VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
B.E. in Robotics & Artificial Intelligence
Scheme of Teaching and Examinations2021
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2021 - 22)

III SEMESTER

Sl. No	Course and Course Code	Course Title	Department (TD) and Question Paper Setting Board	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	/	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	BSC 21MAT31	Transform Calculus, Fourier Series and Numerical Techniques	Maths	2	2	0		03	50	50	100	3
2	IPCC 21RI32	Manufacturing Technology	TD: ME PSB:ME	3	0	2		03	50	50	100	4
3	IPCC 21RI33	Analog & Digital Electronics Circuits	TD:ECE PSB: ECE	3	0	2		03	50	50	100	4
4	PCC 21RI34	Mechanics of Solids and Fluids	TD:ME PSB:ME	3	0	0		03	50	50	100	3
5	PCC 21RIL35	Machine Drawing and GD&T	TD:ME PSB:ME	0	0	2		03	50	50	100	1
6	UHV 21UH36	Social Connect and Responsibility	Any Department	0	0	1		01	50	50	100	1
7	HSMC 21KSK37/47	Samskrutika Kannada	TD and PSB: HSMC	1	0	0		01	50	50	100	1
	HSMC 21KBK37/47	Balake Kannada										
	OR											
	HSMC 21CIP37/47	Constitution of India and Professional Ethics										
8	AEC 21RI38X	Ability Enhancement Course - III	TD: Concerned department PSB: Concerned Board	If offered as Theory Course: 1	0	0		01	50	50	100	1
				If offered as lab. course: 0	0	2		02				
								Total	**400**	**400**	**800**	**18**

9	**Scheduled activities for III to VIII semesters**	NMDC 21NS83	National Service Scheme (NSS)	NSS	All students have to register for any one of the course namely National Service Scheme, Physical Education (PE)(Sports and Athletics) and Yoga with the concerned coordinator of the course during the first week of III semester.The activities shall be carried out from (for 5 semesters) between III semester to VIII semester. SEE in the above courses shall be conducted during VIII semester examinations and the accumulated CIE marks shall be added to the SEE marks. Successful completion of the registered course is mandatory for the award of the degree.
		NMDC 21PE83	Physical Education (PE)(Sports and Athletics)	PE	
		NMDC 21YO83	Yoga	Yoga	

					The events shall be appropriately scheduled by the colleges and the same shall be reflected in the colander prepared for the NSS, PE and Yoga activities.								
Course prescribed to lateral entry Diploma holders admitted to III semester B.E./B.Tech programs													
1	NCMC 21MATDIP31	Additional Mathematics - I	Maths	02	02	--	--	---	100	---	100	0	

Note:BSC: Basic Science Course, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course,**INT** –Internship, **HSMC:** Humanity and Social Science & Management Courses, **AEC**–Ability Enhancement Courses. **UHV:** Universal Human Value Course.

L –Lecture, **T –** Tutorial, P- Practical/ Drawing, **S –** Self Study Component, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Examination.**TD-** Teaching Department, **PSB**: Paper Setting department

21KSK37/47 Samskrutika Kannada is for students who speak, read and write Kannada and **21KBK37/47**Balake Kannada is for non-Kannada speaking, reading, and writing students.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practicals of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (BE/B.Tech.) 2021-22 may be referred.

21INT49 Inter/Intra Institutional Internship: All the students admitted to engineering programs under the lateral entry category shall have to undergo a mandatory 21INT49 Inter/Intra Institutional Internshipof 03 weeks during the intervening period of III and IV semesters. The internship shall be slated for CIE only and will not have SEE. The letter grade earned through CIE shall be included in the IV semester grade card.The internship shall be considered as a head of passing and shall be considered for vertical progression and for the award of degree. Those, who do not take up / complete the internship shall be declared fail and shall have to complete during subsequently after satisfying the internship requirements. The faculty coordinator or mentor shall monitor the students' internship progress and interact with them for the successful completion of the internship.

Non–credit mandatory courses (NCMC):

(A)Additional Mathematics I and II:

(1) These courses are prescribed for III and IV semesters respectively to lateral entry Diploma holders admitted to III semester of B.E./B.Tech., programs. They shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s to earn the qualifying CIE marks. These courses are slated for CIE only and has no SEE.

(2) Additional Mathematics I and II shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

(3) Successful completion of the coursesAdditional Mathematics I and IIshall be indicated as satisfactory in the grade card. Non-completion of the courses Additional Mathematics I and II shall be indicated as Unsatisfactory.

(B) National Service Scheme/Physical Education (Sport and Athletics)/ Yoga:

(1) Securing 40 % or more in CIE,35 % or more marks in SEE and 40 % or more in the sum total of CIE + SEE leads to successful completion of the registered course.

(2) In case, students fail to secure 35 % marks in SEE, they has to appear for SEE during the subsequent examinations conducted by the University.

(3) In case, any student fails to register for NSS, PE or Yoga/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have not completed the requirements of the course. In such a case, the student has to fulfill the course requirements during subsequent semester/s to earn the qualifying CIE marks.

(4) Successful completion of the course shall be indicated as satisfactory in the grade card. Non-completion of the course shall be indicated as Unsatisfactory.

(5) These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

Ability Enhancement Course – III			
21RI381	Introduction to PYTHON (0:0:2:0)	21RI383	Digital Society(1:0:0:0)
21RI382	Fundamentals of Virtual Reality APP Development (1:0:0:0)		

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IV SEMESTER

Sl. No	Course and Course Code	Course Title	Teaching Department (TD) and Question Paper Setting	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	/	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	BSC 21MEMAT41	Complex Analysis, Probability and Linear Programming	Maths	2	2	0		03	50	50	100	3
2	IPCC 21RI42	Measurement Systems	TD: ME PSB:ME	3	0	2		03	50	50	100	4
3	IPCC 21RI43	Microcontrollers	TD: ECE PSB:ECE	3	0	2		03	50	50	100	4
4	PCC 21RI44	Robot Kinematics, Dynamics and Control	TD: ME PSB:ME	3	0	0		03	50	50	100	3
5	AEC 21BE45	Biology for Engineers	BT, CHE, PHY	2	0	0		02	50	50	100	2
6	PCC 21RIL46	Robot Programming and Simulation Lab	TD: ME/IP PSB:ME/IP	0	0	2		03	50	50	100	1
7	HSMC 21KSK37/47	Samskrutika Kannada	HSMC	1	0	0		01	50	50	100	1
	HSMC 21KBK37/47	Balake Kannada										
	OR											
	HSMC 21CIP37/47	Constitution of India & Professional Ethics										
8	AEC 21RI48X	Ability Enhancement Course- IV	TD and PSB: Concerned department	If offered as theory Course: 1	0	0		01	50	50	100	1
				If offered as lab. course: 0	0	2		02				
9	UHV 21UH49	Universal Human Values	Any Department	1	0	0		01	50	50	100	1
10	INT 21INT49	Inter/Intra Institutional Internship	Evaluation By the appropriate authorities	Completed during the intervening period ofII and III semesters by students admitted to first year of BE./B.Tech and during the intervening period of III and IV semesters by Lateral entry				3	100	--	100	2

				students admitted to III semester.								
									Total	**550**	**450**	**1000**	**22**

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs													
1	NCMC 21MATDIP41	Additional Mathematics - II	Maths	02	02	--	--	--	100	--	100	0

Note: BSC: Basic Science Course, IPCC: Integrated Professional Core Course, PCC: Professional Core Course, AEC –Ability Enhancement Courses, HSMC: Humanity and Social Science and Management Courses, UHV- Universal Human Value Courses. L –Lecture, T – Tutorial, P- Practical/ Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

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Non – credit mandatory course (NCMC):

Additional Mathematics - II:

(1) Lateral entry Diploma holders admitted to III semester of B.E./B.Tech., shall attend the classes during the IV semester to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s to earn the qualifying CIE marks. These courses are slated for CIE only and has no SEE.

(2) Additional Mathematics I and II shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

(3) Successful completion of the course Additional Mathematics II shall be indicated as satisfactory in the grade card. Non-completion of the courses Additional Mathematics II shall be indicated as Unsatisfactory.

Ability Enhancement Course – IV			
21RI481	Spread Sheet for Engineers(0:0:2:0)	21RI483	Introduction to Augmented Reality(1:0:0:0)
21RI482	Introduction to AI and ML(1:0:0:0)		

Internship of 04 weeks during the intervening period of IV and V semesters; 21INT68 Innovation/ Entrepreneurship/ Societal based Internship.

(1) All the students shall have to undergo a mandatory internship of 04 weeks during the intervening period of IV and V semesters. The internship shall be slated for CIE only and will not have SEE. The letter grade earned through CIE shall be included in the VI semester grade card.The internship shall be considered as a head of passing and shall be considered for vertical progression and for the award of degree. Those, who do not take up / complete the internship shall be considered under F (fail) grade and shall have to complete during subsequently after satisfying the internship requirements.

(2) Innovation/ Entrepreneurship Internship shall be carried out at industry, State and Central Government /Non-government organizations (NGOs), micro, small and medium enterprise (MSME), Innovation centers or Incubation centers. Innovation need not be a single major breakthrough, it can also be a series of small or incremental changes. Innovation of any kind can also happen outside of the business world.

