1	Edgar Thorpe “Mental Ability & Quantitative Aptitude” 3rd Edition, McGraw Hill Education.
Web References:	
1	https://www.wiziq.com/tutorial/815468-quantitative-aptitude-reasoning-data-interpretation-video-lectures
2	https://learningpundits.com/contest?referrer=harsh.cse15@nituk.ac.in
3	https://nptel.ac.in/courses/114106041/8
4	https://nptel.ac.in/courses/111103020/2
5	http://aptitudetraining.in/home/index.php
6	https://www.udemy.com/vedicmaths/
7	https://www.youtube.com/channel/UCtmn-DsF4BhPug-ff9LiDAA?disable_polymer=true

22MC106	LIFE SKILLS AND ETHICS	2/0/0/0

Nature of Course: Theory Concept

Pre Requisites : Nil

Course Objectives:

1	To develop communication competence in prospective engineers.
2	To enable them to convey thoughts and ideas with clarity and focus.
3	To develop report writing skills.
4	To equip them to face interview & Group Discussion.
5	To inculcate critical thinking process.
6	To prepare them on problem solving skills.
7	To provide symbolic, verbal, and graphical interpretations of statements in a problem description.

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

C106.1	Define and Identify different life skills required in personal and professional life.	[U]
C106.2	Develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.	[AP]
C106.3	Explain the basic mechanics of effective communication and demonstrate these through presentations.	[A]
C106.4	Use appropriate thinking and problem solving techniques to solve new problems.	[AP]
C106.5	Understand the basics of teamwork and leadership	[U]

Course Contents:

Communication Skill:
Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Writing Skills, Technical Writing, Letter Writing, Job Application, Report Writing, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication. **(10 Hours)**

Critical Thinking & Problem Solving:
Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats Mind Mapping & Analytical Thinking. Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts. **(10 Hours)**

Ethics, Moral & Professional Values:
Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics, Global Issues, Code of Ethics like ASME, ASCE, IEEE. **Leadership Skills:** Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, DART Leadership, Leadership Grid & leadership Formulation **(10 Hours)**

Total Hours: 30

Text Books:

1	Barun K. Mitra, “Personality Development & Soft Skills”, First Edition, Oxford Publishers, 2011.
2	Kalyana, “Soft Skill for Managers”, 1st Edition, Wiley Publishing Ltd, 2015.
3	Larry James, “The First Book of Life Skills”, 1st Edition, Embassy Books, 2016

4	Shalini Verma, “Development of Life Skills and Professional Practice”, 1st Edition, Sultan Chand (G/L) & Company, 2014
5	John C. Maxwell, “The 5 Levels of Leadership”, Centre Street, A division of Hachette Book Group Inc, 2014.
Web References:	
1	https://www.coursera.org/courses?query=ethics

22MC107	STRESS MANAGEMENT	2/0/0/0

Nature of Course: Theory Concept

Pre Requisites : Nil

Course Objectives:

1	Understand the basic principles of stress management
2	Recognize your stress triggers and how to manage them
3	Develop proactive responses to stressful situations
4	Use coping tips for managing stress both on and off the job
5	Learn to manage stress through diet, sleep and other lifestyle factors
6	Develop a long term action plan to minimize and better manage stress
7	Understand the basic principles of stress management

Course Outcomes:

Upon completion of the course, students shall have ability to

C107.1	Understand the basic principles of stress management	[U]
C107.2	Apply the concept of recognizing your stress triggers and find was to manage them.	[AP]
C107.3	Develop proactive responses to stressful situations	[A]
C107.4	Develop a long term action plan to minimize and better manage stress	[AP]

Course Contents:

Scientific Foundations of Stress:

What is stress? – Sources of Stress – Types of Stress – Personality Factors and stress – Stress and the college student. Stress Psychophysiology: Stress and nervous system – Hypothalamic – Pituitary – Adrenal (HPA) Axis – Effect of Stress on Immune system – Health risk associated with chronic stress – Stress and Major Psychiatric disorders. **(10 Hours)**

Developing Resilience to Stress:

Understanding you stress level – Role of personality pattern, Self-esteem, Locus of control – Role of Thoughts Beliefs and Emotions – I & II – Life situation Intrapersonal: (Assertiveness, Time Management). **(10 Hours)**

Strategies for Relieving Stress:

Developing cognitive coping skills – Autogenic training, imagery and progressive relaxation – Other relaxation techniques – Exercise and Health – DIY strategies stress management.

