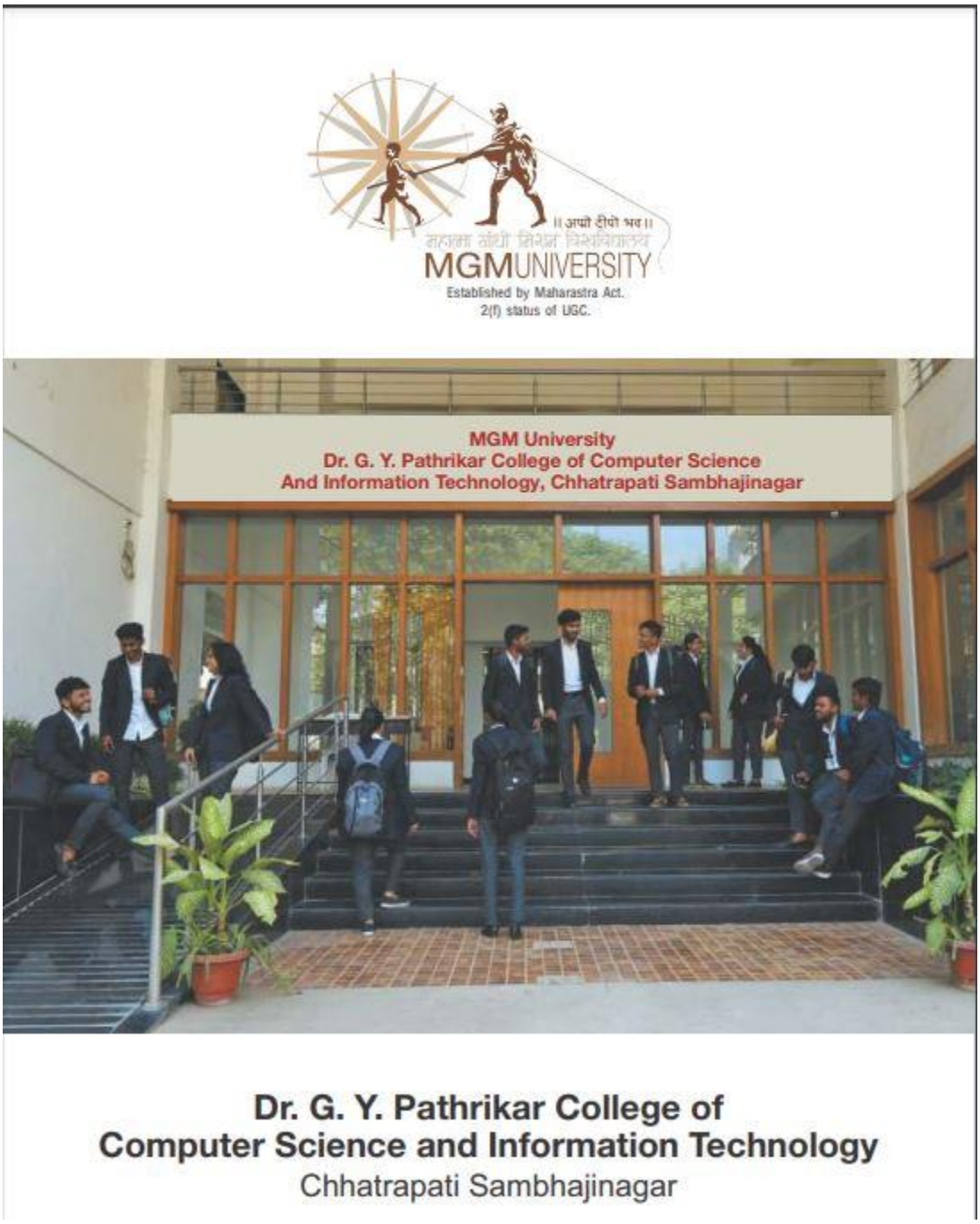

B.Sc. (Hons. /Hons. with Research) Robotics: First, Second and Third Year

(Syllabus)

W.E.F. ACADEMIC YEAR: 2024-25

MGM University

Vision

- To ensure sustainable human development which encourages self-reliant and self-content society.
- To promote activities related to community services, social welfare and also Indian heritage and culture.
- To inculcate the culture of non-violence and truthfulness through vipassanna meditation and Gandhian Philosophy.
- To develop the culture of simple living and high thinking

Mission

- To impart state of art education and technical expertise to students and give necessary training to teachers to create self-reliant society.
- To encourage students to participate in Indian and International activities in sports, literature, etc. so that future generation becomes base for free and liberal society
- To educate students in areas like Management, Finance, Human relations to inculcate philosophy of simple living and high thinking value of simple economic society.
- To inculcate culture of non-violence and truthfulness through Vipassana.

  To sustain activities of Indian culture (viz. classical dance, music and fine arts) through establishing institutes like Mahagami, Naturopathy, etc.

विद्यापीठगीत

अत्तदिपभवभवप्रदिपभव,

स्वरूपरूपभवहो

ज्ञानसब्बविज्ञानसब्बभव ,

सब्बदिपभवहो

अत्ताहिअत्तनोनाथो ,

अत्ताहिअत्तनोगति

अत्तमार्गपरअप्रमादसेहैतुझेचलना

सब्बकाकल्याणहो ,

वोकार्यकुशलकरना

सब्बकाउत्तममंगल , पथप्रदर्शकहो

अत्तदिपभवभवप्रदिपभव ,

स्वरूपरूपभवहो

ज्ञानसब्बविज्ञानसब्बभव ,

सब्बदिपभवहो

बुद्धमंशरनंगच्छामि :

धम्मंशरनंगच्छामि :

संघंशरनंगच्छामि :

Dr. G. Y. Pathrikar College of Computer Science & Information Technology

MGM college of Computer Science and Information Technology was established in 2001 offering undergraduate and postgraduate degree program in Computer Science and Information Technology. College was renamed as Dr. G. Y. Pathrikar College of Computer Science and Information Technology in 2003 in memory of great educationalist, one of the founder member and Ex-Secretary MGM, Dr. G. Y. Pathrikar Sir.

It is first self-financed ISO certified institution offering program dedicated to Computer science and Information technology in Maharashtra and has achieved status of 2f/12b. Ours was the only and first college to be re-accredited as A+ grade with NAAC in the year 2017. Experienced and qualified faculty with Ph. D is strength of our college. Starting with 77 student's College has crossed total students strength of 10,000 passing out. Student are doing well in various MNCs like Infosys, Tech-Mahindra, Wipro, Capgemini, Cognizant etc. Many have their own Startups. Some of the students have completed their Masters and Ph.D. program from foreign countries like US, UK, Australia. Now we are constituent college of MGM University, Chhatrapati Sambhajinagar.

Vision

To be an academic institution in dynamic equilibrium in social, ecological and economical environment striving continuously for excellence in total quality education, research and technological service to the nation.

Mission

- To create and sustain a community of learning in which students acquire knowledge and learn to apply it professionally with due consideration for ethical, and economical issues.
- To upgrade our students in all respect with the help of latest infrastructure in the area of Computer Science and Information Technology in order to build the National Capabilities.
- To understand the culture of Non-violence, truth, peace through Gandhian Philosophy.

Programs offered at Dr. G. Y. Pathrikar College of Computer Science & InformationTechnology

Undergraduate Programmes	Postgraduate Programmes	PhD Programmes
B. Sc. (Computer Science) Honours/ Honours with Research	M.Sc. (Computer Science)	Ph.D. in Computer Science and Information Technology
B. Sc. (Information Technology) Honours/ Honours with Research	M.Sc. (Information Technology)	
BCA(Science) Honours/ Honours with Research	M.Sc. (Data Science)	
B. Sc. (Animation) Honours/ Honours with Research	M.Sc. (Animation)	
Integrated M.Sc. Data Science		
BCA(Digital Marketing)Honours		
B.Sc. (Robotics) Honours		

Name of Program – B. Sc. Robotics

Duration – Four Years

Eligibility –

He / She Must have passed the Higher Secondary (Multipurpose) Examination conducted by H.S.C. Board Government of Maharashtra with Science / Technical Subjects or an Examination of any statutory University and Board recognized as equivalent thereto.

OR

Candidates having offered prescribed vocational courses, (MCVC) with Computer Techniques / Information Technology / Electronics.

OR

Three Years Course in Diploma Engineering conducted by the Board of Technical Education, Maharashtra State. He / She must have passed at qualifying examination.

Name of Faculty: Faculty of Basic and Applied Sciences
Name of the College: Dr. G. Y. Pathrikar College of Computer Science and IT
Name of the Programme: B.Sc. (Robotics) Honours / Honours with Research
Programme Type (UG/PG): UG
Duration: 04 Years (08 Semesters)

List of Options to select from Bucket of Courses provided in various categories:

Major	
Robotics	
Core Major	**Core Elective**

	GYP	**IBT**	**UDBAS**
Minor options for basic and applied science Faculty	Cyber Security	Food Technology and Processing	Chemistry
	Data Analytics	Microbiology	Geo-Informatics
	Block-Chain Technologies	Biotechnology	Mathematics
		Bioinformatics	Statistics
		Food Nutrition and Dietetics	Material Science

	Faculty of Engineering and Technology	**Faculty of Social Sciences & Humanities**	**Faculty of Design**	**Faculty of Management and Commerce**	**Interdisciplinary Faculty**	**Performing Arts**
Minor options from Other Faculty	Data Science	Filmmaking	Product Design	Financial Management	Cosmetic Technology	Theatre Arts
	IoT	Photography	Interior Design	E-Commerce	Education	Dance
	Geo-informatics and Applications	Mass Communication and Journalism	Contemporary Arts	International Business Management	Yog Sciences	Music
	EV Technology	Psychology	Visual Communication	Hospitality Mgmt	Physical Education	Folk Art
	Drone Technology	Economics	Fashion Technology	Travel and Tourism	Home Science	
	Robotics Technology	English		Art of Leadership		
	Chemical Technology	Social Work		Art of Business		
	AI&ML					
	Universal Human Values					
	Energy management					

First Year - Semester I												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	SCR41MML101	Elements of Robotics and Robot kinematics	Lecture	2	2		30	20	50		08	20
MM	SCR41MML102	Basic Electrical and Electronics	Lecture	2	2		30	20	50		08	20
MM	SCR41MMP101	Practical Based on Elements of Robotics and Robot kinematics	Practical	1	-	2	30	20	50	-	08	20
MM	SCR41MMP102	Practical based on Basic Electrical and Electronics	Practical	1	-	2	30	20	50	-	08	20
IKS	SCR41IKT101	Indian Psychology and yoga	Lecture	2	2	-	30	20	50		08	20
AEC		Basket of AEC From University	Lecture	2	2	-	30	20	50		08	20
OE		Basket of OE From University	Lecture	2	2	-	30	20	50		08	20
OE		Basket of OE From University	Lecture	2	2	-	30	20	50		08	20
VSC	SCR41VSP101	Python Programming	Practical	2		4	30	20	50	-	08	20
SEC	SCR41SEL101	Computer System Architecture	Lecture	2	2	-	30	20	50		08	20
VEC		From Basket of value Education courses from university	Lecture	2	2	-	30	20	50		08	20
CC		From Basket of Co-Curricular Courses from University	Practical	2	-	4	50	-	50	20	-	20
				22	**16**	**12**	**380**	**220**	**600**	**-**	**-**	**-**

Note:
Nature of Course:L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,
Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

First Year- Semester II												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	SCR41MML103	Robot Mechanics, dynamics and motion planning	Lecture	2	2		30	20	50		08	20
MM	SCR41MML104	Micro Processors and Embedded System	Lecture	2	2		30	20	50		08	20
MM	SCR41MMP103	Practical based on Robot Mechanics, dynamics and motion planning	Practical	1		2	30	20	50	-	08	20
MM	SCR41MMP104	Practical based on Micro Processors and Embedded System	Practical	1		2	30	20	50		08	20
MI		Basket of MI From University	Lecture	2	2	-	30	20	50		08	20
AEC		Basket of AEC From University	Lecture	2	2	-	30	20	50		08	20
OE		Basket of OE From University	Lecture	2	2	-	30	20	50		08	20
OE		Basket of OE From University	Lecture	2	2	-	30	20	50		08	20
VSC	SCA41VSP102	Electrical Actuators and Drives	Practical	2		4	30	20	50	-	08	20
SEC	SCA41SEL102	Electronic Devices and Circuits	Lecture	2	2	-	30	20	50		08	20
VEC		Universal Human Values (From VEC Annexure)	Lecture	2	2	-	30	20	50		08	20
CC		From Basket of Co-Curricular Courses from University	Practical	2	-	4	50	-	50	20	-	20
				22	**16**	**12**	**380**	**220**	**600**	-		

Note: Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,

Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project.