Entrepreneurship internships offers a chance to gain hands on experience in the world of entrepreneurship and helps to learn what it takes to run a small entrepreneurial business by performing intern duties with an established company. This experience can then be applied to future business endeavours. Start-ups and small companies are a preferred place to learn the business tack ticks for future entrepreneurs as learning how a small business operates will serve the intern well when he/she manages his/her own company. Entrepreneurship acts as a catalyst to open the minds to creativity and innovation. Entrepreneurship internship can be from several sectors, including technology, small and medium-sized, and the service sector.

(3) Societal or social internship. Urbanization is increasing on a global scale; and yet, half the world's population still resides in rural areas and is devoid of many things that urban population enjoy. Rural internship, is a work-based activity in which students will have a chance to solve/reduce the problems of the rural place for better living. As proposed under the AICTE rural internship programme, activities under Societal or social internship, particularly in rural areas, shall be considered for 40 points under AICTE activity point programme.

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V SEMESTER

Sl. No	Course and Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	Practical / Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	BSC 21RI51	Fundamentals of AI for robotics	TD: ME PSB:ME	3	0	0		03	50	50	100	3
2	IPCC 21RI52	Hydraulics and Pneumatics	TD: ME PSB:ME	3	0	2		03	50	50	100	4
3	PCC 21RI53	Natural Language Processing	TD: CSE PSB:CSE	3	0	0		03	50	50	100	3
4	PCC 21RI54	Robot Operating System	TD: CSE PSB:CSE	3	0	0		03	50	50	100	3
5	PCC 21RIL55	Virtual Instrumentation & automation Lab	TD: ME PSB:ME	0	0	2		03	50	50	100	1
6	AEC 21RI56	Research Methodology & Intellectual Property Rights	TD: Any Department PSB: As identified by University	2	0	0		02	50	50	100	2
7	HSMC 21CIV57	Environmental Studies	TD: Civil/ Environmental /Chemistry/ Biotech. PSB: Civil Engg	1	0	0		1	50	50	100	1
8	AEC 21RI58X	Ability Enhancement Course-V	Concerned Board	If offered as Theory courses: 1	0	0		01	50	50	100	1
				If offered as lab. courses: 0	0	2		02				
								Total	**400**	**400**	**800**	**18**

Ability Enhancement Course – V

21RI581	Medical Robots(1:0:0:0)		
21RI582	Basics of MATLAB(0:0:2:0)		

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L –Lecture, T – Tutorial, P- Practical/ Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

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may be referred.

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VI SEMESTER

Sl. No	Course and Course Code	Course Title	Department (TD) and Question Paper Setting Board	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	Practical / Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	HSMC 21RI61	Quality Control Process and Maintenance Management	Any Department	3	0	0		03	50	50	100	3
2	IPCC 21RI62	Computer Vision System	TD: CSE PSB:CSE	3	0	2		03	50	50	100	4
3	PCC 21RI63	Industry 4.0 and IIoT	TD: ECE PSB:ECE	3	0	0		03	50	50	100	3
4	PEC 21RI64x	Professional Elective Course-I		3	0	0		03	50	50	100	3
5	OEC 21RI65x	Open Elective Course-I	Concerned Department	3	0	0		03	50	50	100	3
6	PCC 21RIL66	Finite Element Analysis Lab	TD: ME PSB:ME	0	0	2		03	50	50	100	1
7	MP 21RIMP67	Mini Project		Two contact hours /week for interaction between the faculty and students.				--	100	--	100	2
8	INT 21INT68	Innovation/Entrepreneurship /Societal Internship	Completed during the intervening period of IV and V semesters.					--	100	--	100	3
								Total	**500**	**300**	**800**	**22**

Professional Elective – I

21RI641	Neural Network and Fuzzy Logic Systems	21RI643	Data Structure & Algorithm
21RI642	Micro robotics		

Open Electives – I offered by the Department to other Department students

21RI651	Fundamental of Robotics		
21RI652	Service Oriented Architecture		

Note: HSMC: Humanity and Social Science & Management Courses, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **PEC:** Professional Elective Courses, O**EC**–Open Elective Course, **MP** –Mini Project, INT –Internship. L –Lecture, T – Tutorial, P - Practical / Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching – Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by CIE only and there shall be no SEE. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (BE/B.Tech) 2021-22 may be referred.

Professional Elective Courses(PEC):

A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course out of five course. The minimum students' strength for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the programme is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled for the open electives offered by their parent Department. However, they can opt an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an open elective shall **not be allowed** if,

(i) The candidate has studied the same course during the previous semesters of the program.

(ii) The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.

(iii) A similar course, under any category, is prescribed in the higher semesters of the program.

In case, any college is desirous of offering a course (not included in the Open Elective List of the University) from streams such as Law, Business (MBA), Medicine, Arts, Commerce, etc., can seek permission, at least one month before the commencement of the semester, from the University by submitting a copy of the syllabus along with the details of expertise available to teach the same in the college.

The minimum students' strength for offering open electives is 10. However, this conditional shall not be applicable to cases where the admission to the programme is less than 10.

Mini-project work: Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications.

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for Mini-Project.

VII semester Classwork and Research Internship /Industry Internship (21INT82)

Swapping Facility

Institutions can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate research internship/ industry internship after the VI semester**.**

(2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year or later part of IV year of the program.

Elucidation:

At the beginning of IV year of the programme i.e., after VI semester, VII semester classwork and VIII semester Research Internship /Industrial Internship shall be permitted to be operated simultaneously by the University so that students have ample opportunity for internship. In other words, a good percentage of the class shall attend VII semester classwork and similar percentage of others shall attend to Research Internship or Industrial Internship.

Research/Industrial Internship shall be carried out at an Industry, NGO, MSME, Innovation centre, Incubation centre, Start-up, Centers of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations / institutes. The intership can also be rural internship.

The mandatory Research internship /Industry internship is for 24 weeks. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during the subsequent University examination after satisfying the internship requirements.

INT21INT82 Research Internship/ Industry Internship/Rural Internship

Research internship: A research internship is intended to offer the flavour of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

Rural internship: A long-term goal, as proposed under the AICTE rural internship programme, shall be counted as rural internship activity.

The student can take up Interdisciplinary Research Internship or Industry Internship.

The faculty coordinator or mentor has to monitor the students' internship progress and interact with them to guide for the successful completion of the internship.

The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of internship.

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Swappable VII and VIII SEMESTER

VII SEMESTER

Sl. No	Course and Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	Practical / Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	PCC 21RI71	Industrial Robotics	TD: ME PSB:ME	3	0	0		3	50	50	100	3
2	PCC 21RI72	Control Engineering	TD: ME/ECE PSB:ME/ECE	3	0	0		3	50	50	100	2
3	PEC 21RI73X	Professional elective Course-II	TD: ME/ECE PSB:ME/ECE	3	0	0		3	50	50	100	3
4	PEC 21RI74X	Professional elective Course-III	TD: ME/ECE PSB:ME/ECE	3	0	0		3	50	50	100	3
5	OEC 21RI75X	Open elective Course-II	Concerned Department	3	0	0		3	50	50	100	3
6	Project 21RIP76	Project work	TD: ME/ECE PSB:ME/ECE	Two contact hours /week for interaction between the faculty and students.				3	100	100	200	10
								Total	**350**	**350**	**700**	**24**

VIII SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	Seminar 21RI81		Technical Seminar	TD: ME/ECE PSB:ME/ECE	One contact hour /week for interaction between the faculty and students.				--	100	--	100	01
2	INT 21INT82		Research Internship/ Industry Internship	TD: ME/ECE PSB:ME/ECE	Two contact hours /week for interaction between the faculty and students.				03 (Batch wise)	100	100	200	15
3	NCMC	21NS83	National Service Scheme (NSS)	NSS	Completed during the intervening period of III semester to VIII				--	50	50	100	0
		21PE83	Physical Education (PE)	PE									

			(Sports and Athletics)		semester.					
		21YO83	Yoga	Yoga						
						Total	**250**	**150**	**400**	**16**

Professional Elective – II			
21RI731	TQM(Mechanical)		
21RI732	Data Mining & Data Ware House		

Professional Elective – III			
21RI741	Motors, Drives and Power Electronics (EEE/E&C)		
21RI742	Digital Image Processing (E&C/CSE)		

Open Electives - II offered by the Department to other Department students			
21RI751	Introduction to Mobile Robotics		
21RI752	Introduction to AI		

Note: PCC: Professional Core Course, **PEC:** Professional Elective Courses, **OEC**–Open Elective Course, **AEC** –Ability Enhancement Courses.

L –Lecture, T – Tutorial, P- Practical / Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

Note: VII and VIII semesters of IV year of the programme

(1) Institutions can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate research internship/ industry internship after the VI semester**.**

(2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the

PROJECT WORK (21XXP75): The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.

(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.

(iii) To impart flexibility and adaptability.

(iv) To inspire team working.

(v) To expand intellectual capacity, credibility, judgment and intuition.

(vi) To adhere to punctuality, setting and meeting deadlines.

(vii) To instill responsibilities to oneself and others.

(viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same

for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

TECHNICAL SEMINAR (21XXS81): The objective of the seminar is to inculcate self-learning, present the seminar topic confidently, enhance communication skill, involve in group discussion for exchange of ideas. Each student, under the guidance of a Faculty, shall choose, preferably, a recent topic of his/her interest relevant to the programme of Specialization.