(10 Hours)

Total Hours: 30

Reference Books:

1	Jonathan C. Smith, “Stress Management: A Comprehensive Handbook of Techniques and Strategies”, 1st Edition, Springer Publishing Company, 2011.
2	Bob Stahl, Elisha Goldstein, Jon Kabat-Zinn, “A Mindfulness–based Stress Reduction Workbook”, 2nd Edition, New Harbinger Publications, 2019.
3	Ryan M. Niemiec, “The Strengths-based Workbook for Stress Relief”, 1st Edition, New Harbinger Publications, 2019.

Web References:

1	https://thiswayup.org.au/courses/coping-with-stress-course/
2	https://www.classcentral.com/course/swayam-stress-management-14309

22MC108	CONSTITUTION OF INDIA	2/0/0/0

Nature of Course: Theory

Pre Requisites : Nil

Course Objectives:

1	To familiarize with basic information about Indian constitution
2	To understand the fundamental rights and duties as citizens of India

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

C108.1	Explain the objectives of the Constitution of India and its formation	[U]
C108.2	Recall state and central policies (Union and State Executive), fundamental Rights and their duties.	[R]
C108.3	Make use of legal directions in developing solutions to societal issues	[AP]
C108.4	Solve for competitive exams that requires knowledge of Indian Constitution	[AP]

Course Contents:

Module I
Historical perspective, The making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights, Directive Principles of State Policy, Fundamental Duties, Citizenship Article 5-11.

(10 Hours)

Module II
Federal structure, Powers of the Union and the states, Centre-State Relations, Union Executive – President, Prime Minister, Union Cabinet, Parliament, Supreme Court of India, State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Elections, Electoral Process, and Election Commission of India, Election Laws. Powers and Functions of Municipalities and Panchayat

(10 Hours)

Module II
Amendments - Methods, Emergency Provisions, National Emergency, President Rule, Financial Emergency, Provisions for SC & ST, OBC, women, children and backward classes, Right to Property, Freedom of Trade and Commerce. Agricultural Law

(10 Hours)

Total Hours: 30

Text Books:

1	D. D. Basu, “Introduction to the Constitution of India”, LexisNexis, New Delhi, 22nd edition, 2016.
2	“Bare act-constitution of India”, The universal Publications, LexisNexis 2020, New Delhi, India.

Reference Books:

1	Subhash. C. Kashyap, “Our Constitution: An Introduction to India’s Constitution and Constitutional Law”, National Book Trust, India, 5th edition, 2019.
2	M. Laxmikanth, “Constitution of India”, Cengage Learning India. 1st edition 2018.

Web References:

1	https://unacademy.com/course/the-indian-constitution/NSKQ8XXQ
2	https://unacademy.com/goal/upsc-civil-services-examination-ias-preparation/KSCGY

22MC109	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	2/0/0/0

Nature of Course: Theory

Pre Requisites : Nil

Course Objectives:

1	To make understand the contribution of Indian mind in various fields.
2	To cultivate critical appreciation of the thought content and provide insights relevant for promoting cognitive ability, health, good governance, aesthetic appreciation and right values.

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

C109.1	Relate classical Indian traditions with contemporary traditions and culture.	[U]
C109.2	Describe the thoughts of Indians in different disciplines.	[R]
C109.3	Apply the knowledge to the present context.	[AP]
C109.4	Discover a better appreciation and understanding of Indian traditions.	[AP]

Course Contents:

Indian Ethics: Individual and Social – Society state and Polity (Survey) - Education systems – Agriculture (Survey) – Early & Classical Architecture – Medieval & Colonial Architecture. **(10 hours)**

Astronomy in India – Martial Arts Traditions (Survey) - Indian Literatures - Indian Philosophical Systems - Indian Traditional Knowledge on Environmental Conservation - Ayurveda for Life, Health and Well-being. **(10 hours)**

The Historical Evolution of Medical Tradition in Ancient India - Music in India - Classical & Folk dance - Theatre and Drama in India. **(10 hours)**

Total Hours: 30

Text Books:

1	Kapil Kapoor and Michel Danino, Textbook of “Knowledge Traditions and Practices of India”, Central Board of Secondary Education, 2017.
2	Yogesh Atal, “Indian Society: Continuity and Change”, Pearson Education India, 2016.