Level 4.5 Award of UG certificate with 40 credits and an additional 4-credits core NSQF course / internship OR continue with major and minor

Second Year- Semester III												
Course Category	**Course code**	**Course Title**	**Nature of Course**	**Teaching period per week**		**Credits**	**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
				L	**P**		**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	SCR41MML201	Mobile Robotics	Lecture	2	-	2	30	20	50		08	20
MM	SCR41MML202	Sensors and Signal Processing	Lecture	2	-	2	30	20	50		08	20
MM	SCR41MML203	Design of Machine Elements	Lecture	2	-	2	30	20	50		08	20
MM	SCR41MMP201	Practical Based on Mobile Robotics	Practical	-	2	1	30	20	50	-	08	20
MM	SCR41MMP202	Practical Based on Sensors and Signal Processing	Practical	-	2	1	30	20	50	-	08	20
OE		Basket of OE From University	Lecture	2	-	2	30	20	50		08	20
MIN		Basket of MI From University	Lecture	3	-	3	60	40	100		16	40
MIN		Basket of MI From University	Practical		2	1	30	20	50	-	08	20
AEC		Basket of AEC From University	Lecture	2	-	2	30	20	50		08	20
VSC	SCR41VSP201	Computational Methods for Robotics	Practical		4	2	30	20	50	-	08	20
FP	SCR41FPJ201	Field Project	Project	2	-	4	50	-	50	20	-	20
CC		From Basket of Co-Curricular Courses from University	Practical	2	-	4	50	-	50	20	-	20
				13	**18**	**22**	**430**	**220**	**650**	-	-	-

Note: Nature of Course : L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation, **Course Category: M**M-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives,
VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Second Year- Semester IV												
Course Category	**Course code**	**Course Title**	**Nature of Course**	**Teaching period per week**		**Credits**	**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
				L	**P**		**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	SCR41MML204	Actuators and Drives	Lecture	2	-	2	30	20	50		08	20
MM	SCR41MML205	Robotics and Control	Lecture	2	-	2	30	20	50		08	20
MM	SCR41MML206	Industrial Process Automation	Lecture	2	-	2	30	20	50		08	20
MM	SCR41MMP203	Practical Based on Actuators and Drives	Practical	-	2	1	30	20	50	-	08	20
MM	SCR41MMP204	Practical Based on Robotics and Control	Practical	-	2	1	30	20	50	-	08	20
OE		From Basket of Open Elective courses from University	Lecture	2	-	2	30	20	50		08	20
MIN		From Basket of Minors from University	Lecture	3	-	3	60	40	100		16	40
MIN		From Basket of Minors from University	Practical	-	2	1	30	20	50	-	08	20
AEC		From Basket of from University	Lecture	2	-	2	30	20	50		08	20
SEC	SCR41SEP201	Optimization Techniques for Robots	Practical	-	4	2	30	20	50	-	08	20
CEP	SCR41CEP201	Community Engagement Program(As per University Guideline (	Practical	2	-	4	50	-	50	20	-	20
CC		From Basket of Co-Curricular Courses from University	Practical	2	-	4	50	-	50	20	-	20
				13	**18**	**22**	**430**	**220**	**650**	-	-	**260**

Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation.
Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Third Year - Semester V												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	SCR41MML301	Microcontrollers and embed system	Lecture	2	2	-	30	20	50		08	20
MM	SCR41MML302	Introduction to Machine Learning	Lecture	2	2	-	30	20	50		08	20
MM	SCR41MML303	Manufacturing Process	Lecture	2	2		30	20	50		08	20
MM	SCR41MMP301	Practical Based on Microcontrollers and embed system	Practical	1	-	2	30	20	50		08	20
MM	SCR41MMP302	Practical Based on Introduction Machine Learning	Practical	1	-	2	30	20	50		08	20
ME	SCR41MEL301	Differential Equation and Numerical Methods	Lecture	3	3	-	60	40	100		16	40
	SCR41MEL302	Probability and Statistics										
ME	SCR41MEP301	Practical based on Differential Equation and Numerical Methods	Practical	1	-	2	30	20	50		08	20
	SCR41MEP302	Practical based on Probability and Statistics										
MI		Basket of MI From University	Lecture	3	2	-	60	40	100		16	40
MI		Basket of MI From University	Practical	1	-	2	30	20	50		08	20
VSC	SCR41VSP301	Manufacturing Process	Practical	2	-	4	30	20	50		08	20
FP	SCR41FPJ301	Field Project	Project	2	-	4	50	-	50	20	-	20
Total		**Total**		**20**	**12**	**16**	**410**	**240**	**650**			

Note:

Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,

Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Third Year - Semester VI												
Course Category	**Course code**	**Course Title**	**Nature of Course**	**Teaching period per week**		**Credits**	**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
							Internal	**External**	**Total**	**Internal**	**External**	**Total**
				L	**P**							
MM	SCR41MML304	Micro-Robotics	Lecture	2	-	2	30	20	50		08	20
MM	SCR41MML305	Industrial Internet of Things	Lecture	2	-	2	30	20	50		08	20
MM	SCR41MML306	Introduction to Deep Reinforcement Learning	Lecture	2	-	2	30	20	50		08	20
MM	SCR41MMP303	Practical Based on Micro-Robotics	Practical	-	2	1	30	20	50		08	20
MM	SCR41MMP304	Practical Based on Industrial Internet of Things	Practical	-	2	1	30	20	50		08	20
Open elective	SCR41MEL303	Introduction to Artificial Intelligence	Lecture	3	-	3	60	40	100		16	40
	SCR41MEL304	Computational Geometry										
Open elective	SCR41MEP303	Practical based on Introduction to Artificial Intelligence	Practical	-	2	1	30	20	50		08	20
	SCR41MEP304	Practical based on Computational Geometry										
MI		From Basket of Minors from University	Lecture	3	-	3	60	40	100		16	40
MI		From Basket of Minors from University	Practical	-	2	1	30	20	50		08	20
OJT	SCR41JTP301	On Job Training	Practical		8	4	60	40	100		16	40
				12	**16**	**20**	**390**	**260**	**650**			

Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,
Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Four Year - Semester VII												
Course Category	**Course code**	**Course Title**	**Nature of Course**	**Teaching period per week**		**Credits**	**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
							Internal	**External**	**Total**	**Internal**	**External**	**Total**
				L	**P**							
MM	SCR41MML401	Robot Manipulators	Lecture	3	-	3	60	40	100		16	40
MM	SCR41MML402	Medical Robotics	Lecture	3	-	3	60	40	100		16	40
MM	SCR41MML403	Robot Motion Planning	Lecture	3	-	3	60	40	100		16	40
MM	SCR41MMP401	Practical Based on Robot Manipulators	Practical	-	**2**	1	30	20	50		08	20
MM	SCR41MMP402	Practical Based on Medical Robotics	Practical	-	2	1	30	20	50		08	20
MM	SCR41MMP403	Practical Based on Robot Motion Planning	Practical	-	2	1	30	20	50		08	20
Open elective	SCR41MEL401	Computer Aided Manufacturing	Lecture	3	-	3	60	40	100		16	40
	SCR41MEL402	Computer Integrated Manufacturing System										
Open elective	SCR41MML401	Computer Aided Manufacturing	Practical	-	2	1	30	20	50		08	20
	SCR41MML402	Computer Integrated Manufacturing System										
RM	SCR41RML401	Research Methodology	Lecture	3	-	3	60	40	100		16	40
RM	SCR41RMP401	Practical based on Research Methodology	Practical	-	2	1	30	20	50		08	20
			Total	**15**	**10**	**20**	**450**	**300**	**750**			

Four Year - Semester VIII												
Course Category	**Course code**	**Course Title**	**Nature of Course**	**Teaching period per week**		**Credit**	**Evaluation Scheme**			**Minimum Passing**		
							Internal	**External**	Total	**Internal**	**External**	**Total**
				L	**P**							
MM	SCR41MML404	Power Electronics and Drives	Lecture	3	-	3	60	40	100		16	40
MM	SCR41MML405	Instrumentation and electric drive	Lecture	3	-	3	60	40	100		16	40
MM	SCR41MML406	Field and Service Robotics	Lecture	3	-	3	60	40	100		16	40
MM	SCR41MMP404	Practical Based on Power Electronics and Drives	Practical	-	2	1	30	20	50	-	08	20
MM	SCR41MMP405	Practical Based on Instrumentation and electric drive	Practical	-	2	1	30	20	50	-	08	20
MM	SCR41MMP406	Practical Based on Field and Service Robotics	Practical	-	2	1	30	20	50	-	08	20
Open elective	SCR41MEL403	Applied Thermodynamics	Lecture	3	-	3	60	40	100		16	40
	SCR41MEL404	Strength of Materials										
Open elective	SCR41MEP403	Applied Thermodynamics	Practical	-	2	1	30	20	50		08	20
	SCR41MEP404	Strength of Materials										
OJT	SCR41JTP401	On job Training	Practical		8	4	60	40	100		16	40
			Total	**12**	**16**	**20**	**420**	**280**	**700**		**-**	**-**

Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Four Year (Semester VII) Honours with Research												
Course Category	**Course code**	**Course Title**	**Nature of Course**	**Teaching period per week**		**Credits**	**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
							Internal	**External**	**Total**	**Internal**	**External**	**Total**
				L	**P**							
MM	SCR41MML407	Pneumatics and Hydraulics	Lecture	3	-	3	60	40	100		16	40
MM	SCR41MML408	Digital Image Processing and Machine Vision	Lecture	3	-	3	60	40	100		16	40
MM	SCR41MMP406	Practical Based on Pneumatics and Hydraulics	Practical	-	2	1	30	20	50	-	08	20
MM	SCR41MMP407	Practical Based on Digital Image Processing and Machine Vision	Practical	-	2	1	30	20	50	-	08	20
Open elective	SCR41MEL405	Artificial Intelligence and Expert System	Lecture	3	-	3	60	40	100		16	40
	SCR41MEL406	Flexible Manufacture and System										
Open elective	SCR41MEP405	Artificial Intelligence and Expert System	Practical	-	2	1	30	20	50	-	08	20
	SCR41MEP406	Flexible Manufacture and System										
RM	SCR41RML401	Research Methodology	Lecture	3	-	3	60	40	100		16	40
RM	SCR41RMP401	Practical based on Research Methodology	Practical	-	2	1	30	20	50	-	08	20
RP	SCR41RPJ401	Research Project	Practical	-	8	4	60	40	100	-	16	40
			Total	**12**	**16**	**20**	**420**	**280**	**700**	-	-	-

Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,
Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Lecture 1 credit = 15 hours, tutorial 1 credit = 15 hours, Practical 1 credit = 30hours,

Level 6.0 Four year UG Honours with research Degree in major and minor (44+44+44+44) = 176 credits

*[Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year.]

Four Year (Semester VIII)												
Course Category	**Course code**	**Course Title**	**Nature of Course**	**Teaching period per week**		**Credit**	**Evaluation Scheme**			**Minimum Passing**		
				L	**P**		**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	SCR41MML408	Signal Processing	Lecture	3	-	3	60	40	100		16	40
MM	SCR41MML409	Design and Control	Lecture	3	-	3	60	40	100		16	40
MM	SCR41MMP408	Practical Based on Signal Processing	Practical	-	2	1	30	20	50		08	20
MM	SCR41MMP409	Practical Based on Design and Control	Practical	-	2	1	30	20	50		08	20
Open elective	SCR41MEL407 / SCR41MEL408	Machine Vision Systems / Elements of Mechatronics	Lecture	3	-	3	60	40	100		16	40
Open elective	SCR41MEP407 / SCR41MEP408	Machine Vision Systems / Elements of Mechatronics	Practical	-	2	1	30	20	50	-	08	20
RP	SCR41RPJ402	Research Project	Practical		16	8	120	80	200	-	32	80
			Total	**09**	**22**	**20**	**390**	**260**	**650**	**-**	**-**	**-**

Semester: FIRST

Syllabus
Semester - I

Course code: SCR41MML101 **Course name:** Elements of Robotics and Robot kinematics **Course category:** Major Mandatory
Credits: 2 **Teaching Scheme:** L-2 P-0 **Evaluation Scheme**: CA -30 ESE 20
Pre-requisites: Pre-university mathematics.
Course Objectives:
To impart knowledge on Performance of the fundamental control practices associated with AC and DC
machines (starting, reversing, braking, plugging, etc.) using power electronics To impart industry
Oriented learning.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: To control both the position and orientation of the tool in the three-dimensional space.
CO2: The relationship between the joint variables and the position and the orientation of the tool.
CO3: Planning trajectories for the tool to follow on order to perform meaningful task.
CO4: To precisely control the high-speed motion of the system..

Contents -

Unit	Content	Teaching hours
1	**INTRODUCTION-** position and orientation of objects, objects coordinate frame Rotation matrix, Euler angles Roll, pitch and yaw angles coordinate Transformations, Joint variables and position of end effector, Dot and cross products, coordinate frames, Rotations, Homogeneous coordinates **DIRECT KINEMATICS-** Link coordinates D-H Representation, The ARM equation. Direct kinematic analysis for Four axis, SCARA Robot and three, five and six axis Articulated Robots.	10
2	**INVERSE KINEMATICS** The inverse kinematics problem, General properties of solutions. Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis, Articulated robot.	10
3	**WORKSPACE ANALYSIS AND TRACJECTORY PLANNING** Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique - continuous path motion, Interpolated motion, straight line motion and Cartesian space technique in trajectory planning.	10

Text Books:
1. Fundamentals of Robotics Analysis and Control Robert J. Schilling PHI Learning 2009.
2. Robotics Engineering an Integrated Approach Richard D. Klafter, Thomas. A, Chri Elewski, Michael Negin PHI Learning 2009

Syllabus
Semester - I

Course code: SCR41MML102 **Course name:** Basic Electrical and Electronics **Course category:** Major Mandatory
Credits: 2 **Teaching Scheme:** L-0 P-2 **Evaluation Scheme**: CA -30 ESE- 20
Pre-requisites: Pre-university mathematics.
Course Objectives:
To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics To impart industry oriented learning.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: To introduce the basics of electric circuits and analysis.
CO2: To impart knowledge in the basics of working principles and application of electrical machines.
CO3: To introduce analog devices and their characteristics.
CO4: To educate on the fundamental concepts of linear integrated circuits.