(i) Carry out literature survey, systematically organize the content.

(ii) Prepare the report with own sentences, avoiding a cut and paste act.

(iii) Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.

(iv) Present the seminar topic orally and/or through PowerPoint slides.

(v) Answer the queries and involve in debate/discussion.

(**vi)** Submit a typed report with a list of references.

The participants shall take part in the discussion to foster a friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Evaluation Procedure:

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session, and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three teachers from the department with the senior-most acting as the Chairman.

Marks distribution for CIE of the course:

Seminar Report:50 marks

Presentation skill:25 marks

Question and Answer: 25 marks.■No SEE component for Technical Seminar

Non – credit mandatory courses (NCMC):

National Service Scheme/Physical Education (Sport and Athletics)/ Yoga:

(1) Securing 40 % or more in CIE,35 % or more marks in SEE and 40 % or more in the sum total of CIE + SEE leads to successful completion of the registered course.

(2) In case, students fail to secure 35 % marks in SEE, they has to appear for SEE during the subsequent examinations conducted by the University.

(3) In case, any student fails to register for NSS, PE or Yoga/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have not completed the requirements of the course. In such a case, the student has to fulfill the course requirements during subsequently to earn the qualifying CIE marks subject to the maximum programme period.

(4) Successful completion of the course shall be indicated as satisfactory in the grade card. Non-completion of the course shall be indicated as Unsatisfactory.

(5) These course shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

III SEMESTER			
TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES (BSC)			
Course Code	**21MAT 31**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives: The goal of the course Transform Calculus, Fourier series and Numerical techniques is

- To have an insight into solving ordinary differential equations by using Laplace transform techniques
- Learn to use the Fourier series to represent periodical physical phenomena in engineering analysis.
- To enable the students to study Fourier Transforms and concepts of infinite Fourier Sine and Cosine transforms and to learn the method of solving difference equations by the z-transform method.
- To develop proficiency in solving ordinary and partial differential equations arising in engineering applications, using numerical methods

Teaching-Learning Process (General Instructions):

These are sample Strategies, which teacher scan use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. StatetheneedforMathematicswithEngineeringStudiesandProvidereal-lifeexamples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning home work, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students for group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways:
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lecture activity).
   - As additional examples (post-lecture activity).
   - As an additional material of challenging topics (pre-and post-lecture activity).
   - As a model solution for some exercises (post-lecture activity).

Module-1: Laplace Transform (8 Hours)

Definition and Laplace transforms of elementary functions (statements only). Problems on Laplace's Transform of $e^{at}f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$. Laplace transforms of Periodic functions (statement only) and unit-step function – problems.

Inverse Laplace transforms definition and problems, Convolution theorem to find the inverse Laplace transforms (without Proof) problems. Laplace transforms of derivatives, solution of differential equations. **(8 Hours)**

Self-study: Solution of simultaneous first-order differential equations.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2: Fourier Series (8 Hours)

Introduction to infinite series, convergence and divergence. Periodic functions, Dirichlet's condition. Fourier series of periodic functions with period 2π and arbitrary period. Half range Fourier series. Practical harmonic analysis.

Self-study: Convergence of series by D'Alembert's Ratio test and, Cauchy'sroot test.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3: Infinite Fourier Transforms and Z-Transforms (8 Hours)

Infinite Fourier transforms definition, Fourier sine and cosine transforms. Inverse Fourier transforms, Inverse Fourier cosine and sine transforms. Problems.

Difference equations, z-transform-definition, Standard z-transforms, Damping and shifting rules, Problems. Inverse z-transform and applications to solve difference equations

Self Study: Initial value and final value theorems, problems.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4: Numerical Solution of Partial Differential Equations (8 Hours)

Classifications of second-order partial differential equations, finite difference approximations to derivatives, Solution of Laplace's equation using standard five-point formula. Solution of heat equation by Schmidt explicit formula and Crank-Nicholson method, Solution of the Wave equation. Problems.

Self Study: Solution of Poisson equations using standard five-point formula.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5: Numerical Solution of Second-Order ODEs and Calculus of Variations

Second-order differential equations - Runge-Kutta method and Milne's predictor and corrector method. (No derivations of formulae).

Calculus of Variations: Functionals, Euler's equation, Problems on extremals of functional. Geodesics on a plane, Variational problems

Self Study: Hanging chain problem

(RBT Levels: L1, L2 and L3)

Course outcomes: After successfully completing the course, the students will be able :

- To solve ordinary differential equations using Laplace transform.
- Demonstrate the Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- To use Fourier transforms to analyze problems involving continuous-time signals and to apply Z-Transform techniques to solve difference equations
- To solve mathematical models represented by initial or boundary value problems involving partial differential equations
- Determine the extremals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

First test at the end of 5th week of the semester

Second test at the end of the 10th week of the semester

Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

First assignment at the end of 4th week of the semester

Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

The question paper will have ten questions. Each question is set for 20 marks.

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50 and marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Text Books:

1. **B.S.Grewal**:"Higher Engineering Mathematics ",Khanna publishers,44th Ed.2018
2. **E.Kreyszig**:"AdvancedEngineeringMathematics",John Wiley & Sons,10th Ed.(Reprint),2016.

Reference Books

1. **V.Ramana:**"HigherEngineeringMathematics"McGraw-HillEducation,11th Ed.
2. **SrimantaPal&SubodhC.Bhunia:**"EngineeringMathematics"OxfordUniversityPress,3rd Reprint, 2016.
3. **N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" Laxmi Publications, Latest edition.
4. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co.Newyork, Latested.
5. **Gupta C.B, Sing S.R and Mukesh Kumar:** "Engineering Mathematic for Semester I and II", Mc- Graw Hill Education(India) Pvt. Ltd2015.
6. **H.K.DassandEr.RajnishVerma:**"HigherEngineeringMathematics"S.ChandPublication(2014).
7. **JamesStewart:"**Calculus"Cengagepublications,7th edition,4th Reprint2019.

Web links and Video Lectures (e-Resources):

- http://.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- http://www.bookstreet.in.
- VTU e-ShikshanaProgram
- VTU EDUSATProgram

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes
- Assignments
  Seminars

Robotics & Artificial Intelligence

III SEMESTER

MANUFACTURING TECHNOLOGY (IPCC)

Course Code	**21RI32**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

**** Additional one hour may be considered for Instructions if required***

Course objectives:

This course will enable students to:

- Gain fundamental knowledge of manufacturing process.
- Understand the Techniques used in Traditional, Non Traditional Machining process, advanced Welding Process & CNC Machines.
- Know the applications of various Traditional , Non Traditional manufacturing process & CNC machines

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

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.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration. 3. Chalk and Talk .

MODULE-2 **8 HOURS**

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. Die-design 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

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration. 3. Chalk and Talk .

MODULE-3 **8 HOURS**

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. Rubber forming. Open back inclinable press (OBI press), piercing, blanking, bending, deep 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.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration. 3. Chalk and Talk .
MODULE-4	**8 HOURS**
Non-traditional Machining Processes: Need for non-traditional machining, Principle, equipment & operation of Laser Beam, Plasma Arc Machining, Electro Chemical Machining, Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, Electron Beam Machining, Electron Discharge Machining and Plasma Arc Machining.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration. 3. Chalk and Talk .
MODULE 5	**8 HOURS**
Introducing to CNC machines: Basics of Turning tool Geometry, ATC, Programming methods. – Manual part programming, Milling, Turning, (Simple Programs), Computer Aided part programming (Simple problems, DNC, Types , Applications, Types of CNC Programming Software's, Over view CNC machining centers, Turning centre.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration. 3. Chalk and Talk .

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Preparation of sand specimens and conduction of the following tests: Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2	To determine permeability number of green sand, core sand and raw sand and Sieve Analysis to find Grain Fineness Number (GFN) of Base Sand
3	Clay content determination of Base Sand. Converting the round bar to square bar through forging.
4	Preparation of hexagonal bolt and hook through forging .
5	Preparation of sand mould using hand cut moulds, sold pattern and also split piece pattern .
6	Preparation of welded joints using Arc Welding equipment: T-Joint, Butt joint, Lap joints on M.S. flats.
7	Die and punch design for piercing and blanking operations for a progressive tool . Strip layout and center of pressure calculations.
8	Die and punch design for piercing and blanking operations for a compound tool

9	Die design for bending and deep drawing operations.
10	Die design for deep drawing operations.
11	To study the defects of Cast and Welded components using Non-destructive tests like: a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing
12	Study of microstructural changes in a heat affected zone of welded specimens.
13	Simulation of Casting using any relevant software.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Have knowledge of Mechanical behavior of metals, Smart materials, composite materials, Alloys, Heat treatment process & phase diagrams.
- Understand the mechanism of various Metallurgical process & manufacturing process of composite materials & working of smart sensors.
- Application of metallurgical process, production process of composite & working principle of smart sensor for various engineering solutions.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week o f the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course

(duration 03 hours)

3. The question paper will have ten questions. Each question is set for 20 marks.
4. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
5. The students have to answer 5 full questions, selecting one full question from each module and marks scored shall be proportionally reduced to 50 marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Textbooks

1. Manufacturing Technology, Serope kalpak jain Steuen.R.Sechmid, Pearson Education Asia, 5th Edition 2006.
2. Manufacturing Technology Vol 1 & 2, P.N.Rao, Tata McGraw Hill, 2001.
3. N C Machine Programming and software Design, ChnoHwachang, Michael.A.Melkanoff, Prentice Hall, 1989.