Reference Books:

1	Douglas Osto, “An Indian Tantric Tradition and Its Modern Global Revival”, Routledge publications, 2020.
2	Rao C.N. Shankar, “Sociology: Principles of Sociology with an Introduction to Social Thoughts”, S Chand Publisher, 2019.

Web References:

1	http://nopr.niscair.res.in/handle/123456789/43
2	https://nptel.ac.in/courses/109/104/109104102/

22MC110	BIOLOGY	2/0/0/0

Nature of Course : Theory

Pre requisites : Nil

Course Objectives:

1. To understand the basic biological concepts related to engineering systems.
2. To have adequate knowledge about the various human anatomy and physiological systems.
3. To impart the knowledge about biological systems in the environment.

Course Outcomes:

Upon completion of the course, students shall have ability to

C110.1	Relate the biological system with engineering concepts	[R]
C110.2	Understands the anatomy and physiology of human system.	[U]
C110.3	Understand the concept of plant, animal and microbial systems and growth in real life situations	[U]
C110.4	Apply the knowledge of applications of biological systems in relevant industries.	[AP]

Course Contents:

Introduction, Science and Engineering – Phylogeny, Motivation, Methods, Synthesis, Biological Classification, Biology as whole, Applications of Biology, Principles of biology – Genetic Basics, substance for life – Basic organic chemical structure, chemical bonding, acid, base reactions, physicochemical interactions. **(10 hours)**

Cell – prokaryotes and eukaryotes, biological membrane, membrane transport, eukaryotic cell structure and function. Plant – plant division, Animal – reproductive strategies, Human – Skin, skeletal system, muscular system, nervous system, cardiovascular system, respiratory system, digestion, nutrition, excretory system. **(10 hours)**

Industrial Microbiology and its Applications, Relationship between Engineering and Biology - Living things as solution, models, recipients, inadvertently affected. Biological solutions to Industrial Problems. Cell organization, signalling and deciphering human genetic variation **(10 hours)**

Total hours: 30

Text Books:

1.	A Text book of Biotechnology, R.C.Dubey, S. Chand Higher Academic Publications, 2015.
2.	ThyagaRajan.S., Selvamurugan. N., Rajesh.M.P., Nazeer.R.A., Richard W. Thilagaraj, Barathi.S., and Jaganthan.M.K., "Biology for Engineers", Tata McGraw-Hill, New Delhi, 2017.

Reference Books:

1.	Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2014.
2.	David A. Vaccari, Peter F. Strom, James E. Alleman," Environmental Biology for Engineers and Scientist", A John Willey Inc. publications, 2018.

Web References:

1.	https://www.cellsalive.com/
2.	https://www.visiblebody.com/teaching-anatomy/courseware

Online Resources:

1.	https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/17%3A_Industrial_Microbiology/17.1%3A_Industrial_Microbiology
2.	http://sites.khas.edu.tr/bioinformatics/whats/bioinformatics-genetics/

VALUE ADDED COURSES

22VA600	SOLIDWORKS	0/0/2/1
Nature of Course : Value Added		
Pre Requisites : Nil		
Course Objectives:		
To use the SOLIDWORKS mechanical design software to build parametric models of parts and assemblies, and how to make drawings of those parts and assemblies		
Course Outcomes: **Upon completion of the course, students shall have ability to**		
CV00.1	Examine the product design sketch, model and visualize.	[R]
CV00.2	Understand part and assembly drawing of all machine components using CAD software.	[U]
CV00.3	Apply 2D drafting and 3D modelling for industrial applications.	[AP]
CV00.4	Develop the simulation of four bar mechanism.	[AP]
List of Exercises: 1. Part and Assembly drawing of IC engine connecting rod. 2. Part and Assembly drawing of Lathe tailstock. 3. Name a component that can be used to lift heavy objects with minimum input. Draw the part and assembly of that component. 4. Develop sectional view of a Plummer block. 5. Bottom-Up assembly of a pulley system. 6. Simulation of four bar quick return mechanism.		
Total hours: 30		
Text Books:		
1.	Paul Tran, Textbook of "SOLIDWORKS 2021 Intermediate Skills: Expanding on Solids, Surfaces, Multibodies, Configurations, Drawings, Sheet Metal and Assemblies", SDC Publications; 1st edition, 2021.	
2.	Amit Bhatt, and Mark Wiley, "SolidWorks 2021 - Step-By-Step Guide: Part, Assembly, Drawings, Sheet Metal, & Surfacing", CAD Folks Publisher, 2020.	
Reference Books:		
1	James D. Bethune, "Engineering Design and Graphics with SolidWorks 2019", Peachpit Press; 1st edition, 2019.	
2	Matt Lombard, "Mastering SolidWorks", Wiley Publication, 2018.	
Web References:		
1	https://nptel.ac.in/courses/112105294	
2	https://my.solidworks.com/training/path/106/getting-started-with-solidworks-cad	