Contents -

Unit	Content	Teaching hours
1	**ELECTRICAL CIRCUITS** DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws –Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with independent sources only (Steady state) Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only)	10
2	**ANALOG ELECTRONICS** Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET, IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters	10
3	**MEASUREMENTS AND INSTRUMENTATION** Functional elements of an instrument, Standards and calibration, Operating Principle, types - Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT, DSO- Block diagram- Data acquisition.	10

Text Books:
1. "Basic Electrical and Electronics Engineering D P Kothari and I.J Nagrath McGraw Hill EducationSecond Edition, 2020
2. Measurement and Instrumentation Principles Allan S Moris Butterworth Heinemann Third Edition 2001

Syllabus
Semester - I

Course code: SCR41MMP101 **Course name:** Practical Based on Elements of Robotics and Robot kinematics **Course category:** Major Mandatory
Credits: 1 **Teaching Scheme:** L-0 P-2 **Evaluation Scheme**: CA -30 ESE- 20
Pre-requisites: Pre-university mathematics.
Course Objectives: To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics To impart industry oriented learning.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: To model and simulate a robot and verify its dynamics.
CO2: Analyze the kinematics and dynamics for various robots.
CO3: Simulate and evaluate the kinematics and dynamics for various robots.
CO4: Create a robot and program a trajectory plan for the robot.

Contents -

Sr.no	Description of Experiment	Practical hours
1.	Verification of Forward Kinematics for 2R, 2P and RP Robot	10
2.	Verification of D-H transformation for 6DOF Serial anipulator	
3.	Verification of Inverse Kinematics for 2R, 2P and RP Robot	
4.	Verification of Forward Kinematics for 3R spatial Robot.	
5.	Kinematic Analysis of 2R planar robot for varying trajectories using Robo analyzer	10
6.	Workspace Analysis of 2R planar robot manipulator for a specified trajectory	
7.	Kinematic Analysis of 6 DOF robot for varying trajectories using Robo analyzer	
8.	Inverse Dynamic Analysis of 6 DOF robot robot for varying trajectories using Roboanalyzer	
9.	Forward and Inverse Dynamics of 2R planar robot using Roboanalyzer	10
10.	Creation of Robot in ROS using Gazebo/V-REP	
11.	Motion Simulation of Robot in ROS using Gazebo/V-REP/Moveit/Industrial	
12.	Simulation of Trajectory Analysis of 2R and 3R manipulators using MATLABSIMULINK	

Text Books:

1. Fundamentals of Robotics Analysis and Control Robert J. Schilling PHI Learning 2009.
2. Robotics Engineering an Integrated Approach Richard D. Klafter, Thomas. A, Chri Elewski, Michael Negin PHI Learning 2009

Syllabus
Semester- I

Course code: SCR41MMP102 **Course name:** Practical based on Basic Electrical and Electronics **Course category:** Major Mandatory
Credits: 1 **Teaching Scheme:** L-0 P-2 **Evaluation Scheme**: CA -30 ESE 20
Pre-requisites: Pre-university mathematics.
Course Objectives: To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics To impart industry oriented learning.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: To gain practical experience in characterizing electronic devices.
CO2: To train the students to use DSO for measurements.
CO3: Use experimental methods to verify the Ohm's and Kirchhoff's Laws.
CO4: Analyze experimentally the load characteristics of electrical machines.

Sr.No.	Description of Experiment	Practical Hours
	ELECTRICAL	10
1.	Verification of ohms and Kirchhoff's Laws	
2.	Load test on DC Shunt Motor	
3.	Load test on Self Excited DC Generator	
4.	Load test on Single phase Transformer	
5.	Load Test on Induction Motor	
	ELECTRONICS	10
6.	Experiment on Transistor based application circuits (Inverting and non-inverting amplifier or switching circuits)	
7.	Experiments on Operational Amplifier based Inverting and non-inverting amplifier	
8.	Experiments on ADC. Experiments on 555 timer	
	MEASUREMENTS	10
9.	Study on function of DSO.	
10.	Measurement of Amplitude, Frequency, Time, Phase Measurement using DSO.	

Text Books:
1. "Basic Electrical and Electronics Engineering D P Kothari and I.J Nagrath McGraw Hill EducationSecond Edition, 2020
2. Measurement and Instrumentation Principles Allan S Moris Butterworth Heinemann Third Edition 2001

Syllabus
Semester - I

Course code: SCR41VSP101 **Course category:** Vocational skill course		**Course name:** Python Programming
Credits: 2	**Teaching Scheme:** L-0 P-4	**Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.		
Course Objectives: To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics To impart industry oriented learning.		
Course Outcomes: Upon completion of this course, the students will be able to:		
CO1: Develop algorithmic solutions to simple computational problems.		
CO2: Develop and execute simple Python programs.		
CO3: Develop and execute simple Python programs.		
CO4: Deploy functions to decompose a Python program.		

Contents -

Sr.no.	Description of Practical	Practical Hours
1.	Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)	10
2.	Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).	
3.	Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)	
4.	Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)	
5.	Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)	10
6.	Implementing programs using Functions. (Factorial, largest number in a list, area of shape)	
7.	Implementing programs using Functions. (Factorial, largest number in a list, area of shape)	
8.	Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)	
9.	Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)	10
10.	Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)	
11.	Exploring Pygame tool.	
12.	Developing a game activity using Pygame like bouncing ball, car race.	

Text Books:
1. Think Python: How to Think Like a Computer Scientist Allen B. Downey O'Reill 2nd Edition 2015
Reference Books
1. Computational Thinking: A Beginner's Guide to Problem Solving and Programming Karl Beecher BCS Learning & Development Limited 2017

Syllabus
Semester - I

Course code: SCR41SEL101		**Course name:** Computer System Architecture
Course category: Skill Enhancement Course		
Credits: 2	**Teaching Scheme:** L-2 P-0	**Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.		
Course Objectives: To convey basic introduction of computer system architecture, the structure of computer, Working gates and its functionality.		
Course Outcomes: Upon completion of this course, the students will be able to:		
CO1: Student will be able to learn basic concepts of digital logic.		
CO2: Student will be able to design of basic logic circuits using commonly used combinational and sequential circuits.		
CO3: Student will be able to learn basic concepts of digital logic.		
CO4: Student will be able to learn basic concepts of digital logic		

Content -

Unit	Content	Teaching hours
1	**Data Types** Number Systems, Octal and Hexadecimal Numbers, Decimal Representation, Alphanumeric Representation, 1's Complement, 2's Complement, Subtraction of Unsigned Numbers	10
2	**Introduction** Digital Computers, Logic Gates, Boolean Algebra, Complement of Function, **Karnaugh's Map** Map Simplification, Product of Sums Simplification Don't Care Conditions. **Combinational Circuits** Half Adder, Full Adder, 4-Bit Binary Adder, Half Subtractor and Full Subtractor	10
3	**Flip Flops** SR- Flip Flop, D- Flip Flop, JK- Flip Flop, T- Flip Flop, Edge Triggered Flip Flops, Flip Flop Input Equations, State Table, State Diagram, Problems	10

Text Books:

1. Computer System Architecture : M.Morris Mano -PEARSON
2. Computer System, Digital Design, Fundamentals of Computer Architecture and Assembly Language: AtaElahi -Springer.
3. Digital Electronics andMicro-Computers :R.K. Gaur -Dhanpatrai
4. Introduction to Digital Electronics :John Croweand Barrie Hayes -Gill

Semester: SECOND

Syllabus
Semester - II

Course code: SCR41MML103 **Course name:** Robot Mechanics, dynamics and motion planning **Course category:** Major Mandatory
Credits: 2 **Teaching Scheme:** L-2 P-0 **Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives:
Compute the electric circuit parameters for simple problems.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: This course aims to familiarize students with basic terminologies of the robotics.
CO2: Essential knowledge to be acquainted in the field of Robotics.
CO3: Identify gripper, sensor and actuator of a robot.
CO4: Apply mathematics for manipulator positioning and motion planning

Content -

Unit	Content	Teaching hours
1	**Introduction to robotics:** Brief History, Definition, Robot Anatomy, Three laws, Classification of robots, Robot terminologies: work volume, Degree of Freedom, resolution, accuracy, repeatability, dexterity, compliance, payload capacity, speed of response etc., Wrist assembly, Joint notations, Selection criteria of any robot, Industrial applications of robot, Futuristic robotics. **Robot drive systems, End effectors and Automation:**Types of drives – Hydraulic, Pneumatic and Electric, Comparison of all such drives, DC servo motors, Stepper motors, AC servo motor – salient features and applications, pulse count calculations, Types of Grippers – Mechanical, Magnetic, vacuum, pneumatic and hydraulic, selection and design considerations	10
2	**Robot sensors and Machine Vision:** Need for sensors, types of sensors used in Robotics, classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Robot Vision setup (RVS), block diagram, components, working of RVS, Human vision Vs Robot Vision, Gradient calculations, Applications of RVS **Mathematical Preliminaries of Robotics:**Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, Homogeneous transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, Euler Parameters.	10
3	**Robot Kinematic** : Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations,Forward Kinematics, Inverse Kinematics	10

Text Books:
1**.** Introduction to Robotics S. K. Saha McGraw Hill Education Second Edition, 2014
2. Robotics: Fundamental concepts and analysis Asitava Ghosha Oxford University Press 2006

Syllabus
Semester- II

Course code: SCR41MML104 **Course name:** Microprocessor and Embedded Systems **Course category:** Major Mandatory
Credits: 2 **Teaching Scheme:** L-2 P-0 **Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives: Compute the electric circuit parameters for simple problems.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: This course aims to familiarize students with basic terminologies of the robotics.
CO2: It also aims to inculcate thorough understanding about basic terminologies, grippers, sensors, actuators and robot kinematic.
CO3: Write programs for interfacing various sensors for robotics applications.
CO4: Identify gripper, sensor and actuator of a robot.

Contents-

Unit	Content	Teaching hours
1	**Fundamentals of Microprocessors** History of microprocessor and microcontrollers, Difference between microprocessors and microcontrollers and Applications of microcontrollers, Role of microcontrollers in embedded Systems. **Architecture and instruction set of 8-bit AVR Microcontroller** Microcontroller architecture: Registers, AVR status register, Memory Space, ATmega32 (Arduino) pin-configuration & function of each pin, Addressing mode and instruction set of AVR microcontroller, Data transfer, Arithmetic, Logic and Compare, Rotate and Shift, Branch and Call instructions, Bit manipulation instructions	10
2	**AVR Assembly and C Programming** AVR data types and assembler directives, AVR assembly language programs,AVR I/O Port Programming, Time delay loop, Bit addressability, MACROs, Pros and cons of C and assembly language programming, Data types, Simple C programs for general purpose I/O and bit accessibility **AVR on-chip peripherals and its programming** General purpose I/O Ports, Timers, Interrupts, serial port, Serial port Interfacing protocols, SPI, I2C, UART. Assembly and C Language programming for peripherals	10
3	**Device interfacing and its programming** Sensor interfacing, Relay, Optoisolator and Stepper Motor Interfacing, Industrial servo interfacing, Raspberry Pi based programming for robots. Inverse Kinematics and Path Planning Programming using ROS.	10

Text Books:
1. The AVR Microcontroller and Embedded Systems Using Assembly and C Muhammad Ali Mazidi, SarmadNaimi and SepehrNaimi Pearson Education 1st Edition, 2012
2. Introduction to Robotics. S. K. Saha Tata McGraw Hill Education Pvt. Ltd Press
3. Introduction to Digital Electronics :John Croweand Barrie Hayes -Gill

Syllabus
Semester- II

Course code: SCR41MMP103 **Course name:** Practical based on Robot Mechanics, dynamics and motion planning **Course category:** Major Mandatory
Credits: 1 **Teaching Scheme:** L-0 P-2 **Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives: Compute the electric circuit parameters for simple problems.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: This course aims to familiarize students with basic terminologies of the robotics.
CO2 It also aims to inculcate thorough understanding about basic terminologies, grippers, sensors, actuators and robot kinematic.
CO3: Write programs for interfacing various sensors for robotics applications.
CO4: Identify gripper, sensor and actuator of a robot.

Contents -

Sr.No.	Description of Practical	Practical Hours
1.	Study of components of real robot and its performance	10
2.	Basics of 3D modeling software	
3.	Modeling of Robot Joints	
4.	Assembly of 2DOF/3DOF Robot Manipulator	
5.	Use of drives for robotic joints and its simulation	10
6.	Roboanalyzer: A learning software of robotics study	
7.	Understanding coordinate frames and transformation	
8.	Formulation of DH parameters of robot configuration	
9.	Simulation using open source software of robot kinematics using DH Parameters	10
10.	Forward kinematic analysis of a robot	
11.	Inverse kinematic analysis of a robot	
12.	Introduction of MATLAB and Robotic Toolkit introduction	

Text Books:
1. Introduction to Robotics S. K. Saha McGraw Hill Education Second Edition, 2014
2. Robotics: Fundamental concepts and analysis Asitava Ghosha Oxford University Press 2006

Syllabus
Semester - II

Course code: SCR41MMP104 **Course name:** Practical based on Micro Processors and Embedded System **Course category:** Major Mandatory
Credits: 1 **Teaching Scheme:** L-0 P-2 **Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives: This course aims to teach the detailed functioning of AVR Microcontroller and the role of embedded systems in a robotic system.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: To prepare block diagrams for any robotic control-hardware design.
CO2: Learn and analyze assembly language programs for AVR Microcontroller for various peripheral interfacings.
CO3: Write programs for interfacing various sensors for robotics applications.
CO4: To use advanced embedded processor and software.