Reference books

1. Workshop Technology Vol I & II, Hajra Choudhary, Media Publishers, Bombay, 2004.
2. Production Technology, HMT, Tata McGraw Hill, 2001.
3. Manufacturing Science, Amitabh Ghosh and Mallik, Affiliated East West Press, 2003.
4. Automation Production system and computer Integrated Manufacturing, Mikell.O.Grover, PHI New Delhi, 2002.

Web links and Video Lectures (e-Resources):

- **https://onlinecourses.nptel.ac.in/noc22_me28/preview**

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Metal Casting: Design pattern/core for a given component drawing and develop a sand mould with optimum gating and riser system for ferrous and non-ferrous materials. Melting and casting, inspection for macroscopic casting defects.
- Welding: TIG and MIG welding processes – design weld joints – welding practice –weld quality inspection.
- Metal Forming: Press working operation – hydraulic and mechanical press -load calculation: blanking, bending and drawing operations – sheet metal layout design.
- **Course seminar**
- **Industrial tour**

III SEMESTER Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

III SEMESTER

ANALOG AND DIGITAL ELECTRONICS CIRCUITS (IPCC)			
Course Code	**21RI33**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives: This course will enable students :

- To understand the basics and applications of diodes and transistors
- To understand the basics and applications of OPAMPS
- To Illustrate simplification of Algebraic equations using Karnaugh Maps and Quine-McClusky Techniques.
- To Design Decoders, Encoders, Digital Multiplexer, Adders, Subtractors and Binary Comparators.
- To Describe Latches and Flip-flops, Registers and Counters.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various analog and digital circuits.
3. Encourage collaborative (Group) Learning in the class
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Junction diode for HW and FW rectification, Clippers and Clamping circuits, Transistor biasing, Dc load line analysis, Different biasing circuits, stability factors(without derivation), Transistor switching networks.

Concept of Amplifiers : RC Coupled Amplifier (Analysis), Feedback Amplifiers: Different types of feedback amplifers(Analysis),Power Amplifiers: Concept of Power Amplifiers , Class A and Class B , Push-pull power amplifier, Oscillators: Concept, Audio and Radio Frequency Oscillators, JFET and MOSFET - Working Principle and Biasing., (Text-1)

Teaching-Learning Process	Chalk and Talk Method

Module-2

OPAMP :Dual-input Balanced output Differential amplifier, Block diagram representation of an opamp, Interpretation of datasheets (Ideal V/s) practical values, Frequency response of an OPMAP, OPAMP Configurations: inverting, Non-inverting, Differential:

OPAMP Applications: Summer, integrator, differentiator, Schmitt triggers.555 Timer Applications: Astable and MonostableMultivibrator, Active Filtes. Binary weighted Resistor D/A converter and Successive Approximation A/D converter.(Text-2)

Teaching-Learning Process	Chalk and Talk Method, PPT

Module-3

Principles of combinational logic: Definition of combinational logic, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4,5 variables,Incompletely specified functions (Don't care terms) Simplifying Max term equations,Quine-McClusky techniques – 3 & 4 variables.**(Text 3 - Chapter 3)**	
Teaching-Learning Process	Chalk and Talk Method, Blended learning
Module-4	
Analysis and design of combinational logic: Decoders, Encoders, Digital multiplexers, Adders and subtractors, Look ahead carry, Binary comparators.**(Text 3 - Chapter 4).** Programmable Logic Devices, Complex PLD, FPGA. **(Text 5 - Chapter 9, 9.6 to 9.8)**	
Teaching-Learning Process	Chalk and Talk Method, Flipped classroom
Module-5	
Flip-Flops and its Applications: Basic Bistable elements, Latches, The master-slave flip flops (pulse-triggered flip-flops): SR flip-flops, JK flip-flops, Characteristic equations, Registers, binary ripple counters, and synchronous binary counters. **(Text 4 - Chapter 6)**	
Teaching-Learning Process	Chalk and Talk Method, PPT
Course outcome (Course Skill Set) At the end of the course the student will be able to : 1. CO1: Analyse Diode Rectifier Circuits and transistor biasing circuits. 2. CO2: Analyse Transistor Amplifier and Oscillator circuits. 3. CO3: Explain opamp basics and Analyse OPAMP applications. 4. CO4:Explain the concept of combinational and sequential logic circuits. 5. CO5:Design the combinational logic circuits. 6. CO6:Design the sequential circuits using SR, JK, D, T flip-flops	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week o f the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

6. The question paper will have ten questions. Each question is set for 20 marks.
7. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
8. The students have to answer 5 full questions, selecting one full question from each module and marks scored shall be proportionally reduced to 50 marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

  SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1.Analog Electronic Circuits: A simplified approach by U.B. Mahadevaswamy

2.OPAMPS and Linear IC's by RamakantGayakwad

3.John M Yarbrough,-Digital Logic Applications and Design, Thomson Learning, 2001.

4.Donald D. Givone, —Digital Principles and Design, McGraw Hill, 2002.

5. Charles H Roth Jr., Larry L. Kinney —Fundamentals of Logic Design, Cengage Learning, 7th Edition.

Web links and Video Lectures (e-Resources):

- E-book versions are available at 'https://www.knimbus.com/' of the VTU consortium. Remote login available through respective college IDs.
- You tube videos

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- To construct and observe clipping for different configurations.
- To construct and find bandwidth of RC coupled amplifier.
- To construct and check oscillation frequency for RC phase shift oscillator.
- To construct and obtain OPAMP Astablemultivibrator.
- Design and implement (i) Half Adder & Full Adder using i) basic gates. ii) NAND gates (ii) Half subtractor& Full subtractor using i) basic gates ii) NAND gates
- Design and implement 4-bitParallelAdder/Subtractor using IC 7483.
- Design and Implementation of 1-bit Comparator.
- Realize4-variable function using IC74151(8:1MUX).
- Realize the following flip-flops using NAND Gates. JK, D Flip-Flop.
- Realize 4 bit SISO, SIPO, PIPO using D Flip flop
- Realize 3 bit asynchronous counter using JK flip flop
- Realize 3 bit synchronous counter using D flip flop

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

III SEMESTER

MECHANICS OF SOLID AND FLUIDS (PCC)

Course Code	21RI34	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

The course will enable the students to

- Gain knowledge of linear elastic properties and stress strain relations.
- Derive and solve problems on Principal stresses developed in structures.
- Compute the stress strain for bars, beams, shafts, and column and to apply the concept of dynamic similarity and to apply it to experimental modeling.
- Gain knowledge of basic properties of fluids, fluid statics.
- To apply conservation of mass, momentum and energy equation and to determine the discharge of fluid flow.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through Power Point presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt collaborative (Group Learning) Learning in the class.
4. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.
5. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1 **8 hours**

Simple Stress and Strain: Introduction, Concept of Stress and Strain, Linear elasticity, Hooke's Law and Poisson's ratio. Extension / Shortening of a bar, bars with varying cross sections (step and tapering circular and rectangular), Elongation due to self-weight, Principle of super position, St. Venant's Principle**.**

Simple shear stress and Shear strain. Volumetric strain: expression for volumetric strain, Elastic Constants and relations. Stresses in Composite Section

Teaching-Learning Process	1. Power-point Presentation. 2. Video demonstration or Simulations. 3. Chalk and Talk are used for Problem Solving. Laboratory Demonstrations and Practical Experiments.

Module-2 **8 hours**

Compound Stresses: Introduction, Concept of Plane stress, Stress tensor for plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress.

Teaching-Learning Process	1. Power-point Presentation. 2. Video demonstration or Simulations. 3. Chalk and Talk are used for Problem Solving. Laboratory Demonstrations and Practical Experiments.

Module-3 **8 hours**

Torsion of Circular Shafts: Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts.

Elastic Stability of Columns: Euler's theory for axially loaded elastic long columns. Derivation of Euler's load for various end conditions, limitations of Euler's theory, Rankine's formula.

Teaching-Learning Process	1. Power-point Presentation. 2. Video demonstration or Simulations. 3. Chalk and Talk are used for Problem Solving. Laboratory Demonstrations and Practical Experiments.

Module-4

8 hours

Introduction to Fluid mechanics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc., pressure at a point in the static mass of fluid, variation of pressure. Pascal's law, absolute, gauge, atmospheric and vacuum pressures; pressure measurement by simple, differential manometers and mechanical gauges.

Fluid Statics: Total pressure and centre of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid.

Teaching-Learning Process	1. Power-point Presentation. 2. Video demonstration or Simulations. 3. Chalk and Talk are used for Problem Solving. Laboratory Demonstrations and Practical Experiments.

Module-5

8 hours

Fluid Kinematics: Velocity of fluid particle, types of fluid flow, description of flow, continuity equation, Coordinate free form, acceleration of fluid particle, rotational & irrotational flow, Laplace's equation in velocity potential and Poisson's equation in stream function, flow net.

Fluid Dynamics; Introduction. Forces acting on fluid in motion. Euler's equation of motion along a streamline. Integration of Euler's equation to obtain Bernoulli's equation, Assumptions and limitations of Bernoulli's equation. Major head loss (frictional), Introduction to Navier-Stokes equation. Application of Bernoulli's theorem such as venturi-meter, orifice meter, rectangular and triangular notch, pitot tube.