22VA601	MATLAB PROGRAMMING	0/0/2/1
Nature of Course : Value Added		
Pre Requisites : Nil		
Course Objectives:		
1.	To learn the features of MATLAB as a programming tool for basic problem-solving for various applications	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
CV01.1	Relate the features of MATLAB as a programming tool	[AP]
CV01.2	Develop programming skills and technique to solve mathematical problems	[AP]
CV01.3	Visualize MATLAB graphic features and its applications	[U]
CV01.4	Employ MATLAB as a simulation tool for various engineering problems	[AP]
List of Exercises: 1. Basic arithmetic operations, Data import/export and plotting using MATLAB. 2. Loading And Writing Results To External Files: Load & Save Commands, Variable Editor. 3. Writing Scripts & Functions. 4. Animation methods 5. Simulation with Control system toolbox and Robotics system tool box 6. Modelling and simulation using simscape fluid		
	Total hours:	**30**
Text Books:		
1.	Dr. Brijesh Parmar Bakariya, Dr. Kulwinder Singh, “Fundamental Concepts of MATLAB Programming. India: BPB Publications”,2020.	
2.	Eshkabilov, S. “Beginning MATLAB and Simulink: From Novice to Professional”, Apress, 2019.	
Reference Books:		
1	Weeks, M. “Programming Fundamentals Using MATLAB”, Mercury Learning & Information, 2020.	
2	Mohindru, P., Mohindru, P. “MATLAB and SIMULINK (A Basic Understanding for Engineers)”,Cambridge Scholars Publishing, 2020.	
Web References:		
1	https://www.mathworks.com/help/index.html	
2	http://www.mathworks.com/academia/student_center/tutorials/launchpad.html	
3	https://www.mathworks.com/academia/student_center/tutorials/sltutorial_launchpad.html	
4	http://www.mathworks.com/videos/	

22VA602	ANDRIOD STUDIO	0/0/2/1
Nature of Course : Value Added		
Pre Requisites : Nil		
Course Objectives:		
1.	To use the Java Programming and Android Studio develop the Android mobile application.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
CV02.1	Explain about the Java Programming	[U]
CV02.2	Illustrate the Concept of Android Studio	[U]
CV02.3	Interpret the basic features of Android Studio	[AP]
CV02.4	Develop an app using the Android Studio	[AP]
List of Exercises: 1. Create an application that takes the name from a text box and shows hello message along with the name entered in text box, when the user clicks the OK button. 2. Create a screen that has input boxes for User Name, Password, Address, Gender (radio buttons for male and female), Age (numeric), Date of Birth (Date Picket), State (Spinner) and a Submit button. On clicking the submit button, print all the data below the Submit Button (use any layout). 3. Design an android application Send SMS using Intent. 4. Design an android application Using Radio buttons and Menu. 5. Create a user registration application that stores the user details in a database table. 6. Develop BMI calculator Application.		
	Total hours:	**30**
Text Books:		
1.	Beginning Android® Programming with Android Studio, J F DiMarzio , 2016	
2.	Android App Development in Android Studio Java + Android Edition for Beginners J. Paul Cardle	
Web References:		
1	https://www.coursera.org/specializations/android-app-development#courses	

22VA603	INTELLECTUAL PROPERTY RIGHTS & ENTREPRENEURSHIP	1/0/0/1

Nature of Course: Value Added

Pre Requisites : Nil

Course Objectives:

1.	To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.

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

CV03.1	Understand the concepts of IPR and filing patents.	[U]
CV03.2	Define the basic concepts of entrepreneurship and skills needed for entrepreneurial management.	[R]
CV03.3	Explain the types, characteristics of entrepreneurship and its role in economic development.	[U]
CV03.4	Select the appropriate form of business ownership in setting up an enterprise.	[U]

Course Contents:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. **(5 hours)**

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur- Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth. **(5 hours)**

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies. **(5 hours)**

Total hours: 15

References:

1.	Robert P Merges, Peter S, Menell, Mark A, Lemley, “Intellectual Property in New Technological Age” 2016.
2.	Hisrich R D, Peters M P, Shepherd D A, Sinha S, “Entrepreneurship”11th Edition, Tata McGraw-Hill, 2020.
3.	Khanka S.S., “Entrepreneurial Development” S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.

22VA604	FINANCIAL LITERACY	1/0/0/1
Nature of Course: Value Added		
Pre Requisites: Nil		
Course Objectives:		
1.	Explain the time value of money scripts, goal setting, budgeting and to understand importance of saving, investing, debt management, Cash Flow and capital Budgeting	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
CV04.1	Interpret the value of money, budgeting and taxation concepts	[R]
CV04.2	Administer Loans and Investment planning	[AP]
CV04.3	Choose appropriate insurance schemes	[AP]
CV04.4	Apply corporate finance concepts and practice Profitability and liquidity	[AP]
Course Contents: **Personal Finance**: Time Value of Money & Present Value, Time value of money- Effective Interest Rate- Budgeting, Taxation Concepts and Tax Planning, Managing Liquid Assets, Credit Card Features & Costs. **(5 hours)** Saving and expenses, Compounding effect, Investment planning- Equities-Mutual Funds-Bonds-Fixed Deposit and Recurring Deposit- Real estate and Metals-Exchange Traded Funds- Crypto currency basics - Inflation-Retirement planning, Consumer Loans, Repo Rate, Reverse Repo rate, Life Insurance, Property Insurance- Financial independence and retire early (FIRE). **(5 hours)** **Corporate Finance:** Introduction to Corporate Finance, Cash Flow- Types- Capital Budgeting Alternate Valuation method- Payback period- Cost of capital and its impact on firm valuation, Profitability and liquidity, operating and cash conversion cycles. Payout Decision: Dividend and Right Issues. Capital recovery method. **(5 hours)**		
Total hours:		**15**
References:		
1.	https://www.edx.org/professional-certificate/iux-personal finance?index=product&queryID=3871cbe99e2b094f41fd45ec98598516&position=4	
2.	https://onlinecourses.nptel.ac.in/noc22_mg92/preview	

22VA605	AUTOMATION STUDIO	0/0/2/1

Nature of Course: Value Added

Pre Requisites : Nil

Course Objectives:

1.	To learn design and simulation software covering all automation technologies including fluid power, electrical controls, PLC and HMI

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

CV05.1	Illustrate fluid power and electrical circuits	[AP]
CV05.2	Simulate fluid power and power grid circuits using PLC and HMI.	[AP]
CV05.3	Examine and troubleshoot fluid power and electrical circuits	[AP]

Course Contents:

1. Simulation and actuation of pneumatic circuit using sequential and cascade method (2 &3 - cylinder circuit)
2. Simulation and actuation of electro pneumatic circuits and control in HMI.
3. Simulation and actuation of car rotation in paint room by using hydraulic circuits.
4. Belt conveyor control with PLC programming with hydraulic rotary actuators and control using HMI.
5. Troubleshooting the PLC and sensors for the garage door open and closing and car lifting mechanism using hydraulic circuit.
6. PLC program for power grid circuits.