Contents -

Sr.no.	Description of Practical	Practical hours
1	Introduction to Robotic controller card like Arduino UNO board and write program to blink LED using Arduino instructions, C language & Assembly language.	10
2	Interfacing drivers for Arduino Controller for Robotic application. Various sensor interfacing with Robotic Controller like Arduino UNO board	
3	Interface Digital/Analog input output interfacing module with Arduino board and write programs related to I/O module	
4	Write and execute Arduino program for serial communication. Transmit temperature value through serial communication and store it in spreadsheet or text file	
5	1.Write assembly language programs for ATMega32 Microcontroller and simulate using ATMEL Studio	10
6	2. Interface Stepper motor with AVR Microcontroller and Write program to rotate stepper motor in clockwise and anticlockwise direction.	
7	3. Interface DC Motor with AVR Microcontroller and write program to rotate DC motor in clockwise and anticlockwise direction.	
8	4. Write Arduino program to receive IR Signal from IR remote and operate Electrical device based on switch pressed.	
9	1.To simulate joint torque control of manipulator	10
10	2.To study feedback control of robot manipulator	
11	3. To study adaptive control of robot manipulator	
12	4. Design a robotic car using Arduino and other accessories	

Text Books:
1. The AVR Microcontroller and Embedded Systems Using Assembly and C Muhammad Ali Mazidi, SarmadNaimi and SepehrNaimi Pearson Education 1st Edition, 2012
2. Introduction to Robotics. S. K. Saha Tata McGraw Hill Education Pvt. Ltd Press
3. Introduction to Digital Electronics :John Croweand Barrie Hayes -Gill

Syllabus
Semester - II

Course code: SCR41VSP102 **Course name:** Electrical Actuators and Drives **Course category:** Vocational skill course
Credits: 2 **Teaching Scheme:** L-0 P-4 **Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives: To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics To impart industry oriented learning.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: To evaluate the use of computer-based analysis tools to review the major classes of machines and their physical basis for operation.
CO2: Practice the basic working of AC, DC motor, stepper motor, servo motor and synchronous motor using power electronic drive.
CO3: Demonstrate the control of AC, DC motor, stepper motor, servo motor and synchronous motor using power electronic drive.
CO4: Analyze the performance of AC, DC motor, stepper motor, servo motor and synchronous motor using power electronic drive.

Sr.no.	Description of Practical	Practical Hours
1.	Load test on DC Motor	10
2.	Load test on DC Motor	
3.	Load test on 3 Phase Synchronous Motor.	
4.	Rheostat based Speed control of motors (AC and DC)	
5.	Switching circuits of MOSFET, IGBT, SCR and TRAIC.	10
6.	Gate pulsation generation using PWM signals	
7.	Speed control of DC motor using Power Electronic Drive.	
8.	Position and direction control DC servomotor using Power ecteronic Drive	
9.	Position, Direction and speed control of stepper Motor.	10
10.	Four quadrant operation of three-phase Induction Motor using Power Electronic Drive.	
11.	VFD control of single phase and three-phase induction motor using Power Electronic Drive.	
12.	AC servomotor position, direction and speed control using Power Electronic Drive.	

Syllabus
Semester - II

Course code: SCR41SEL102 **Course name:** Electronic Devices and Circuits **Course category:** Skill Enhancement course
Credits: 2 **Teaching Scheme:** L-2 P-0 **Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives: To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: To analyze the frequency response of small signal amplifiers.
CO2: To design and analyze single stage and multistage amplifier circuits.
CO3: To study about feedback amplifiers and oscillators principles.
CO4: To understand the analysis and design of multi vibrators.

Contents -

Unit	Content	Teaching hours
1	**SEMICONDUCTOR DEVICES** PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator. **AMPLIFIERS :** Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis	10
2	**MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER** Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods. **FEEDBACK AMPLIFIERS AND OSCILLATORS** Advantages of negative feedback – Analysis of Voltage / Current, Series, Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.	10
3	**POWER AMPLIFIERS AND DC/DC CONVERTERS** Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.	10

Text Books:
1. Electronic Devices and Circuits David A. Bell Oxford Higher Education press 5th Edition,2010
2. Electronic Devices and Circuit Theory Robert L. Boylestad and Louis Nasheresky Pearson Education / PHI 10th Edition 2008

Semester: THIRD

Syllabus
Semester- III

Course code: SCR41MML201 **Course name:** Mobile Robotics **Course category:** Major Mandatory
Credits: 2 **Teaching Scheme:** L-2 P-0 **Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives: To introduce mobile robotic technology and its types in detail, kinematics of wheeled and legged robot. To familiarize the intelligence into the mobile robots using various sensors, localization strategies and mapping technique for mobile robot.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: Evaluate the appropriate mobile robots for the desired application
CO2: Analyze the sensors for the intelligence of mobile robotics
CO3: Evaluate the kinematics for given wheeled and legged robot.
CO4: Create the localization strategies and mapping technique for mobile robot

Contents -

Unit	Content	Teaching hours
1	**INTRODUCTION TO MOBILE ROBOTICS** Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles – Teleportation and Control.	8
2	**KINEMATICS** Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – Manoeuvrability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots – Open Loop and Feedback Motion Control – Humanoid Robot - Kinematics Overview	8
3	**PERCEPTION** Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons – Active Ranging - Motion/Speed Sensors – Vision Based Sensors – Uncertainty - Statistical Representation - Error Propagation - Feature Extraction Based on Range Data (Laser, Ultrasonic, Vision-Based Ranging) - Visual Appearance based Feature Extraction. **LOCALIZATION** The Challenge of Localization - Sensor Noise and Aliasing - Effector Noise – Localization Based Navigation Versus Programmed Solutions - Belief Representation – Single - Hypothesis Belief And Multiple-Hypothesis Belief - Map Representation - Continuous Representations - Decomposition Strategies - Current Challenges In Map Representation - Probabilistic Map-Based Localization - Markov Localization - Kalman Filter Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Stochastic Map Technique - Other Mapping Techniques. Simultaneous Localization and Mapping (SLAM)	7

4	**PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS** Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Modularity for Code Reuse and Sharing - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.	7

Text Books:
1. "Basic Electrical and Electronics Engineering" Roland Siegwart and Illah R. Nourbakish, MIT Press, Cambridge 2004

Syllabus
Semester - III

Course code: SCR41MML202 **Course name:** Sensors and Signal Processing **Course category:** Major Mandatory
Credits: 2 **Teaching Scheme:** L-2 P-0 **Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives:
This course equips students with the knowledge and skills necessary for working with sensors, processing signals, and contributing to cutting-edge technologies in various domains
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: use well-developed cognitive and technical skills to understand and express the characteristics of a wide range of sensor types;
CO2: Understanding of sensor types, be able to design and apply sensors to solve real-world instrumentation problems;
CO3: Define and evaluate the essential characteristics of digital data acquisition systems
CO4: Analyses and process digitally acquired signals using Fourier transform techniques.

Contents -

Unit	Content	Teaching hours
1	**SCIENCE OF MEASUREMENT** Units and Standards – Calibration techniques –Errors in Measurements – Generalized Measurement System – Static and dynamic characteristics of transducers – Generalized Performance of Zero Order and First Order Systems - Response of transducers to different time varying inputs – Classification of transducers	8
2	**MECHANICAL MEASUREMENTS** Temperature: Filled thermometer – Bimetallic thermometer – monometers – elastictrans ducers– bourdon gauge – bellows – diaphragm. Vacuum: McLeod gauge, thermal conductivity. Gauge –Ionization gauge, flow measurement: orifice, venture, nozzle, pilot tube, turbine flow meter, hot wire anemometer.	8
3	**ELECTRICAL MEASUREMENTS** Resistive transducers – Potentiometer– RTD – Thermistor – Thermocouple – Strain gauges –use in displacement, temperature, force measurement – Inductive transducer – LVDT –RVDT –use in displacement – Capacitive transducer – Piezo electric transducer – Digital displacement transducers.	7
4	**SMART SENSORS:** Radiation Sensors - Smart Sensors - Film sensor, MEMS, Nano Sensors – applications -Automobile, Aerospace, Home appliances, Manufacturing, Medical diagnostics, Environmental monitoring. **SIGNAL CONDITIONING AND DATA ACQUISITION:** Amplification – Filtering – Sample and Hold circuits –Data Acquisition: Single channel and multi-channel data acquisition – Data logging.	7

Text Books:
1. E. O. Doebelin, 'Measurement Systems – Applications and Design ', Tata McGraw Hill, edition 1992.
2. A. K. Sawhney, A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co (P) Ltd, 2004.
Reference Books:
1. Beckwith, Marangoni and Lienhard, 'Mechanical Measurements', Addison – Wesley, 5th Edition, 2000.
2. D. Roy Choudry, Sheil Jain, ' Linear Integrated Circuits', New Age International Pvt. Ltd., 2000.
3. Patranabis. D, "Sensors and Transducers", 2nd edition PHI, New Delhi, 2003.

Syllabus
Semester - III

Course code: SCR41MML203		**Course name:** Design of Machine Elements
Course category: Major Mandatory		
Credits: 2	**Teaching Scheme:** L-2 P-0	**Evaluation Scheme**: CA -30 ESE 20
Pre-requisites: Pre-university mathematics.		
Course Objectives:		
To learn the various steps involved in the Design Process, To Learn designing shafts and couplings for various applications		
Course Outcomes: Upon completion of this course, the students will be able to:		
CO1: Explain the design machine members subjected to static and variable loads		
CO2: Apply the concepts design to shafts, key and couplings.		
CO3: Apply the concepts of design to bolted, Knuckle, Cotter, riveted and welded joints.		
CO4: Apply the concept of design helical, leaf springs, flywheels, connecting rods and crank shafts.		

Contents -

Unit	Content	Teaching hours
1	**FUNDAMENTAL CONCEPTS IN DESIGN :**Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers- Direct, Bending and torsional loading- Modes of failure - Factor of safety – Combined loads – Principal stresses – Eccentric loading – curved beams – crane hook and 'C' frame- theories of failure – Design based on strength and stiffness – stress concentration – Fluctuating stresses – Endurance limit –Design for finite and infinite life under variable loading - Exposure to standards.	8
2	**DESIGN OF SHAFTS AND COUPLINGS:** Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys and splines – Rigid and flexible couplings. **DESIGN OF TEMPORARY AND PERMANENT JOINTS:** Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints Butt, Fillet and parallel transverse fillet welds – welded joints subjected to bending, torsional and eccentric loads, riveted joints for structures - theory of bonded joints.	8
3	**DESIGN OF ENERGY STORING ELEMENTS AND ENGINE COMPONENTS** Types of springs, design of helical and concentric springs–surge in springs, Design of laminated springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines-- Solid and Rimmed flywheels-connecting rods and crank shafts.	7
4	**DESIGN OF BEARINGS AND MISCELLANEOUS ELEMENTS**:Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi & Boyd graphs, -- Selection of Rolling Contact bearings –Design of Seals and Gaskets.	7

Text Books:

1. Bhandari V B, "Design of Machine Elements", 4th Edition , Tata McGraw-Hill Book Co, 2016
2. Joseph Shigley, Richard G. Budynas and J. Keith Nisbett "Mechanical Engineering Design", 10th Edition, Tata McGraw-Hill , 2015

Syllabus
Semester- III

Course code: SCR41MMP201		**Course name:** Practical based on Mobile Robotics
Course category: Major Mandatory		
Credits: 1	**Teaching Scheme:** L-0 P-2	**Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.		
Course Objectives:		
Compute the Mobile Robotics parameters for simple problems		
Course Outcomes: Upon completion of this course, the students will be able to:		
CO1: This course aims to familiarize students with basic terminologies of the Mobile Robotics		
CO2: It also aims to inculcate thorough understanding about basic terminologies, grippers, sensors, actuators and robot kinematic		
CO3: Essential knowledge to be acquainted in the field of Robotics		
CO4: Implement it practically.		

Contents -

Sr. No.	Description of Practical	Practical hours
1	**Robot Locomotion**:Understand different types of locomotion, including hopping robots, legged robots, and wheeled robots,Study stability, maneuverability, and controllability of mobile robots.	10
2	**Mobile Robot Kinematics and Dynamics**:Dive into forward and inverse kinematics, Explore holonomic and nonholonomic constraints,Model simple car and legged robots kinematically,Simulate dynamics of mobile robots.	
3	**Perception**: Learn about proprioceptive and exteroceptive sensors,Understand passive and active sensors,Explore performance measures for sensors,Study sensors like GPS, Doppler effect-based sensors, and vision-based sensors,Tackle uncertainty in sensing and filtering.	10
4	**Localization**: Estimate position using odometry. Represent beliefs.Explore probabilistic mapping and localization techniques (Markov, Bayesian, Kalman). Understand positioning beacon systems.	
5	**Introduction to Planning and Navigation**: Dive into path planning algorithms (A-star, Dijkstra, Voronoi diagrams). Explore probabilistic roadmaps (PRM) and rapidly exploring random trees (RRT).Study Markov Decision Processes (MDP) and stochastic dynamic programming (SDP).	10
6	**Robotics Project**: Engage in a semester-long project, Design, fabricate, and program a mobile robotic platform, Apply theoretical concepts practically.	