Teaching-Learning Process	1. Power-point Presentation. 2. Video demonstration or Simulations. 3. Chalk and Talk are used for Problem Solving. Laboratory Demonstrations and Practical Experiments.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO 1. Gain the knowledge of properties, and stress-strain relations in linear elastic solid members and fluids. To understand the concepts of fluid statics, kinematics and dynamics.

CO 2. Describe stress-strain equation for axial, bending and torsion loads while addressing problems in engineering.

CO 3. Apply the concepts of fluid statics, kinematics and dynamics while addressing problems in engineering and to determine the fluid flow through open and closed channel.

CO 4. Determine the stress & strain for simple stresses, compound stresses, shafts & columns.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

The question paper will have ten questions. Each question is set for 20 marks.

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. Marks scored out of 100 shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. "Mechanics of Materials", by R.C.Hibbeler, Prentice Hall. Pearson Edu., 2011.
2. "Mechanics of materials", James.M.Gere, Thomson, Eighth edition2013.
3. "Mechanics of materials", in SI Units, Ferdinand Beer & Russell Johston, 5th Ed., TATA McGraw Hill- 2003.
4. A Text Book of Fluid Mechanics and Hydraulic Machines" Dr R.K Bansal Laxmi Publishers.
5. "Fluid Mechanics (SI Units)" Yunus A. Cengel John M.Cimbala, TataMcGraw Hill 3rd Ed.,2014.

Reference Books:

1. "Strength of Materials", S.S. Rattan, Tata McGraw Hill, 2009.
2. "Strength of Materials", S.S.Bhavikatti, Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.
3. "Engineering Mechanics of Solids", Egor.P. Popov, Pearson Edu. India, 2nd, Edition, 1998.
4. "Strength of Materials", W.A. Nash, 5th Ed., Schaum's Outline Series, Fourth Edition-2007.
5. "Fluid Mechanics" F M White, McGraw Hill Publications Eighth Edition.
6. "Introduction to Fluid Mechanics" Fox, McDonald John, Wiley Publications 8th edition.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Preparation of specimen for Metallographic examination of different engineering materials. To report microstructures of plain carbon steel, tool steel, grey C.I, SG iron, Brass, Bronze & composites.
- Tensile, shear and compression tests of steel, aluminium and cast iron specimens using Universal Testing Machine
- Torsion Test on steel bar. andIzod and Charpy Tests on Mild steel and C.I Specimen.
- Determination of coefficient of friction of flow in a pipe.
- Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades.
- Calibration of flow measuring devices.

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

III SEMESTER

MACHINE DRAWING AND GD & T (PCC)

Course Code	21RIL35	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Credits	01	Exam Hours	03

* One additional hour may be considered wherever required

Course objectives:

- To acquire the knowledge of limits, tolerance and fits and indicate them on machine drawings.
- To make drawings using orthographic projections and sectional views
- To impart knowledge of thread forms, fasteners, keys, joints, couplings and clutches.
- To understand and interpret drawings of machine components leading to preparation of assembly drawings manually and using CAD packages.

Module 1 (only for CIE) **01 Sessions**

Review of basic concepts of Engineering Visualization

Geometrical Dimensioning and Tolerances (GD&T): Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry.

Module 2 (only for CIE) **02 Sessions**

Sections of Simple and hollow solids: True shape of sections.

Module 3 (only for CIE) **03 Sessions**

Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme. Sellers thread, American Standard thread, Helicoil thread inserts

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly), simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, countersunk head screw, grub screw, Allen screw

Rivets

Keys: Parallel key, Taper key, Feather key, Gib-head key and Woodruff key.

Module 4 **03 Sessions**

Assembly of Joints, couplings and clutches (with GD&T)using 2D environment

Joints: Like Cotter joint (socket and spigot), knuckle joint (pin joint).

Couplings: Like flanged coupling, universal coupling

Clutches: Like Single Plate clutch, cone clutches

Module 5 **05 Sessions**

Assembly of Machine Components (with GD&T) using 3D environment

(Part drawings shall be given)

1. **Bearings**
2. **Valves**
3. **Safety Valves**
4. **I.C. Engine components**
5. **Lifting devices**
6. **Machine tool components**
7. **Pumps**

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Interpret the Machining and surface finish symbols on the component drawings.

CO2: Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies.

CO3: Illustrate various machine components through drawings

CO4: Create assembly drawings as per the conventions.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks) and that for SEE minimum passing mark is 35% of the maximum marks (18 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

- CIE shall be evaluated for max marks 100. Marks obtained shall be accounted for CIE final marks, reducing it by 50%.
- CIE component should comprise of
    - Continuous evaluation of Drawing work of students as and when the Modules are covered.
    - At least one closed book **Test** covering all the modules on the basis of below detailed weightage.
    - ***Weightage for Test and Continuous evaluation shall be suitably decided by respective course coordinators***.

Module	**Max. Marks weightage**	**Evaluation Weightage in marks**	
		Computer display & printout	**Preparatory sketching**
Module 1	10	05	05
Module 2	15	10	05
Module 3	25	20	05
Module 4	25	20	05
Module 5	25	25	00
Total	**100**	**80**	**20**

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

- The duration of SEE is 03 hours**. Questions shall be set worth of 3 hours**
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.
- SEE shall be conducted and evaluated for maximum marks 100. Marks obtained shall be accounted for SEE final marks, reducing it to 50 marks.
- Question paper shall be set jointly by both examiners and made available for each batch as per schedule. **Questions are to be set preferably from Text Books.**
- Evaluation shall be carried jointly by both the examiners.
- Scheme of Evaluation: *To be defined by the examiners jointly and the same shall be submitted to the university along with question paper.*
- One full question shall be set from Modules 3 and 4 as per the below tabled weightage details. ***However, the student may be awarded full marks, if he/she completes solution on computer display without sketch***.

Module	Max. Marks Weightage	Evaluation Weightage in marks	
		Computer display & printout	Preparatory sketching
Module 4	40	30	10
Module 5	60	50	10
Total	**100**	**80**	**20**

Suggested Learning Resources:

Books:

- K L Narayana, P Kannaiah, K Venkata Reddy, “Machine Drawing”, New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5, 2006
- N D Bhatt , “Machine Drawing”, Charotar Publishing House Pvt. Ltd.,50th Edition, ISBN-13: 978-9385039232, 2014

Reference Books:

- Sadhu Singh, P. L. Sah, “Fundamentals of Machine Drawing”, PHI Learning Pvt. Ltd, 2nd Edition, ISBN: 9788120346796, 2012
- Ajeet Singh, “MACHINE DRAWING”, Tata McGraw-Hill Education, , ISBN: 9781259084607, 2012

III Semester **Ability Enhancement Course III**

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

INTRODUCTION TO PYTHON (AEC-III)

Course Code	21RI381	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	01

Course objectives:

The students will be able to:

- Demonstrate the use of Anaconda or PyCharm IDE to create Python Applications
- Develop Python programming language to develop programs for solving real-world problems
- Utilize Object-Oriented Programming concepts in Python.
- Analyse the working of various documents like PDF, Word file

Sl.NO	Experiments
1	Develop a python program to find the better of two test average marks out of three test's marks accepted from the user.
2	Develop a python program to find the smallest and largest number in a list
3	Develop a python program to arrange the numbers in ascending and descending order
4	Develop a binary search program in python
5	Develop a bubble sort program in python
6	Develop a Python program to check whether a given number is palindrome or not and also count the number of occurrences of each digit in the input number.
7	Write a Python program that accepts a sentence and find the number of words, digits, Uppercase letters and lowercase letters.
8	Write a Python program for pattern recognition with and without using regular expressions
	Demonstration Experiments (For CIE)
9	Demonstrate python program to read the data from the spreadsheet and write the data in to the spreadsheet
10	Demonstration of reading, writing and organizing files.
11	Demonstration of the concepts of classes, methods, objects and inheritance
12	Demonstration of working with PDF and word files

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Demonstrate proficiency in handling of loops and creation of functions.
- Identify the methods to create and manipulate lists, tuples and dictionaries.
- Discover the commonly used operations involving regular expressions and file system.
- Examine working of PDF and word file formats

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3" 1^{st} Edition, CreateSpace Independent Publishing Platform, 2016. (http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf)
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2^{nd} Edition, Green Tea Press, 2015. (http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Download pdf files from the above links)
3. Al Sweigart, "Automate the Boring Stuff with Python",1stEdition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/)
4. Reema Thareja "Python Programming Using Problem Solving Approach" Oxford University Press.

III Semester **Ability Enhancement Course-III**

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

FUNDAMENTALS OF VIRTUAL REALITY AND APP DEVELOPMENT (AEC-III)			
Course Code	**21RI382**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Describe how VR systems work and list the applications of VR.
- Understand the design and implementation of the hardware that enables VR systems to be built.
- Understand the system of human vision and its implication on perception and rendering.
- Explain the concepts of motion and tracking in VR systems.
- Describe the importance of interaction and audio in VR systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction to Virtual Reality : Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

Representing the Virtual World : Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3

The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4

Visual Perception & Rendering : Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5	
Motion & Tracking : Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1: Describe how VR systems work and list the applications of VR.