Total hours:	**30**

References:

1.	https://www.famictech.com/en/Support/Automation-Studio/Training
2.	https://www.br-automation.com/en-in/academy/seminars-in-india/all countries/seminars/automation-studio-training-accelerated-basics-sem2104a/

22VA606	ELECTRIC VEHICLE DESIGN AND FABRICATION	1/0/0/1
Nature of Course: Value Added		
Pre Requisites : Nil		
Course Objectives:		
1.	To understand the concept of electric vehicle fabrication.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
CV06.1	Explain about batteries	[U]
CV06.2	Illustrate the Concept of motor and controller	[U]
CV06.3	Interpret the design consideration of electric vehicle	[AP]
Course Contents: Introduction, Types of electric vehicle -Batteries, flywheels and super capacitors – battery parameter- lead acid, nickel, sodium, lithium, metal air batteries, Battery charging, Modelling, BMS. **(5 hours)** Electric Machine and their controllers, Brushed DC electric motor, DC regulation and Voltage conversion, brushless electric motor, motor cooling, efficiency, selection of motor and design consideration. **(5 hours)** Electric vehicle modelling, tractive effort, modelling vehicle acceleration, modelling electric vehicle range – design consideration, aerodynamic, rolling resistance, transmission efficiency, vehicle mass, vehicle chassis and body design. **(5 hours)**		
	Total hours:	**15**
References:		
1.	James Larmine, “Electric vehicle technology”. Wiley, Second edition,2012.	
Web Resources		
1.	https://onlinecourses.nptel.ac.in/noc20_ee18/preview	

22VA607	MASTERING EMBEDDED SYSTEMS: UNLEASH THE POWER OF CONTROLLER BOARDS	0/0/2/1

Nature of Course : Value Added

Pre Requisites : Nil

Course Objective:

1.To illustrate the concept of microcontroller and processor boards.

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

CV07.1	Explain the features and applications of ATmega2560, LPC2148	[U]
CV07.2	Illustrate the Concept of Raspberry pi an STM32	[U]
CV07.3	Interpret the applications of FPGA and ESP8266	[AP]

Course Contents:

ATMEGA2560 AND LPC2148

ATmega2560 Development Board, Features, Led Blinking, LCD Interfacing, Sensor interface Ultrasonic Sensors, Temperature sensor, Motion Sensor, IR sensor, Different types of motors, DC/Servo/ Stepper motor interface - LPC2148 Development Board, Overview, Installing Keil µVision4 IDE, Led blink, LCD interface, Buzzer. (**10 hours)**

RASPBERRY PI AND STM32 BOARD

Raspberry Pi, LED, Push button, LCD interface, Soil Moisture, Light (LDR) Sensor, Temperature Sensor, ECG sensor, servo motor, STM32 Nucleo boards, Installation, LED, Buzzer, Fading Led, LCD, Push Button, IR Proximity, Light Sensor, DHT 11, DC Motor (**10 hours)**

FPGA AND ESP8266

FPGA DE0-Nano, Installation of Software, Blinking LED, Buzzer, ESP8266 & ESP32 Development Board, Buzzer, Fading Led, LCD, Push Button, Moisture Sensor, Water Sensor, Light Sensor, DHT 11, DC motor, IOT Cloud platforms, Bluetooth control. (**10 hours)**

Total hours: 30

Text Books

1.	Michael Margolis ,"Arduino Cookbook", O'Reilly first edition,2011
2.	Simon Monk "Raspberry Pi Cookbook: Software and Hardware Problems and Solutions" McGraw Hill TAB, 2014

Web Resources

1.	https://sites.google.com/e-yantra.org/atmega2560-dev/home?authuser=0
2.	https://sites.google.com/e-yantra.org/lpc2148/home?authuser=0
3.	https://sites.google.com/e-yantra.org/rpi/home?authuser=0
4.	https://sites.google.com/e-yantra.org/nucleo-f103rb/home?authuser=0
5.	https://sites.google.com/e-yantra.org/esp-development-boards/home?authuser=0

22VA608	PROGRAMMING WITH LabVIEW	0/0/2/1
Nature of Course : Value Added		
Pre Requisites : Nil		
Course Objectives:		
1	To learn the features of LabVIEW as a programming tool for basic problem-solving for various applications	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
CV08.1	Apply programming concepts in LabVIEW	[AP]
CV08.2	Develop program for real time data acquisition	[AP]
CV08.3	Visualize LabVIEW graphic features and its applications using myDAQ	[U]
CV08.4	Employ LabVIEW programming tool to measure physical quantities using myDAQ	[AP]