Text Books:
1."Basic Electrical and Electronics Engineering" Roland Siegwart and Illah R. Nourbakish, MIT Press, Cambridge 2004

Syllabus
Semester - III

Course code: SCR41MMP202 **Course name:** Practical Based on Sensors and Signal Processing **Course category:** Major Mandatory
Credits: 1 **Teaching Scheme:** L-0 P-2 **Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives:
1. The practical component of this course involves hands-on experience with various sensors and signal processing techniques. Here are some key areas covered in practical sessions
2. Compute the Sensors and Signal Processing for simple problems
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: practical sessions provide a hands-on understanding of the theoretical concepts covered in the course
CO2: This course aims to familiarize students with basic terminologies of the Sensors and Signal Processing

Contents -

Sr. No	Description of Practical	Practical hours
1	**Signal Conditioning and Measurement:** Understand how to interface sensors with microcontrollers or data acquisition systems, Implement signal conditioning circuits (amplification, filtering, etc.) for accurate measurements.	10
2	**Data Acquisition and Processing**: Work with data acquisition boards or microcontrollers to collect sensor data. Process acquired signals using software tools (MATLAB, Python, etc.). Explore techniques like filtering, noise reduction, and feature extraction.	
3	**Sensor Calibration and Testing**: Calibrate sensors to ensure accurate measurements, Perform experiments to validate sensor characteristics (linearity, sensitivity, etc.)	10
	Real-world Applications: Apply signal processing techniques to real-world scenarios, Design and implement sensor-based systems (e.g., temperature monitoring, motion detection).	
4	**Project Work**: Engage in practical projects related to sensors and signal processing. Develop sensor-based applications or prototypes.	10

Text Books:
1. E. O. Doebelin, 'Measurement Systems – Applications and Design ', Tata McGraw Hill, edition 1992.
2.A. K. Sawhney, A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co (P) Ltd, 2004.
Reference Books:
1. Beckwith, Marangoni and Lienhard, 'Mechanical Measurements', Addison – Wesley, 5th Edition, 2000.
2. D. Roy Choudry, Sheil Jain, ' Linear Integrated Circuits', New Age International Pvt. Ltd., 2000.
3. Patranabis. D, "Sensors and Transducers", 2nd edition PHI, New Delhi, 2003.

Syllabus
Semester- III

Course code: SCR41VSP201 **Course name:** Computational Methods for Robotics **Course category:** Vocational Skill Course
Credits: 2 **Teaching Scheme:** L-0 P-4 **Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives:
This course aims to teach the detailed functioning Computational Methods for Robotics
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: Linear equations (Gauss Elimination, Jacobi method etc)
CO2: Non-linear equations (Newton-Raphson method, Fixed point method etc)

Contents -

Sr. No.	Description of Practical	Practical hours
1.	Linear equations Gauss Elimination Using Python	4
2.	Linear system using Gaussian elimination with pivoting Using Python	4
3.	Linear equations Jacobi method Using Python	4
4.	Non-linear equations Newton-Raphson method Using Python	4
5.	Non-linear equations Fixed point method Using Python	4
6.	Interpolation Cubic Splines Using Python	4
7.	Interpolation Polynomial fit Using Python	4
8.	Integration Euler Integration Using Python	4
9.	Integration Trapezoidal method Using Python	4
10.	Differential equation Runge-Kutta method	4
11.	Differential equation Finite difference method	4
12.	Project	16

Text Books:
1. Mark W. Spong et al, “Robot Modeling and Control”, 2nd Ed.
2. C. T. Chen, “Linear System Theory and Design”, 3rd Ed.
3. Gilbert Strang, “Introduction to Linear Algebra”, 5th Ed.
4. Timmy Siauw et al, “An Introduction to MATLAB® Programming and Numerical Methods for Engineers”.
Reference Books:
1 Stephen Boyd et al, “Convex Optimization” 6. T6: Dimitri P. Bertsekas, “Nonlinear programming”, 3rd Ed.

Semester: FOURTH

Syllabus
Semester - IV

Course code: SCR41MML204	**Course name:** Actuators and Drives Course	
Course category: Major Mandatory		
Credits: 2	**Teaching Scheme:** L-2 P-0	**Evaluation Scheme**: CA-30 ESE-20
Pre-requisites: Pre-university mathematics.		
Course Objectives:		
To familiarize a relay and power semiconductor devices, knowledge on drive characteristics, knowledge on DC motors and drives and obtain the knowledge on AC motors and drives.		
Course Outcomes: Upon completion of this course, the students will be able to:		
CO1: Recognize the principles and working of relays, drives and motors.		
CO2: Explain the working and characteristics of various drives and motors.		
CO3: Apply the solid state switching circuits to operate various types of Motors and Drivers.		
CO4: Interpret the performance of Motors and Drives. CO 5: Suggest the Motors and Drivers for given applications		

Contents

Unit	Content	Teaching Hours
1	**RELAY AND POWER SEMI-CONDUCTOR DEVICES** Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT-: SCR, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits	8
2	**DRIVE CHARACTERISTICS** Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor.	8
3	**DC MOTORS AND DRIVES** DC Servomotor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control – Drives- H bridge - Single and Three Phases – 4 quadrant operation – Applications	7
4	**AC MOTORS AND DRIVES** Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control, Stepper and servo motor.	7

Text Books:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012
2. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S. Chand & Co. Ltd., New Delhi, 2016.

Syllabus
Semester - IV

Course code: SCR41MML205	**Course name** Robotics and Control	
Course category: Major Mandatory		
Credits: 2	**Teaching Scheme:** L-2 P-0	**Evaluation Scheme**: CA -30 ESE-20
Pre-requisites: Pre-university mathematics.		
Course Objectives:		
To know the basic terminologies, classification, configurations and components of serial manipulator, To understand the mechanical design and robot arm kinematics. To learn and understand the various linear control techniques on manipulators, To learn and understand the various non-linear control techniques on manipulators.		
Course Outcomes: Upon completion of this course, the students will be able to:		
CO1: Understand the basics of Industrial Robotics and Control		
CO2: Create the kinematic solutions for the serial manipulators		
CO3: Analyze linear control of manipulators.		
CO4: Analyze non-linear control of manipulators		

Contents -

Unit	Content	Teaching hours
1	**INTRODUCTION** Definition – Robot anatomy – Classification - Geometrical configurations, wrist and its motions - End effectors and its type - links and joints. Robot drive system: – Hydraulic, Electric and pneumatic drive system, Resolution, accuracy and repeatability, Advantage and disadvantage of drive system. - Robot actuation and Feedback component – position, velocity sensors – Robotic vision	8
2	**ROBOT ARM KINEMATICS** Introduction – Matrix representation Homogeneous transformation, forward and inverse – Kinematic equations, Denvit – Hartenberg representations – Inverse Kinematic relations. Fundamental problems with D-H representation, differential motion and velocity of frames – Jacobian, Differential Charges between frames: **ROBOT DYNAMICS AND TRAJECTORY PLANNING** Lagrangeon mechanics, dynamic equations for sing, double and multiple DOF robots – static force analysis of robots, Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning	8
3	**NONLINEAR CONTROL OF MANIPULATORS** Introduction - nonlinear and time - varying systems - multi-input, multi-output control systems - the control problem for manipulators - practical considerations - current industrial-robot control systems - Lyapunov stability analysis – Cartesian - based control systems - adaptive control.	7
4	**ROBOT PROGRAMMING AND APPLICATIONS** Lead through Programming, Robot programming Languages - VAL Programming - Motion Commands, Sensor Commands, End Effector commands and simple Programs – Applications: Robotic Surgery - Manufacturing Industries - Material Handling, Assembly, Inspection - Space – Underwater – Nuclear industry – Humanoid Robots.	7

Text Books:
1. John J. Craig, "Introduction to Robotics – Mechanics and control", 3rd edition, Prentice hall, 2005.
2. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int., 1986.
Reference Books:
1. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
2. Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 2nd edition, John Wiley & sons, Inc., 2011

Syllabus
Semester - IV

Course code: SCR41MML206	**Course name** Industrial Process Automation	
Course category: Major Mandatory		
Credits: 2	**Teaching Scheme:** L-2 P-0	**Evaluation Scheme**: CA-30 ESE-20
Pre-requisites: Pre-university mathematics.		
Course Objectives:		
1. To educate on design of signal conditioning circuits for various applications. 2. To Introduce signal transmission techniques and their design. 3. Study of components used in data acquisition systems interface techniques 4. To educate on the components used in distributed control systems		
Course Outcomes: Upon completion of this course, the students will be able to:		
CO1: Design a signal conditioning circuits for various application.		
CO2: Acquire a detail knowledge on data acquisition system interface and DCS system.		
CO3: Understand the basics and Importance of communication buses in applied automation Engineering.		
CO4: Ability to design PLC Programs by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.		

Contents

Unit	Content	Teaching hours
1	**INTRODUCTION** Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus **AUTOMATION COMPONENTS** Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.	8
2	**COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS** Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.	8
3	**PROGRAMMABLE LOGIC CONTROLLERS** Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.	7
4	**DISTRIBUTED CONTROL SYSTEM** Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.	7

Text Books:
1. John W. Webb and Ronald A. Reis, “Programmable Logic Controllers: Principles and Applications”, 5th Edition, Prentice Hall Inc., New Jersey, 2003.
Reference Books:
1. Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw- Hill, New York, 2016.
2. Krishna Kant, “Computer - Based Industrial Control”, 2nd Edition, Prentice Hall, New Delhi, 2011
3. Gary Dunning, Thomson Delmar, “Programmable Logic Controller”, Ceneage Learning, 3 rd Edition,2005.

Syllabus
Semester - IV

Course code: SCR41MMP203 **Course name:** Practical based on Actuators and Drives **Course category:** Major Mandatory
Credits: 1 **Teaching Scheme:** L-0 P-2 **Evaluation Scheme**: CA-30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives:
1. To familiarize a relay and power semiconductor devices
2. To get a knowledge on drive characteristics
3. To obtain the knowledge on DC motors and drives
4. To obtain the knowledge on AC motors and drives
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: Recognize the principles and working of relays, drives and motors.
CO2: Explain the working and characteristics of various drives and motors.
CO3: Apply the solid state switching circuits to operate various types of Motors and Drivers.

Contents -

Sr. No	Description of Practical	Practical hours
1	Practical based on RELAY AND POWER SEMI-CONDUCTOR DEVICES	8
2	Practical's based on Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor.	8
3	Practical's based on DC Servomotor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control – Drives- H bridge - Single and Three Phases – 4 quadrant operation – Applications	7
4	Practical's based on Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control. Practical's based on STEPPER AND SERVO MOTOR	7

Text Books:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2016.

Syllabus
Semester - IV

Course code: SCR41MMP204 **Course name:** Practical Based on Robotics and Control **Course category:** Major Mandatory
Credits: 1 **Teaching Scheme:** L-0 P-2 **Evaluation Scheme**: CA -30 ESE 20
Pre-requisites: Pre-university mathematics.
Course Objectives:
Compute the electric circuit parameters for simple problems
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: For more comprehensive information, refer to the official syllabus provided by your educational institution or the relevant course coordinator
CO2: To grasp the principles of robot motion, including forward and inverse kinematics
CO3: To acquire programming skills specific to robotics

Contents -

Sr. No	Description of Practical	Practical hours
1	Practical's based on Study of forward and inverse kinematics. Differential kinematics for designing robots and their controllers. Familiarization with the coordinate system, motion programming parameters, and application-based dedicated commands. Optimizing robot operation processes.	10
2	Practical's based Automatic Control Systems: Understanding control system principles and applications. Medical Robots: Exploring the use of robots in medical applications.	10
3	Practical's based Nonlinear Control Systems: Concepts related to nonlinear control systems. Wireless Sensor Networks: Basics of wireless sensor networks and their relevance in robotics.	10

Text Books:

1. John J. Craig, "Introduction to Robotics – Mechanics and control", 3rd edition, Prentice hall, 2005.
2. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int., 1986.

Reference Books:

1. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
2. Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 2nd edition, John Wiley & sons, Inc., 2011

Syllabus
Semester- IV

Course code: SCR41SEP201 **Course name:** Optimization Techniques for Robots **Course category:** Skill Enhancement Course
Credits: 2 **Teaching Scheme:** L-0 P-4 **Evaluation Scheme**: CA-30 ESE-20
Pre-requisites: Pre-university mathematics.
Course Objectives:
To help robots to find the best or most efficient solution to a problem, subject to some constraints or criteria.
Course Outcomes: Upon completion of this course, the students will be able to:
CO1: Solve problems that involve maximizing or minimizing a linear function of several variables, such as allocating resources, scheduling tasks, or designing systems.
CO2: Evaluate and generate solutions by combining and mutating existing ones, such as finding optimal shapes, structures, or parameters
CO3: Design Intelligent and natural or artificial systems, such as ants, bees, or robots, and coordinate their actions to achieve a common goal, such as exploring, searching, or clustering.