CO2: Understand the design and implementation of the hardware that enables VR systems to be built.

CO3: Understand the system of human vision and its implication on perception and rendering.

CO4: Explain the concepts of motion and tracking in VR systems.

CO5: Describe the importance of interaction and audio in VR systems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

1. First assignment at the end of 4th week of the semester
2. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

Reference Books:

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

Web links and Video Lectures (e-Resources):

http://lavalle.pl/vr/book.html
https://nptel.ac.in/courses/106/106/106106138/
https://www.coursera.org/learn/introduction-virtual-reality.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Course seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

III SEMESTER	**Ability Enhancement Course III**		
DIGITAL SOCIETY (AEC-III)			
Course Code	**21RI383**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Introduce students to the dominant discourses that frame debates on digital society
- Familiarize students with the literature pertaining to web technologies and their
- cultural, legal and ethical formations and practices
- Familiarize students with the complex relationships between digital cultures and digital divides

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.

Module-1

Introduction to Digital Society: Digital components of a connected society

Theorizing Digital Society: New forms of power; Datas sociomaterial objects; Archives;Digital veillance

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Module-2

Digital Identities and Relationships: Self and the Digital Society; Embodied Identities in Digital Society; Bias and Privilege Digital Inequalities; Marginalised Histories**;** Cyborgs

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Module-3

Digital Spaces and Practices: Rethinking space and surveillance in digital societies; Gender,Space,and Place in Digital Societies**;** Urban Informatics and Sociological Imagination – Smart cities**;** Digital Healthcare; Mobility in Digital Society; Digital Heritage

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Module-4

Network Society: The Internet as a Network; Networks and the Cultural Imaginary; Inequalities in the Network Society; Information Capital;Interface Design for Diverse Populations

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Module-5

Re-conceptualizing Research in a Digital Age: Information Management Data Analysis Software**;** Large Digital Systems; Data protection and the politics of data privacy

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

- Identify the ways in which digital media shape identity
- Utilize new opportunities for meaningful data collection from and using sophisticated forms of artificial intelligence
- Identify knowledge and truth amongst the abundance of information

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

4. First test at the end of 5th week of the semester
5. Second test at the end of the 10th week of the semester
6. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

3. First assignment at the end of 4th week of the semester
4. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Lupton,D.,(2015), *Digital Sociology*, London, New York: Routledge
2. Gere,C., (2008), *Digital Culture*, 2nd Edition, London: Reaktion Books Limited

Reference Books

1. Bentkowska-Kafel, A., Cashen, T., and Gardiner, H. (Eds.) (2009), *Digital Visual Culture:Theory andPractice*, Bristol and Chicago: Intellect Books

2. Karaganis, J. (Ed.), (2007), *Structures of Participation in Digital Culture*, Social ScienceResearch Council,Columbia University Press
3. Tredinnick, L. (2008), *Digital Information Culture: The Individual and Society in theDigitalAge*, Oxford: Chandos Publishing Limited

Web links and Video Lectures (e-Resources):

Digital Humanities Seminar Video Archive of the Open University, UK,
http://www.open.ac.uk/arts/research/digital-humanities/videos

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Course Seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

IV SEMESTER

MEASUREMENT SYSTEMS (IPCC)			
Course Code	**21RI42**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

This course will enable students:

- To understand the concept of metrology and standards of measurement.
- To equip with knowledge of limits, fits, tolerances and gauging
- To understand the knowledge of measurement systems and methods with emphasis ondifferent Transducers, intermediate modifying and terminating devices.
- To understand the concept of control system.

Pedagogy (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Introduction to Metrology: Definition, objectives of metrology, Material Standards, Wavelength Standards, Classification of standards, Line and End standards, Calibration of End bars. Numerical examples.

System of Limits, Fits, Tolerance and Gauging: Definitions, Tolerance, Tolerance analysis (addition & subtraction of tolerances) Inter changeability & Selective assembly. Class &grade of tolerance, Fits, Types of fits, Numerical on limits, fit and tolerance. Hole base system & shaft base system. Taylor's principle, Types of limit gauges, Numerical on limit gauge design.

Pedagogy	Power point presentation along with solving numerical using chalk and board Real time examples through video

Module-2

Measurement system and basic concepts of measurement methods: Definition, Significance of measurement, generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors.

Transducers: Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical, Electronic transducers, Relative comparison of each type of transducers.

Intermediate Modifying and Terminating Devices: Mechanical systems, Inherent problems, Electrical intermediate

modifying devices, Input circuitry, Ballast circuit, Electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs	
Pedagogy	Power point presentation along with solving numerical using chalk and board
Module-3	
Micro And Smart Devices And Systems: Principles And Materials: Definitions and salient features of sensors, actuators, and systems. **Sensors:** silicon capacitive accelerometer, piezo-resistive pressure sensor, blood analyzer, conductometric gas sensor, fiber-optic gyroscope and surface-acoustic-wave based wireless strain sensor. **Actuators:** silicon micro-mirror arrays, piezo-electric based inkjet print- head, electrostatic comb-drive and micromotor, magnetic micro relay, shape- memory-alloy based actuator, electro-thermal actuator. **Systems:** micro gas turbine, portable clinical analyzer, active noise control in a helicopter cabin.	

Pedagogy	Demonstrating image classification using MATLAB Power point presentation along with solving numerical using chalk and board
Module-4	
Modeling: Scaling issues.Elastic deformation and stress analysis of beams and plates. Residual stresses and stress gradients. Thermal loading. Heat transfer issues. Basic fluids issues.Electrostatics. Coupled electromechanics. Electromagnetic actuation. Capillary electro-phoresis. Piezoresistive modeling. Piezoelectric modeling. Magnetostrictive actuators.	
Pedagogy	Demonstrating Hopfield network videos Power point presentation along with solving numerical using chalk and board
Module-5	
Electronics, Circuits And Control: Carrier concentrations, semiconductor diodes, transistors, MOSFET amplifiers, operational amplifiers. Basic Op-Amp circuits. Charge-measuring circuits. Examples from microsystems. Transfer function, state-space modeling, stability, PID controllers, and model order reduction. Examples from smart systems and micromachined accelerometer or a thermal cycler.	
Pedagogy	Animation, Power point presentation and video demonstration of application

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Study of instruments for Liner measurement and angular measurements: Slip gauges- Measurement of angle- sine bar, Sine centre, Angle gauges, Optical instruments for angular measurements.
2	Study of Autocollimator-Applications for measuring straightness and squareness.
3	Study of different Comparators and calibration of Dial indicator, Electrical comparators, LVDT, Pneumatic comparators
4	To Study various Temperature Measuring Instruments and to Estimate their Response times. (a) Mercury – in glass thermometer (b) Thermocouple (c) Electrical resistance thermometer (d) Bi-metallic strip
5	Various parameter measurement using computerized profile projector
6	Surface topology measurement using Surface Roughness Tester
7	Calibration of Pressure gauge, Thermocouple and Load cell
8	Circularity measurement using Electronic and Mechanical comparator
9	Demonstration of Measurement using Coordinate Measuring Machine (CMM) / Laser Scanner
10	Study of distortion factor meter and determination of the % distortion of the given oscillator.
11	Study of the following transducer (i) PT-100 transducer (ii) K –type transducer (iii) Pressure transducer
12	Characteristics of LDR, Photo-Diode, and Phototransistor
13	To measure torque of a rotating shaft using torsion meter/strain gauge torque transducer
14	To measure static/dynamic pressure of fluid in pipe/tube using pressure transducer/pressure cell.
	Choose any product used in the day to day life based on his/her choice, prepare a measurement plan and implement the measurement with existing tools)

Course outcome (Course Skill Set)

At the end of the course, students will be able to:

1. Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters.
2. Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design
3. Explain measurement systems, transducers, intermediate modifying devices and terminating devices.
4. Understand basics of control system.
5. Ability to perform stability analysis of a control system.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 02/03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

11. The question paper will have ten questions. Each question is set for 20 marks. Marks scorded shall be proportionally scaled down to 50 Marks
12. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
13. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Text Book:

- Mechanical Measurements, Beckwith Marangoni and Lienhard Pearson Education 6th Ed., 2006
- Instrumentation, Measurement and Analysis B C Nakra, K K Chaudhry McGraw–Hill 4th Edition
- Discrete-Time Control systems Ogata K 2nd Edition, PHI Learning Pvt. Ltd 2009.
- Digital Control Systems Kuo B.C 2nd Edition, Oxford University Press 2007
- MEMS & Microsystems: Design and Manufacture, Tai-Ran Tsu, Tata Mc-Graw-Hill.
- "Micro and Smart Systems" by Dr. A.K.Aatre, Prof. Ananth Suresh, Prof.K.J.Vinoy, Prof. S. Gopalakrishna,, Prof. K.N.Bhat.,John Wiley Publications.