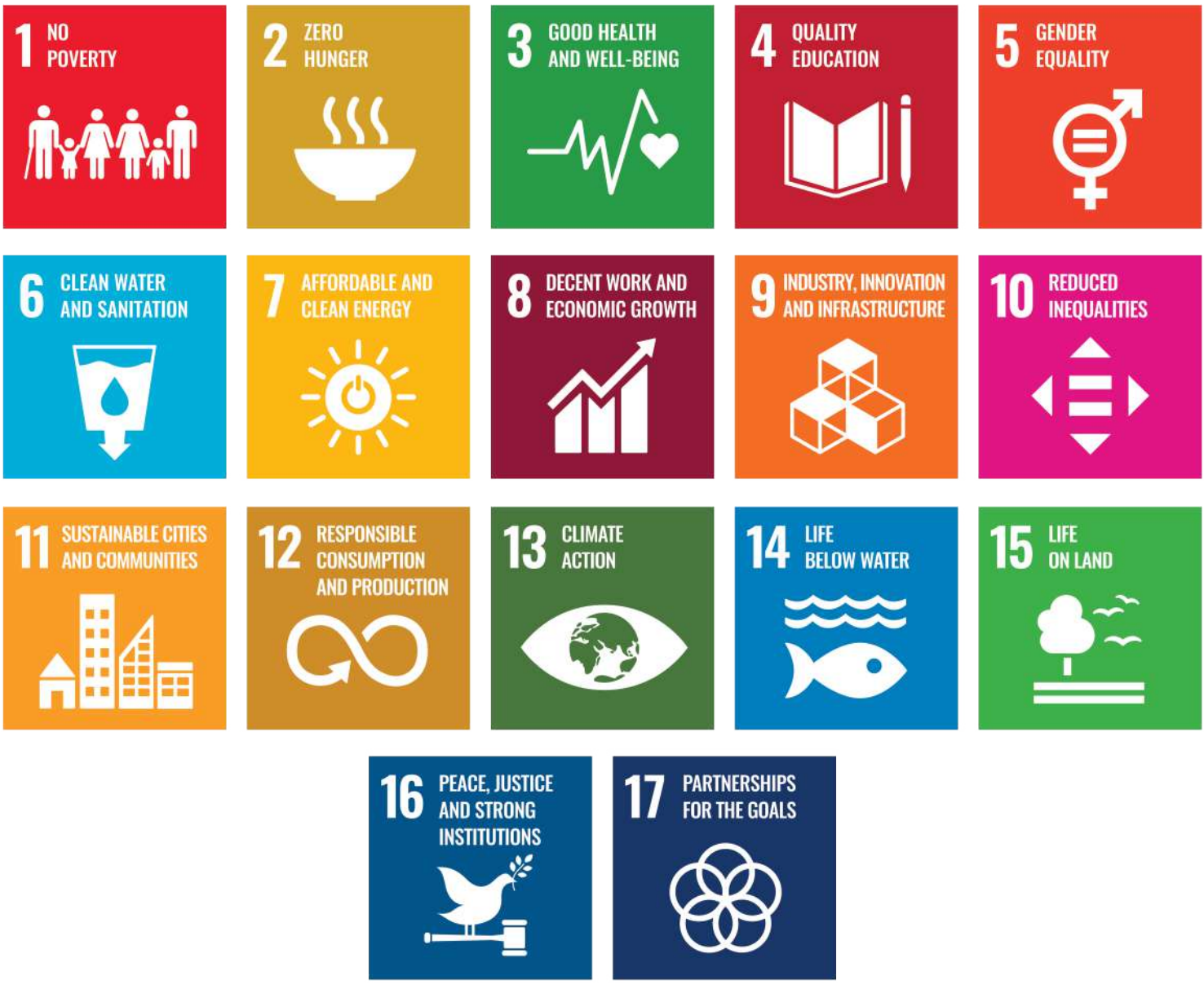
List of Exercises:

1. Programming exercises for performing arithmetic operations.
2. Programming to find Addition of First n natural numbers using for and while loop
3. Programming to create a sine wave using formula node.
4. Programming to implement user authentication
5. Programming exercises on case and sequence structures, file Input / Output.
6. Programming to develop voltmeter using DAQ
7. Programming for measurement of real time temperature using LM35 sensor using DAC
8. Arduino Based Data Acquisition System Using LabVIEW.

Total hours:	**30**

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 References:	
1	http://www.ni.com
2	www.nptel.ac.in/syllabus/112106152

SUSTAINABLE DEVELOPMENT GOALS



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