Contents -

Sr. No	Description of Practical	Practical hours
1.	Implementation of Simplex Algorithm using python	5
2.	Implementation of The Ellipsoid Algorithm using python	5
3.	Implementation of Interior-Point Algorithms using python	5
4.	Implementation of Optimization Problem using GA using python	5
5.	Implementation of Ant Colony Optimization using python	5
6.	Implementation of Artificial Bee Colony Algorithm using python	5
7.	Implementation of Crow Search Algorithm using python	5
8.	Implementation of Bat Algorithm using python	5
9.	Implementation of Cockroach Swarm Optimization using python	5
10.	Project	15

Text Books:

1. Hands-On Genetic Algorithms with Python: Applying genetic algorithms to solve real-world deep learning and artificial intelligence problems, Eyal Wirsansky First Ed 2020
2. Mixed Integer Linear Programming with Python, Haroldo G. Santos, Coin, 2020
3. Swarm Intelligence By Russell C. Eberhart, Yuhui Shi, James Kennedy
4. ROBOTICS AND AUTOMATION HANDBOOK, EDITED BY Thomas R. Kurfess Ph.D., P.E. 2005

References book:

1. Modern Robotics By Kevin M. Lynch, Frank C. Park 2017

Semester: FIFTH

Syllabus
Semester - V

Course code: SCR41MML301	**Course name:** Microcontrollers and embed system
Course category: Major Mandatory	
Credits: 2	**Teaching scheme**: L-2 P-0 **Evaluation scheme:** CA-30 ESE-20
Pre-requisites: Foundational Programming Skills, Basic Electronics Knowledge, Computer Architecture Basics, Interest and Curiosity.	
Course Objectives: To provide fundamental operating concepts of microprocessors and microcontrollers.	
Course Outcomes: At the end of the course, the students will be able to –	
CO1: Distinguish various types of processor architectures.	
CO2: Describe architecture, memory organization of 8085 and 8051	
CO3: Create sketches, libraries and Arduino development environment.	
CO4: Design Raspberry Pi hardware and implement program.	

Contents-

Unit	Content	Teaching hours
1	**Arduino:** Introduction to the Arduino, creating an Arduino programming Environment, Arduino IDE, creating an Arduino program, Arduino Libraries, Analog and Digital Interfacing, Adding Interrupts, communicating with devices and sensors.	6
2	**Raspberry Pi:** Introduction to the Raspberry Pi, basic functionality of the Raspberry Pi board and its processor, setting and configuring the board, programming on Raspberry Pi, python programming environment, python expressions, general purpose IO pins, Protocol pins, RPi, GPIO library, communicating with devices and sensors.	8
3	**Fire Bird**: V ATMEGA2560, Fire Bird V Block Diagram, Fire Bird V ATMEGA2560 technical specification, Programming the Fire Bird V ATMEGA2560 Robot,	8
4	ATMEGA2560 microcontroller pin configuration, PC Based Control Using Serial Communication, Robot Control using 'GUI' for Fire Bird V ATMEGA2560, Hardware Description	8

Reference Books:

1. fire-bird-v-atmega2560-hardware-manual-2010-12-21
2. "Arduino Cookbook", Michael Margolis, O'Reilly Media, Inc., 1st Edition.
3. "Arduino for beginners: Essential Skills Every Maker Needs", John Baichtal, Person Education, Inc., 1st Edition.
4. "Raspberry Pi User Guide", Eben Upton and Gareth Halfacree, August 2016, 4th Edition, John Wiley & Sons.
5. "Programming with Raspberry Pi: Getting Started with Python", Simon Monk, January 2012, McGraw Hill Professional

Syllabus
Semester - V

Course code: SCR41MML302 **Course name:** Introduction to Machine Learning **Course category:** Major Mandatory
Credits: 2 **Teaching scheme**: L-2 P-0 **Evaluation scheme:** CA-30 ESE-20
Pre-requisites: Basic knowledge of Mathematics, Stastics and computer programming.
Course Objectives: Understand the fundamental concepts of machine learning
Course Outcomes: At the end of the course, the students will be able to –
CO1: Implement and evaluate supervised learning algorithms such as linear regression, logistic regression.
CO2: Identify machine learning techniques suitable for a given problem
CO3: Understand the Support Vector Machine and Neural Network
CO4: Understand the use of machine learning model for application

Contents-

Unit	Content	Teaching hours
1	**Introduction to Machine Learning:** Intelligent Machine, Machine Learning Problem, Applications, Data Representation, Domain Knowledge for Productive use of Machine Learning, Diversity of Data: Structured and Unstructured, Forms of Learning, Machine Learning and Data Mining.	6
2	**Descriptive Analytics:** Working with Data Frames in Python, Handling Missing Values, Exploration of Data using Visualization: Drawing Plots, Bar Chart, Histogram, Distribution or Density Plot, Box Plot, Comparing Distributions, Scatter Plot, Pair Plot, Correlation and Heatmap.	8
3	**Linear Regression**: Simple Linear Regression, Steps in Building a Regression Model, Building Simple Linear Regression Model, Model Diagnostics, Multiple Linear Regression	8
4	**Classification and Clustering:** Classification Overview, Binary Logistic Regression, Credit Classification, Gain Chart and Lift Chart, Classification Tree (Decision Tree Learning) Clustering, How Does Clustering Work? ,K-Means Clustering, Creating Product Segments Using Clustering, Hierarchical Clustering..	8

Text Books:
1**.** Applied Machine Learning , McGraw Hill Publication
Reference Books:
1. Machine Learning for Text, Charu C. Aggarwal, Springer.

Syllabus
Semester - V

Course code: SCR41MML303 **Course name:** Manufacturing Process **Course category:** Major Mandatory
Credits: 2 **Teaching scheme**: L-2 P-0 **Evaluation scheme:** CA-30 ESE-20
Pre-requisites: Basic Knowledge of Electronics.
Course Objectives: Develop an understanding of the materials used in robotic component fabrication and their properties.
Course Outcomes:
CO1: Understand various fabrication methods and their applications in the robotics field.
CO2: Understand the material behaviour and analyze its usages for different robotic components based on their properties
CO3 : Apply traditional manufacturing processes to fabricate robotic components accurately
CO4: Adopt additive manufacturing techniques for rapid prototyping and production of robotic components.

Contents-

Unit	Content	Teaching hours
1	**Materials for Robotic Components:** Material Selection for Robotic Components, Introduction to materials used in robotics (metals, polymers and composites), Material properties and their significance in robotic component design,Factors influencing material selection for specific applications. Metal Alloys and Composites: Overview of commonly used metal alloys in robotics, Properties and advantages of composite materials, Application areas and considerations for using composites in robotic components, Polymers and Elastomers, Properties and characteristics of polymers and elastomers, Use of polymers and elastomers in robotic component fabrication, Selection criteria and limitations of polymer-based materials.	6
2	**Introduction to Manufacturing Process:** Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Casting: Introduction to Casting process &steps involved. Various components produced by casting process, Advantages & Limitations. Patterns: Definition and types. Sand Moulding: Binders and Additives: **Definition, Need and Types**: Types of base sand, requirements of base sand. Types of Sand Moulding. Cores: Definition, Need and Types. Concept of Gating & Risers: Principle and types. Introduction to Die Casting and injection moulding. Introduction to metal working: Classification of metal working processes, characteristics of wrought products, advantages and limitations of metal working processes. Forging: Classification, Forging machines & equipment. Diedesign parameters. Forging defects, Residual stresses in forging, Applications of forging. Rolling: Classification, Types of rolling mills, Defects in rolled products. Rolling variables, Applications of Rolling. Drawing: Drawing equipment & dies, drawing variables, Tube drawing, classification of tube drawing, Application	8
3	**Extrusion:** Types of extrusion processes, extrusion equipment & dies, Extrusion of seamless tubes, lubrication & defects in extrusion, Extrusion variables, Applications. Sheet & Metal Forming: Forming methods dies & punches, progressive die, compound die, combination die., piercing, blanking, bending, deep	8

	drawing, defects of drawn products, stretch forming, Roll bending & contouring, Applications. Advanced Welding processes: Classification, Advantages &limitations of welding. Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding processes (AHW), Resistance welding, Applications.	
4	**Additive Manufacturing:** Introduction to Additive Manufacturing, Definition and principles of additive manufacturing, Various additive manufacturing technologies (3D printing, selective laser sintering, etc.), Benefits and limitations of additive manufacturing in robotics. **Additive Manufacturing Techniques:** Detailed study of different additive anufacturing processes, Materials used in additive manufacturing for robotic components, Design considerations and optimization for additive manufacturing, Applications of Additive Manufacturing in Robotics, Case studies showcasing the use of additive manufacturing in robotics, Rapid prototyping and customization possibilities with additive manufacturing, Future trends and advancements in additive manufacturing for robotics	8

Text Book

1. "Manufacturing Engineering and Technology" by Serope Kalpakjian and Steven R. Schmid. Kalpakjian, Serope. 6th edition in SI units Serope Kalpakjian Illinois Institute of Technology Steven R. Schmid The University of Notre Dame SI Conversion by Hamldon Musa Universiti Teknologi Malaysia Prentice Hall Singapore London." (2007).
2. "Materials Science and Engineering: An Introduction" by William D. Callister Jr. and David G. Rethwisch. 10th edition, John Wiley & Sons, 2020.
3. "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing" by Ian Gibson, David W. Rosen, and Brent Stucker. 2nd edition, Springer Publications 2015.

Reference Books:

1. Introduction to Robotics: Mechanics and Control Authors: John J. Craig.
2. Renfrew, Alasdair. "Introduction to robotics: Mechanics and control." International Journal of Electrical, Engineering & 4 (2004Education 41.): 388.

Online Reference:

1. Robotics Online (https://www.robotics.org/) Description: This website provides comprehensive resources related to robotics, including articles, industry news, and information on fabrication methods.
2. Video Lecture Series: MIT Open Course Ware - Introduction to Robotics (https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/)

Syllabus
Semester - V

Course code: SCR41MMP301 **Course name:** Practical Based on Microcontrollers and embed system **Course category:** Major Mandatory
Credits: 1 **Teaching scheme:** L-0 P-2 **Evaluation scheme:** CA-30 ESE-20
Pre requisites: Foundational Programming Skills, Basic Electronics Knowledge, Computer Architecture Basics, Interest and Curiosity.
Course Objectives: Explore Microcontrollers and embed system to control and automate specific tasks within a system.
Course Outcomes: At the end of the course, the students will be able to –
CO1: Give students a good foundation in Arduino programming and interfacing.
CO2: Install and configure the Arduino IDE on computer.

Contents-

Sr.No.	Description of Practical	Practical Hours
1	IDE Installation, Installing WIN AVR, Installing AVR Studio, Setting up Project in AVR Studio,	2
2	Write code in AVR Studio program will make robot's buzzer beep.	2
3	Installing Bootloader GUI on the PC,	2
4	Installing Bootloader GUI on the PC	2
5	Loading code on the robot using ATMEL's AVRISP mkII programmer	2
6	Robot control using ZigBee wireless communication module	2
7	Project	10

Reference Books:

1. fire-bird-v-atmega2560-hardware-manual-2010-12-21
2. "Arduino Cookbook", Michael Margolis, O'Reilly Media, Inc., 1st Edition.
3. "Arduino for beginners: Essential Skills Every Maker Needs", John Baichtal, Person Education, Inc., 1st Edition.
4. "Raspberry Pi User Guide", Eben Upton and Gareth Halfacree, August 2016, 4th Edition, John Wiley & Sons.
5. "Programming with Raspberry Pi: Getting Started with Python", Simon Monk, January 2012, McGraw Hill Professional

Syllabus
Semester - V

Course code: SCR41MMP302 **Course name:** Practical Based on Introduction Machine Learning **Course category:** Major Mandatory
Credits: 1 **Teaching scheme:** L-0 P-2 **Evaluation scheme:** CA-30 ESE-20
Pre requisites: Knowledge of fundamental concepts in computer programming, such as loops, conditionals, and functions.
Course Objectives: Explore machine learning techniques such as supervised learning, unsupervised learning, and reinforcement learning
Course Outcomes: At the end of the course, the students will be able to –
CO1: Understand the ethical implications and considerations in machine learning applications.
CO2: Develop critical thinking skills to select appropriate techniques for different problems.

Contents-

Sr.No.	Description of Practical	Practical Hours
1	Explore various analytics and machine learning use cases across different industries.	2
2	Working with DataFrames in Python using libraries such as Pandas.	2
3	Exploring data using visualization techniques: creating various plots such as bar charts, histograms, scatter plots, etc., using libraries like Matplotlib and Seaborn.	2
4	Reading Data Form CSV File.	2
5	Implement simple linear regression from scratch or using libraries like scikit-learn	2
6	Extend to multiple linear regression and compare the results.	2
7	Implement binary logistic regression for a classification task.	2
8	Implement K-Means clustering algorithm from scratch or using libraries like scikit-learn.	2
9	Use clustering to create product segments or customer segments from a given dataset.	2
10	Implement the K-Nearest Neighbors (KNN) algorithm for classification or regression tasks.	2
11	Project	10

Text Books:
1**.** Applied Machine Learning , McGraw Hill Publication
Reference Books:
1. Machine Learning for Text, Charu C. Aggarwal, Springer.

Syllabus
Semester - V

Course code: SCR41MEL301 **Course name**: Differential Equations And Numerical Methods **Course Category:** Major electives
Credits: 3 **Teaching scheme:** L-3 P-0 **Evaluation scheme:** CA-60 ESE-40
Pre-requisites: Basic knowledge of mathematics**.**
Course Objectives:
To develop logical understanding of numerical computational technique.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Apply Numerical analysis which has enormous application in the field of computer Science.
CO2: Familiar with numerical solutions of nonlinear equations in a single variable.
CO3: Familiar with numerical integration and differentiation, numerical solution of ordinary Differential equations.
CO4: Understand least square curve Fitting and Numerical Integration.