Reference Books:

- Engineering Metrology and Measurements Bentley Pearson Education
- Theory and Design for Mechanical Measurements, III edition Richard S Figliola, Donald E Beasley WILEY India Publishers
- Animations of working principles, process flows and processing techniques, A CD-supplement with Matlab codes, photographs and movie clips of processing machinery and working devices.
- Laboratory hardware kits for (i) BEL pressure sensor, (ii) thermal-cycler and (iii) active control of a cantilever beam.
- Microsystems Design, S. D. Senturia, 2001, Kluwer Academic Publishers, Boston, USA. ISBN 0-7923-7246-8. 2. Analysis and Design Principles of MEMS Devices, Minhang Bao, Elsevier, Amsterdam, The Netherlands, ISBN 0-444-51616-6
- Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Gopalakrishnan, Wiley.
- MEMS- Nitaigour Premchand Mahalik, TMH 2007

Web links and Video Lectures (e-Resources):

- www.electronics-tutorials.ws
- www.electrical4u.com/electronic-ballast
- www.sciencedirect.com/topic/computer-science/sampling-theorem
- https://nptel.ac.in/content/storsge2/courses/108103008/PDF/module3/m3_lec2.pdf

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit QC section of nearby small scale industries.
- http://sl-coep.vlabs.ac.in/

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

IV SEMESTER

MICROCONTROLLER (IPCC)			
Course Code	**21RI43**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	03

Course Learning Objectives: This course will enable students to:

- Understand the difference between a Microprocessor and a Microcontroller and embedded microcontrollers.
- Familiarize the basic architecture of 8051 microcontroller.
- Program 8051microprocessor using Assembly Level Language and C.
- Understand the interrupt system of 8051 and the use of interrupts.
- Understand the operation and use of inbuilt Timers/Counters and Serial port of 8051.
- Interface 8051 to external memory and I/O devices using its I/O ports.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various Micrcontrollers and digital circuits.
3. Encourage collaborative (Group) Learning in the class
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

8051 Microcontroller:

Microprocessor Vs Microcontroller, Embedded Systems, Embedded Microcontrollers, 8051 Architecture- Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.

Teaching-Learning Process	Chalk and Talk Method

Module-2

8051 Instruction Set:

Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions.

Teaching-Learning Process	Chalk and Talk Method

Module-3

8051 Stack, I/O Port Interfacing and Programming:

8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops. Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status.

Teaching-Learning Process	Chalk and Talk Method

Module-4

8051 Timers and Serial Port:

8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode- 2 on a port pin. 8051 Serial Communication- Basics of Serial Data Communication, RS- 232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.

Teaching-Learning Process	Chalk and Talk Method

Module-5

8051 Interrupts and Interfacing Applications:

8051 Interrupts. 8051 Assembly language programming to generate an external interrupt using a switch, 8051 C programming to generate a square waveform on a port pin using a Timer interrupt. Interfacing 8051 to ADC-0804, DAC, LCD and Stepper motor and their 8051 Assembly language interfacing programming

Teaching-Learning Process	Chalk and Talk Method

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

CO1: Explain the difference between Microprocessors & Microcontrollers, Architecture of 8051 Microcontroller, Interfacing of 8051 to external memory and Instruction set of 8051.

CO2: Write 8051 Assembly level programs using 8051 instruction set.

CO3: Explain the Interrupt system, operation of Timers/Counters and Serial port of 8051.

CO4: Write 8051 Assembly language program to generate timings and waveforms using 8051 timers, to send & receive serial data using 8051 serial port and to generate an external interrupt using a switch.

CO5: Write 8051 Assembly language programs to generate square wave on 8051 I/O port pin using interrupt and C Programme to send & receive serial data using 8051 serial port.

CO6: Interface simple switches, simple LEDs, ADC 0804, LCD and Stepper Motor to 8051 using 8051 I/O ports.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 02/03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

14. The question paper will have ten questions. Each question is set for 20 marks. Marks scorded shall be proportionally scaled down to 50 Marks
15. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
16. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. “The 8051 Microcontroller and Embedded Systems – using assembly and C”, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006.
2. “The 8051 Microcontroller”, Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.

Reference Books:

1. “The 8051 Microcontroller Based Embedded Systems”, Manish K Patel, McGraw Hill, 2014, ISBN: 978-93-329-0125-4.
2. “Microcontrollers: Architecture, Programming, Interfacing and System Design”, Raj Kamal, Pearson Education, 2005.

Web links and Video Lectures (e-Resources):

- E-book versions are available at ‘https://www.knimbus.com/’ of the VTU consortium. Remote login available through respective college IDs.
- You tube videos

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- To construct and observe clipping for different configurations.
- To construct and find bandwidth of RC coupled amplifier.
- To construct and check oscillation frequency for RC phase shift oscillator.
- To construct and obtain OPAMP Astablemultivibrator.
- To design and implement Simple combinational logic circuits like half adder, full adder, 2X1 MUX etc
- Verify the working of sequential logic circuitsviz flip flop, shift register.
- Programs to generate delay, Programs using serial port and on-Chip timer/counter.
- Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII; HEX - Decimal and Decimal -HEX.
- Write a C program to (i) transmit and (ii) to receive a set of characters serially by interfacing 8051 to a terminal.
- Write ALPs to generate waveforms using ADC interface.
- Write ALP to interface an LCD display and to display a message on it. 5. Write ALP to interface a Stepper Motor to 8051 to rotate the motor.
- Write ALP to interface ADC-0804 and convert an analog input connected to it.

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

IV SEMESTER

Robot Kinematics, Dynamics and Control (PCC)

Course Code	21RI44	CIE Marks	50
Teaching Hour/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning Objectives:

The course will enable the students to

- Understand the functional elements of a robot and robotic workspace.
- Acquire a basic understanding of direct and inverse kinematics.
- Acquire the basic concepts of Robot dynamics.
- Understand the robotic motion planning techniques.
- Gain the knowledge of robotic control action.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information..

Module 1

Introduction to Robotics, Elements of Robots: Joints, links , End effectors, Grippers, actuators and sensors, Fundamentals of Robot Degrees of Freedom, Robot Components, Rigid body motions, Concepts of Rigid Body, Robotic manipulator Frames, Euclidean Space, Inertial Frame, Fundamentals of Robotic Manipulator, Vectors, matrices.

Module 2

Forward kinematics- Homogeneous Co-ordinates, Euler angle and transformations, Translation and Rotation, Screw transformations, Composite homogeneous transformations, Kinematic parameters, Roll – Pitch- Yaw transformations, Denavit-Hartenberg representation of robotic arm equation, Forward kinematics for 2 DOF and 3 DOF planar manipulators (Simple derivation and numerical exercises)

Inverse Kinematics- General properties of solutions, Homogeneous differential transformations, Inverse kinematics for 2 DOF and 3 DOF planar manipulators (Simple derivation and numerical exercises), Jacobian Transformation for Robotic arm manipulation, Joint and end effector velocities relation.

Module 3

Lagrenge-Euler dynamic formulation of Robotic Manipulators: Basic Definitions, Generalized robotic coordinates, Dynamic Constraints, Velocity & Acceleration of Moving Frames, Robotic mass distribution and inertia tensors, Expression for Kinetic Energy and Potential Energy of arms,, velocity of links, Jacobian, Euler-Lagranze equation.

Effect of friction and actuator's rotor inertia. Evaluation of joint coordinates and Torque. Robotic Dynamics of two link with distributed mass, Dynamic equations of motion for a general 6 axis Robotic Manipulator, Dynamic modelling of planar and serial robots of 2 DOF.

Module 4

Path Planning- Joint space planning, use of cubic polynomial, Cartesian space planning, Straight line and circular paths, position and orientation planning.

Trajectory Planning- Joint space trajectory planning, cartesian and operational space trajectory planning techniques, velocity and positional control.

Module 5

Introduction to Robot control, concepts of point to point and continuous path control, Basics of feedback devices, Encoders, Resolver and LVDT, Open and closed loop control techniques. Fundamentals of PD and PID controllers.

Linear control schemes, PD and PID control of a single link manipulator, Adaptive control scheme, Force and torque control of robotic manipulators, Hybrid control, compliance and impedance control.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

1. Understand the functional elements of a robot and robotic workspace.
2. Acquire a basic understanding of direct and inverse kinematics.
3. Acquire the basic concepts of Robot dynamics.
4. Understand the robotic motion planning techniques.
5. Gain the knowledge of robotic control action.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5^{th} week of the semester
- Second test at the end of the 10^{th} week of the semester
- Third test at the end of the 15^{th} week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4^{th} week of the semester
- Second assignment at the end of 9^{th} week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13^{th} week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and

will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. Marks scored out of 100 shall be proportionally reduced to 50 marks

Reference books:

1. Introduction to robotics by S.K.Saha, Tata Mc Graw Hill Education, 2014.
2.M.P.Groover,M.Weiss, R.N.Nageland, N.G.Odrej, Industrial Robotics, McGraw-Hill,1986.
3. Mark.W. Spong and M. Vidyasagar, Robotic dynamics and control, Wiley Publishers, 2008.
4. Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University press, 2008.
5. Fu. K. S., Gonzalez. R. C & Lee C.S.G., "Robotics control, sensing, vision and intelligence", Mc Graw Hill Book co, 1987
6.Fundamentals of Robotics by D.K. Pratihar, Narosa Publishing House, New-Delhi, 2017
7.Introduction to Robotics by J.J. Craig, Addison-Wesley Publishing Company, 1986

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_me76/preview

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Course seminar
- Term project

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Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

IV SEMESTER

Robot Programming And Simulation Lab (PCC)

Course Code	**21RIL46**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	3

Course objectives:

- To introduce different types of robotics and demonstrate them to identify different parts and components.
- To write programming for simple operations

Sl.NO	Experiments
1	Determination of maximum and minimum position of links.
2	Verification of transformation (Position and orientation) with respect to gripper and world coordinate system.
3	Estimation of accuracy, repeatability and resolution.
4	Robot programming and simulation for pick and place.
5	Robot programming and simulation for Colour identification.
6	Robot programming and simulation for Shape identification.
7	Robot programming and simulation for machining (cutting, welding).
8	Robot programming and simulation for any industrial process (Packaging, Assembly).
	Demonstration Experiments (For CIE)
9	Robot programming and simulation for writing practice.
10	Robot programming and simulation for multi process.
11	
12	

LIST OF EQUIPMENTS BATCH OF 30 STUDENTS:

ROS (Robotic Operating System)

30 Systems with server

Verification of direct kinematics equations and inverse kinematics equations of 1DOF "R-configuration" robot.