Contents -

Unit	Content	Teaching hours
1	**Differential equations:** introduction ,order, degree ,types, ordinary differential equations ,First order linear differential equations ,Exact differential equations Equations reducible to exact equations – .	9
2	**Introduction**: Introduction to Numerical Computing, Numeric Data, Analog computing, digital computing, characteristics of numerical computing, computational environment, new trends in numerical computing.	9
3	**Approximation and Errors in computing :** Introduction, Significant digit, Inherent errors ,Numerical error modeling error, blunders, absolute and Relative error, Numerical solution of Transcendental Equation : Introduction, Definition Root of a function, Concept of iterative method, Search method for initial guess, bisection method, False position method, Newton Raphson method	9
4	**Interpolation I :** Definition, polynomial interpolation, Forward Differences, Backward differences Interpolation II :Newton-Gregory Forward Difference Interpolation Formula, Newton-Gregory Backward Difference Interpolation Formula, Newton's divided Difference Interpolation ,Lagrange's Interpolation.	9
5	**Least square curve Fitting :** Concept of best fit, criteria for best fit least square fit,fitting a straight line Numerical Integration: Introduction, Trapezoidal Rule, simpson's 1/3 Rule, Simpson's 3/8 Rule.	9

Text Books:

1. Numerical Methods, E. Balguruswamy, McGraw Hill Publication
2. Numerical Computational Methods, Dr. P.B. Patil, Narosa Publication House

Reference Books:

1. Introductory Methods of Numerical Analysis, S.S Sastry, PHI Publication
2. Fundamental of Numerical Computation, Tobin A. Driscoll and Richard J. Braun,2017

Syllabus
Semester - V

Course code: SCR41MEL302 **Course name**: Probability and Statistics **Course category: -** Major Elective
Credits: 3 **Teaching scheme:** L-3 P-0 **Evaluation scheme:** CA-60 ESE-40
Pre-requisites: Programming Knowledge**,** knowledge of Mathematics concepts like probability, statistics, Calculus
Course Objectives:
To understand and handle the concept of Set theory& emphasis descriptive statistics, understand various statistical methods: measures of central tendency
Course Outcomes: At the end of the course, the students will be able to -
CO1: Understand and handle the concept of Set & Probabilities
CO2: Understand the elementary statistical methods.
CO3: Analyze the data to represent it graphically
CO4: Understand tabulate and interpret data it to generate information in descriptive form.

Contents -

Unit	Content	Teaching hours
1	**Sets and Probabilities:** Fundamental concepts of set theory,types of sets,combination of sets, Finite &infinite sets, Probaility,Discrete Probability, Conditional Probability,Independent events.	9
2	**Statistical Methods**: Definition, scope and importance of Statistics, concepts of statistical population and sample. Data & Types of data: Primary and Secondary data, qualitative & quantitative data Classification	9
3	**Tabulation and Graphical Representation:** Preparation of Tables, Presentation of Data: Variable, Random Variable, Frequency, And Frequency Distribution. Diagrammatic representation of Measures of Skewness and Kurtosis: Data: Line and Bar Diagram, Histogram, Component Bar diagram Pie Chart, Line Graph, Frequency polygon.	9
4	**Measures of Central Tendency:** Characteristics of Good measure of Central Tendency. Concept of central tendency- for Group and Ungroup data. Mean, Arithmetic mean (A.M.): simple and weighted Merits and demerits example Geometric mean (G.M.): computation for G M, Merits demerits and applications of G.M.	9
5	**Measures of Central Tendency** I Median: Definition, Median for grouped and ungrouped data, Properties and Merits & demerits. Mode: Definition, Mode for grouped & ungrouped data, Graphical Method for finding mode, Merits and demerits.	9

Text Books:
1. Discrete Mathematics : Dr Chandraashekhar Bemmbalkar II edition
2. Elements of DiscreteMathematics-A ComputerOriented ApproachC. L Liu,D.P.Mohapatra 3. TataMcGrawHill 3rdedition
4. Fundamental of Mathematical Statistics, S. C. Gupta & V. K. Kapoor, Sultan Chand & Sons publication
Reference Books:
1. Basic Statistics, B.L.Agarwal, New Age (P) Limited.Publication

Syllabus
Semester - V

Course code: SCR41MEP301 **Course name:** Practical based on Differential Equations And Numerical Methods **Course category:** Major Elective
Credits: 1 **Teaching scheme:** L-0 P-2 **Evaluation scheme:** CA-30 ESE-20
Pre requisites: Basic knowledge of mathematics.
Course Objectives: To develop logical understanding of numerical computational technique.
Course Outcomes: At the end of the course, the students will be able to –
CO1: Apply Numerical analysis which has enormous application in the field of computer Science.
CO2: Familiar with numerical solutions of nonlinear equations in a single variable.
CO3: Familiar with numerical integration and differentiation, numerical solution of ordinary Differential equations.
CO4: Understand least square curve Fitting and Numerical Integration**.**

Contents-

Sr.No.	Description of Practical	Practical Hours
1	Analysis of different Numerical Computational Technique.	2
2	Implementation of Program in C++ for representation of, Bisection	2
3	To develop program in C ++ for representation of, False Position Method	2
4	To develop Program in C ++ for representation of, Newton-Raphson Method.	2
5	Implementation of Program in C++ for representation of, addition of two Matrices	2
6	To develop Program in C ++ for representation of, Matrix Inverse Method	2
7	Implementation of Program in C++ for representation of, Newton-Gregory Forward Difference Interpolation Formula.	2
8	To develop Program in C++ for representation of, Newton-Gregory Backward Difference Interpolation Formula.	2
9	To develop Program in C++ for representation of Newton's Divided Difference Interpolation	2
10	Implementation of Program in C for representation of Lagrange's Interpolation	2

Text Books:
1**.** Numerical Methods, E. Balguruswamy, McGraw Hill Publication
2. Numerical Computational Methods, Dr. P.B. Patil, Narosa Publication House
Reference Books:
1. Introductory Methods of Numerical Analysis, S.S Sastry, PHI Publication
2. Fundamental of Numerical Computation,Tobin A. Driscoll and Richard J. Braun,2017

Syllabus
Semester - V

Course code: SCR41MEP302 **Course name:** Practical based on Probability and Statistics **Course category:** Major Elective
Credits: 1 **Teaching scheme:** L-0 P-2 **Evaluation scheme:** CA-30 ESE-20
Pre requisites: Programming Knowledge, knowledge of Mathematics concepts like probability, statistics, Calculus
Course Objectives: To understand and handle the concept of Set theory& emphasis descriptive statistics, understand various statistical methods: measures of central tendency
Course Outcomes: At the end of the course, the students will be able to –
CO1: Understand and handle the concept of Set & Probabilities
CO2: Understand the elementary statistical methods.
CO3: Analyze the data to represent it graphically
CO4: Understand tabulate and interpret data it to generate information in descriptive form.

Contents -

Sr.No.	Description of Practical	Practical Hours
1	Any 10 Practical based on Theory Syllabus	30

Syllabus
Semester - V

Course code: SCR41VSP301 **Course name:** Manufacturing Process **Course category:** Vocational Skill Course		
Credits: 2	**Teaching scheme:** L-0 P-4	**Evaluation scheme:** CA-30 ESE-20
Pre requisites: Basic Electronics Knowledge		
Course Objectives: To efficiently and effectively produce robots that meet specific design requirements and performance standards		
Course Outcomes: At the end of the course, the students will be able to –		
CO1: Students will be able to design and fabricate basic robot components		
CO2: Students will be able to assemble and integrate different robot components into a functional robot system		

Contents -

Sr. No.	Description of Practical	Practical Hours
1	Fabrication Method Demonstration: Conduct hands-on demonstrations of different fabrication methods, such as welding, milling, 3D printing, and laser cutting, to help students understand the practical aspects.	10
2	Material Selection Exercise: Assign students a project where they have to analyze the requirements of a robotic component and select the most suitable material based on its properties.	10
3	Traditional Manufacturing Case Study: Present a case study of a real-world robotic component manufacturing process and discuss the challenges faced and the solutions employed in the industry.	10
4	Additive Manufacturing Workshop: Organize a workshop where students can experiment with additive manufacturing techniques like fused deposition modeling (FDM) or stereo lithography (SLA) to create robotic component prototypes.	10

Semester: SIXTH

Syllabus
Semester - VI

Course code: SCR41MML304 **Course name:** Micro-Robotics **Course category:**Major Mandatory		
Credits: 2	**Teaching scheme:** L-2 P-0	**Evaluation scheme:** CA–30 ESE–20
Pre-requisites: Basic knowledge of robotics, MEMS, control systems, and micro fabrication techniques.		
Course Objectives: The course covers the fundamental concepts, design methodologies, fabrication techniques, and applications of microrobots.		
Course Outcomes: After completion of the course the student will be able to :		
CO1: Understand the principles of microrobotics and their applications		
CO2: Learn about the design and fabrication techniques for microrobots.		
CO3: Explore the control and actuation mechanisms for microrobots		

Contents -

Unit	Topics to be covered	Teaching hours
1.	**Introduction to Microrobotics**: Definition and scope of microrobotics, Historical development and milestones, Applications in medicine, manufacturing, and environmental monitoring **Scaling Laws in Microrobotics**: Scaling effects on physical forces, implications for design and control. **Materials for Microrobotics**: Properties of materials at the micro and nano scales, smart materials, biocompatible materials for medical applications, fabrication techniques for micro-scale material	10
2.	**Microfabrication Techniques:** Photolithography and soft lithography, micro-electro-mechanical systems (MEMS) fabrication, 3D printing and additive manufacturing at the micro scale, self-assembly and biofabrication techniques Actuation Mechanisms in **Microrobotics**: Electrostatic, electromagnetic, and piezoelectric actuation, thermal and shape memory alloy actuation, chemical and biological actuation, comparison of actuation methods and their applications	10
3	**Sensing and Control in Microrobotics:** Microsensors, Feedback control systems for microrobots, autonomous navigation and swarm intelligence, challenges in real-time control and sensing at the micro scale **Power and Energy Management:**Energy sources for microrobots, power consumption and efficiency, wireless	10

Text Books:
1. Micro- and Nanorobotics: Fundamentals and Applications" by Toshio Fukuda, Fumihito Arai, and Lixin Dong, 2nd Edition.
2. Microbiorobotics, Biologically Inspired Microscale Robotic Systems, by Minjun Kim, AnakAgung Julius, U Kei Cheang2nd Edition
Reference Books:
1. Introduction to Microelectromechanical Systems (MEMS), by NadimMaluf and Kirt Williams. 2nd Edition.
2. MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering by Tai-Ran Hsu. 2nd Edition.
Online Resources:
1. https://www.classcentral.com/course/engineering-eth-zurich-microrobotics-349976
2. https://academy.universal-robots.com/free-e-learning/?utm_source=chatgpt.com

Syllabus
Semester - VI

Course code: SCR41MML305	**Course name:** Industrial Internet of Things	
Course category: Major Mandatory		
Credits: 2	**Teaching scheme:** L-2 P-0	**Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Basics of Computer Networks and Mobile Computing		
Course Outcomes: After completion of the course the student will be able to :		
CO1: To understand the concepts of network and sensor		
CO2: To understand the MAC and transport protocols for ad hoc networks.		
CO3: To understand the security of sensor networks.		
CO4: To understand the applications of adhoc and sensor networks.		

Contents -

Unit	Topics to be covered	Teaching hours
1	**Foundation of IIoT:** Introduction & concepts: definition and characteristics of IoT, block diagram, IoT enabling technologies, IoT levels **Operating Systems for IoT:** Introducing Micropython: Micropython Features, Micropython Limitations, Introduction & Features Windows 10 Iot Core **IoT Networking** Connectivity Technologies, Introduction, IEEE 802.15.4, ZigBee, 6LoWPAN, RFID, HART and Wireless HART, NFC, Bluetooth, Z-Wave, ISA 100.11A. 8	10
2	**Wireless Sensor Network:** Introduction, Components of Sensor Node, Modes of Detection, Challenges in WSN. UAV Network: Introduction, UAV Network (Feature, Challenges and Topology) FANET: Introduction, FANET design consideration. **Application of IoT:** Smart Homes Introduction, Origin of Smart Homes, Smart Home ,Technologies. Smart Cities Characteristics of Smart Cities, Smart City Framework, Challenges in Smart Cities. Connected Vehicles Introduction, levels of Automation, Vehicle to Everything(V2X) Paradigm, Vehicular Ad-hoc Network (VANETs)	10
3	**Ad-hoc & Sensor Networks for IoT** Introduction to Ad Hoc Networks - Characteristics of MANETs, Applications of MANETs and Challenges of MANETs. Routing in MANETs - Criteria for classification,Taxonomy of MANET routing algorithmsroducing Micropython: Mpython: Micropython Features, Micropython Limitationsntroducing Micropython:thon **IoT Communication Protocols** 5G and IoT Technologies, Wireless Sensor Networks: Introduction, Sensor Network Architecture, Data, Dissemination, Data Gathering, MAC Protocols for Sensor Networks, Location, Discovery, Quality of a Sensor Network, Evolving Standards, Other Issues,Operating Systems for IoTems for IoT	10

Syllabus
Semester - VI

Course code: SCR41MML306 **Course name:** Introduction to Deep Reinforcement Learning **Course category:** Major Mandatory	
Credits: 2	**Teaching scheme:** L-2 P-0 **Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Basic knowledge about Machine Learning and Python Programming	
Course Objectives: Students will be able to design, implement, and optimize reinforcement learning agents using OpenAI Gym, Gymnasium, and PyTorch.	
Course Outcomes: After completion of the course the student will be able to :	
CO1: Understand the Foundations of Reinforcement Learning (RL)	
CO2: Develop and Implement RL Agents Using OpenAI Gym & Gymnasium	
CO3: Apply Deep Learning Techniques for RL with PyTorch	
CO4: Explore Advanced RL Methods and Real-World Applications	

Contents -

Unit	Topics to be covered	Teaching hours
1.	**Foundations of Deep Reinforcement Learning** **Introduction to Reinforcement Learning (RL):** Definition and key concepts, Differences between Supervised, Unsupervised, and Reinforcement Learning, Applications of RL in real-world scenarios **Complications in RL :** Exploration vs. Exploitation dilemma, Temporal credit assignment problem, Curse of dimensionality **RL Formalisms :** Reward, The agent, environment, Actions and observations **Theoretical Foundations of RL:** Markov Decision Processes (MDP), The Markov Process, Markov Reward Process, Adding actions to MDP (Markov Decision Processes), Policies and value functions	6
2.	**Implementing RL with OpenAI Gym & Gymnasium Introduction to OpenAI Gym & Gymnasium:** The anatomy of an RL agent, Hardware and software requirements **Understanding the OpenAI Gym API:** Action space, Observation space, Environment interactions **Creating and Interacting with RL Environments :** Setting up an RL environment, CartPole session: Understanding dynamics, Implementing a random CartPole agent **Advanced Gym API Functionalities:** Wrappers for modifying environments, Rendering environments, Using additional wrappers for observation and action modifications	8
3	**Deep Learning with PyTorch for RL** **Introduction to PyTorch for RL:** Understanding Tensors and their operations, GPU acceleration for RL training **Gradients and Backpropagation :** Tensors and gradients in PyTorch, Automatic differentiation in PyTorch **Building Neural Networks for RL Agents:** Neural network building blocks in PyTorch, Custom layers for RL, Loss functions and optimizers for RL **Monitoring RL Training with TensorBoard:** Introduction to TensorBoard, Logging RL agent metrics	8

	Generative Adversarial Networks (GAN) in RL: Applying GANs to Atari game images, Using PyTorch Ignite for efficient training, GAN-based training workflow	
4	**Advanced RL Techniques –** **The Cross-Entropy Method & Beyond** **Taxonomy of RL Methods :** Model-free vs. Model-based RL , Policy-based vs. Value-based approaches **The Cross-Entropy Method (CEM) for RL:** Understanding CEM in practice, Implementing CEM for CartPole, CEM on FrozenLake environment **Theoretical Background of Cross-Entropy Method:** Importance sampling and optimization, Policy search with cross-entropy **Future Trends and Research in RL:** Deep Q-Networks (DQN) and Policy Gradient Methods, Advanced techniques like Proximal Policy Optimization (PPO) and Soft Actor-Critic (SAC), Real-world applications of DRL	8

Text Books:
1. "Deep Reinforcement Learning Hands-On" – Maxim Lapan
2. "Reinforcement Learning: An Introduction" – Richard S. Sutton & Andrew G. Barto
Reference Books:
1. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" – AurélienGéron
2. "Grokking Deep Reinforcement Learning" – Miguel Morales
3. "Deep Learning for Robotics" – RamviyasParasuraman&Anand Paul
4. "Foundations of Deep Reinforcement Learning" – Laura Graesser&Wah Loon Keng

Syllabus
Semester - VI

Course code: SCR41MMP303 **Course name:** Practical Based on Micro-Robotics **Course category:**Major Mandatory
Credits: 1 **Teaching scheme:** L-0 P-2 **Evaluation scheme:** CA–30 ESE–20
Pre-requisites: Basic knowledge of robotics, MEMS, control systems, and microfabrication techniques.
Course Objectives: To learn Simulating, designing, creating and assembling various microrobot terminologies and MEMS structure to build a microrobot project.
Course Outcomes: After completion of the course the student will be able to :
CO1: Simulation of microgripper, behavior of small robots on liquid surface, microrobot swarms, microrobot capable of targeted drug delivery.
CO2: Create and build electrostatic actuator, small robot using external magnetic fields and MEMS
CO3: Design and fabricatepressure or temperature sensor using MEMS techniques, swimming microrobot

Contents -

Sr.no.	Description of Experiment	Practical hours
1	Design a microgripper using CAD software and simulate its operation.	2
2	Study how surface tension affects small objects by observing the behavior of microspheres or small robots on a liquid surface.	2
3	Program a simulation of microrobot swarms using software like MATLAB or Python.	2
4	Create a simple electrostatic actuator and observe its motion.	2
5	Build a simple actuator using shape memory alloys (SMA) or piezoelectric materials	2
6	Create a small robot that can be controlled using an external magnetic field.	2
7	Create a basic MEMS structureusing photolithography.	2
8	Simulate or prototype a microrobot capable of targeted drug delivery.	2
9	Design a simple swimming microrobot inspired by bacterial flagella or fish tail	2
10	Fabricate a simple pressure or temperature sensor using MEMS techniques.	2
11	Project	2

Text Books:
1. Micro- and Nanorobotics: Fundamentals and Applications" by Toshio Fukuda, Fumihito Arai, and Lixin Dong, 2nd Edition.
2. Microbiorobotics, Biologically Inspired Microscale Robotic Systems, by Minjun Kim, AnakAgung Julius, U Kei Cheang2nd Edition
Reference Books:
1. Introduction to Microelectromechanical Systems (MEMS), by NadimMaluf and Kirt Williams. 2nd Edition.
2. MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering by Tai-Ran Hsu. 2nd Edition.
Online Resources:
1. https://www.classcentral.com/course/engineering-eth-zurich-microrobotics-349976 2. https://academy.universal-robots.com/free-e-learning/?utm_source=chatgpt.com

Syllabus
Semester - VI

Course code: SCR41MMP304 **Course name:** Practical Based on Industrial Internet of Things **Course category:** Major Mandatory
Credits: 1 **Teaching scheme:** L-0 P-2 **Evaluation scheme:** CA–30 ESE–20
Pre-requisites: Computer Networks, Mobile Computing.
Course Outcomes: After completion of the course the student will be able to :
CO1: To understand the concepts of network and sensor
CO2: To understand the MAC and transport protocols for ad hoc networks.
CO3: To understand the security of sensor networks.
CO4: To understand the applications of adhoc and sensor networks.

Contents -

Sr.no.	Description of Experiment	Practical hours
1	Any 10 Practical Based on Theory Syllabus	30

Syllabus
Semester VI

Course code: SCR41MEL303 **Course name**: - Introduction to Artificial Intelligence **Course Category:** Major Electives
Credits: 3 **Teaching scheme:** L-3 P-0 **Evaluation scheme:** CA-60 ESE-40
Pre-requisites: Programming Knowledge**,** knowledge of Mathematics concepts like probability, statistics, Calculus
Course Objectives:
1. To understand the basic concept of AI
2. To understand strength and weakness of problem solving and search algorithms.
3. To know about basic concepts of knowledge, and reasoning
Course Outcomes: At the end of the course, the students will be able to -
CO1: Able to evaluate Artificial Intelligence (AI) methods.
CO2: Describe their foundations.
CO3: Analyze and illustrate how search algorithms play vital role in problem solving, inference, perception, knowledge representation and learning.
CO4: Demonstrate knowledge of reasoning and knowledge representation for solving real world problems

Contents-

Unit	Content	Teaching hours
1	**Introduction to AI** Basic Definitions, History of AI, Overview of AI, Evolution of AI, Applications of AI, Classification of A, AI &related Fields Artificial Intelligence vs Machine learning.	9
2	**Concepts of knowledge and reasoning**: Introduction, types of, Knowledge in AI, DeclarativeProcedural,MetaHeuristic Structural,Knowledge,Applications of Knowledge Representation in AI,Reasoning in AI ,types of Reasoning in AI, Applications of Reasoning in AI	9
3	**Search algorithm in AI** Introduction Search Algorithm Terminologies, Importance of Search Algorithms Properties of Search Algorithms: Types of search algorithms**: uninformed (Blind search) search and informed search (Heuristic search) algorithms.**	9
4	**Uninformed (Blind search) search algorithm**, Introduction. **types of uninformed search algorithms** Breadth-first Search, Depth-first Search Depth-limited Search,Iterative deepening depth-first search, Uniform cost search, Bidirectional Search Advantage ,Disadvantage,Example	9
5	**Informed Search algorithm :** Introduction, Key Characteristics of Informed Search Algorithms, types of Informed Search algorithm**,** Greedy Best First Search, A* Algorithm Advantage & limitation, concepts of knowledge and reasoning	9

Text Books:
1. Artificial Intelligence and Expert System -Dan W. Patterson pearson Prentice hall
2. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall
Reference Books:
1. Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill.

Syllabus
Semester - VI

Course code: SCR41MEL304 **Course name**: Computational Geometry **Course Category:** Major Elective
Credits: 3 **Teaching scheme:** L-3 P-0 **Evaluation scheme:** CA-60 ESE-40
Pre-requisites: Basic knowledge of algorithms and data structures.
Course Objectives:
Ability to apply and expand geometric techniques in computing.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Exposure to algorithms and data structures for geometric problems
CO2: Exposure to techniques for addressing degenerate cases.
CO3: Exposure to randomization as a tool for developing geometric algorithms
CO4: a student will be able to effectively apply the techniques to specific application domains of interest or pursue independent research in this area.

Contents-

Unit	Content	Teaching hours
1	Computational Geometry - Introduction An Example: convex sets ,concave sets Convex Hulls ,Degeneracy and Robustness, Application Domains.	9
2	Voronoi diagram, Delaunay triangulation, Geometric Data Structures,Interval tree, Range tree, Segment tree. Complex numberssimplicial complex, Rips complex, alpha complex.	9
3	homology, Betti numbers, persistence homology, Morse functions, Reeb graph, approximation and fixed parameter algorithms for geometric problems - hitting set and set cover	9
4	Polygon Triangulation,Guarding and Triangulations ,Dual graph of triangulation, Ear clipping method ,Partitioning a Polygon into Monotone Pieces , Triangulating a Monotone Polygon	9
5	Epsilon nets, epsilon approximations, geometric intersection graphs, geometric discrepancy, clustering.	9

Text Books:
1.Computational Geometry: Algorithms and Applications, Mark de Berg et al., Third Edition, Springer, 2011
2. Computational Topology : An Introduction, Herbert Edelsbrunner and John L. Harer, Indian Edition, 2010.
Reference Books:
1. S.L. Devadoss and J. O'Rourke, Discrete and Computational Geometry, Princeton University Press, 2011.

Syllabus
Semester - VI

Course code: SCR41MEP303 **Course name**: - Introduction to Artificial Intelligence **Course Category:** Major Electives
Credits: 1 **Teaching scheme:** L-0 P-2 **Evaluation scheme:** CA-30 ESE-20
Pre-requisites: Programming Knowledge, knowledge of Mathematics concepts like probability, statistics, Calculus
Course Objectives:
1. To understand the basic concept of AI
2. To understand strength and weakness of problem solving and search algorithms.
3. To know about basic concepts of knowledge, and reasoning
Course Outcomes: At the end of the course, the students will be able to -
CO1: Able to evaluate Artificial Intelligence (AI) methods.
CO2: Describe their foundations.
CO3: Analyze and illustrate how search algorithms play vital role in problem solving, inference, perception, knowledge representation and learning.
CO4: Demonstrate knowledge of reasoning and knowledge representation for solving real world problems

Contents -

Sr.no.	Description of Practical	Practical hours
1	Any 10 practical based on theory syllabus	30

Text Books:
1. Artificial Intelligence and Expert System -Dan W. Patterson pearson Prentice hall
2. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall
Reference Books:
1. Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill.

Syllabus
Semester - VI

Course code: SCR41MEP304 **Course name:** Computational Geometry **Course category:**Major Mandatory
Credits: 1 **Teaching scheme:** L-0 P-2 **Evaluation scheme:** CA–30 ESE–20
Pre-requisites: Basic knowledge of algorithms and data structures.
Course Objectives: Ability to apply and expand geometric techniques in computing.
Course Outcomes: After completion of the course the student will be able to :
CO1: Exposure to algorithms and data structures for geometric problems.
CO2: Exposure to techniques for addressing degenerate cases.
CO3: Exposure to randomization as a tool for developing geometric algorithms
CO4: A student will be able to effectively apply the techniques to specific application domains of interest or pursue independent research in this area.

Contents -

Sr.no.	Description of Experiment	Practical hours
1	Program for Line Intersection	2
2	Program for Convex Hull	2
3	Program for Point in Polygon	2
4	Program for Voronoi Diagram	2
5	Program for Delaunay Triangulation	2
6	Program for Closest Pair of Points	2
7	Program for **Polygon Triangulation**	2
8	Program for **Geometric Median**	2
9	Program for Sweep Line Algorithm for Segment Intersection	2
10	Program for Geometric Transformation:scaling	2

Text Books:
1.Computational Geometry: Algorithms and Applications, Mark de Berg et al., Third Edition, Springer, 2011
2. Computational Topology : An Introduction, Herbert Edelsbrunner and John L. Harer, Indian Edition, 2010.
Reference Books:
1. S.L. Devadoss and J. O'Rourke, Discrete and Computational Geometry, Princeton University Press, 2011.