Verification of direct kinematics equations and inverse kinematics equations of 2DOF "R-R-configuration" robot.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Use of any robotic simulation software to model the different types of robots and calculate

work volume for different robots.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- https://www.coppeliarobotics.com/
- https://www.youtube.com/watch?v=MX3VXvZFk0U

Ability Enhancement Course IV

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

IV SEMESTER

SPREAD SHEETS FOR ENGINEERS (AEC-IV)

Course Code	21RI481	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	02

Course objectives:

- To create different plots and charts
- To compute different functions, conditional functions and make regression analysis
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- To carryout matrix operations
- To Understand VBA and UDF
- To understand VBA subroutines and Macros
- To carryout numerical integration and solving differential equations using different methods

Sl.NO	Experiments
1	**Charting:** Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart
2	**Functions:** Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using The CONVERT Function to Convert Units
3	**Conditional Functions:** Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.
4	**Regression Analysis:** Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis ToolPack.
5	**Iterative Solutions Using Excel:** Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver, Minimization Analysis, NonLinear Regression Analysis.
6	**Matrix Operations Using Excel:** Adding Two Matrices, Multiplying a Matrix by a Scalar, Multiplying Two Matrices, Transposing a Matrix, Inverting a Matrix and Solving System of Linear Equations.
7	**VBA User-Defined Functions (UDF):** The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The For Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function The Excel Object Model, For Each Next Structure.
8	**VBA Subroutines or Macros:** Recording a Macro, Coding a Macro Finding Roots by Bisection, Using Arrays, Adding a Control and Creating User Forms.
	Demonstration Exercises
9	**Numerical Integration Using Excel:** The Rectangle Rule, The Trapezoid Rule, The Simpson's Rule, Creating a User-Defined Function Using the Simpson's Rule.
10	.
11	**Differential Equations:** Euler's Method, Modified Euler's Method, The Runge Kutta Method, Solving a Second Order Differential Equation
12	

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- To create different plots and charts
- To compute different functions, conditional functions and make regression analysis
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- To carryout matrix operations
- To Understand VBA and UDF

- To understand VBA subroutines and Macros
- To carryout numerical integration and solving differential equations using different methods

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

McFedries Pau lMicrosoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

IV SEMESTER

INTRODUCTION TO AI AND ML (AEC-IV)

Course Code	**21RI482**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- To familiarize basic principles, and applications of AI
- To guide the students on generalization as a means to capturing patterns in the data.
- To demonstrate the reasoning to internal representations of knowledge.
- To make to understand the of challenges in Artificial Intelligence domain.
- To acquaint with the future trends of Artificial Intelligence.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information..

Module-1

Introduction to AI: Introduction, The Turing Test Approach, Cognitive Modeling Approach, Laws of thought Approach, Rational agent Approach, AI Methods and tools, Foundations of Artificial Intelligence, Goals of AI, Performing Natural Language Processing using Email Filters in Gmail, Performing Natural Language Generation using Smart replies in Gmail.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

Fundamentals of Machine Learning: Describing structural patterns, Machine Learning, Data Mining, Simple Examples, Fielded Examples, Machine Learning and statistics, Generalization as a search, Data mining and ethics.Data preprocessing using Weka, Handling high dimensional data through feature reduction in Weka.

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3

Machine Learning Tasks:Decision Tables, Decision Trees, Classification rules, Association rules, Rules with exceptions, Rules involving relations, Trees for numeric prediction, Instancebased representation, Clusters.Building soybean classification model using decision trees, generating association rules on weather data using Weka, Exploring Classification and Clustering techniques using scikit-learn or Weka.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4

Nature-inspired techniques in AI:Inspiration from brain, Perceptron, Artificial Neural Net, Unsupervised Learning, Genetic Algorithms. Weather Prediction through Neural Networks using Weka, Perform data labelling for various images using Supervisely.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5	
Deep Learning: Basics of Deep Learning, Medical Image Analysis using Tensor Flow or Supervisely. Present and Future trends: The social effects of AI, A World with Robots, AI and Art, The Future, Integration, Artificial agents.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

- Understand the basic principles and goals of AI tasks.
- Outline the role of AI in different real-time applications.
- Construct a problem with the suitable AI task.
- Demonstrate the importance of biology in AI.
- Survey the future development of AI.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Text Book:

1. BlayWhitby, Artificial Intelligence: A Beginners Guide, Second Edition, One World Publisher, 2008.

2. Ian H. Witten, Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufman Publishers, 3rd Edition, 2011.

Reference Books:

1. AurélienGéron,Hands on Machine Learning with Scikit-Learn and TensorFlow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O'Reilly Media,2017
2. Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence,TMH Education Pvt. Ltd., 2008.
3. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Pearson.

Web links and Video Lectures (e-Resources):

- .

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Course seminar
- Term projects

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

IV SEMESTER

Introduction to Augmented Reality (AEC-IV)			
Course Code	**21RI483**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Describe how AR systems work and list the applications of AR.
- Understand and analyse the hardware requirement of AR.
- Use computer vision concepts for AR and describe AR techniques
- Analyse and understand the working of various state of the art AR devices
- Acquire knowledge of mixed reality

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

5. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
6. Chalk and Talk method for Problem Solving.
7. Adopt flipped classroom teaching method.
8. Adopt collaborative (Group Learning) learning in the class.
9. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction to Augmented Reality (A.R): Defining augmented reality, history of augmented reality, The Relationship between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum between Real and Virtual Worlds, applications of augmented reality

Augmented Reality Concepts- Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

Augmented Reality Hardware:

Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception , Requirements and Characteristics, Spatial Display Model.

Processors – Role of Processors, Processor System Architecture, Processor Specifications.

Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3

Computer Vision for Augmented Reality & A.R. Software: Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking **Augmented Reality Software -** Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-4	
AR Techniques- Marker based & Markerless tracking: Marker-based approach- Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication **Marker types-** Template markers, 2D barcode markers, imperceptible markers. **Marker-less approach**- Localization based augmentation, real world examples **Tracking methods-** Visual tracking, feature based tracking, hybrid tracking, and initialization and recovery.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5	
AR Devices & Components : AR Components – Scene Generator, Tracking system, monitoring system, display, Game scene **AR Devices –** Optical See- through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, and Video see-through systems	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Course outcome (Course Skill Set) At the end of the course the student will be able to: CO1: Describe how AR systems work and list the applications of AR. CO2: Understand and analyse the hardware requirement of AR. CO3: Use computer vision concepts for AR and describe AR techniques CO4: Analyse and understand the working of various state of the art AR devices CO5: Acquire knowledge of mixed reality	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

- First test at the end of 5^{th} week of the semester
- Second test at the end of the 10^{th} week of the semester
- Third test at the end of the 15^{th} week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4^{th} week of the semester
- Second assignment at the end of 9^{th} week of the semester
- Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Allan Fowler-AR Game Development‖, 1st Edition, A press Publications, 2018, ISBN 978-1484236178

2. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494

Reference Books:

1. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381

2. Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

Web links and Video Lectures (e-Resources):

- https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf
- https://docs.microsoft.com/en-us/windows/mixed-reality/
- https://docs.microsoft.com/en-us/archive/msdn-magazine/2016/november/hololens-introduction-to-the-hololens

MOOC Courses:

- https://www.coursera.org/learn/ar
- https://www.udemy.com/share/101XPi/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Course seminar
- Term project

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

V SEMESTER

FUNDAMENTALS OF AI FOR ROBOTICS (BSC)

Course Code	**21RI51**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

Students will be able

- Gain a historical perspective of AI and its foundations.
- Become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning.
- Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
- Experience AI development tools such as an 'AI language', expert system shell, and/or data mining tool.
- Experiment with a machine learning model for simulation and analysis.
- Explore the current scope, potential, limitations, and implications of intelligent systems.

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

INTRODUCTION: Introduction – History, Definition of AI, Emulation of human cognitive process, Intelligent agents – The concept of rationality, the nature of environments, the structure of agents.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 **8 HOURS**

SEARCH METHODS: Problem – Solving Agents : Problem Definitions, Formulating Problems, Searching for solutions – measuring Problem – Solving Performance with examples. Search Strategies : Uninformed search strategies – Breadth – first Search, Uniform – Cost Search, depth –first search, depth – limited search, Iterative deepening depth – first search, bidirectional search, comparing uniformed search strategies. Informed search strategies – heuristic information, Hill climbing methods, best – first search, branch – and – bound search, optimal search and A* and Iterative deepening A*.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 **8 HOURS**

PROGRAMMING AND LOGICS IN ARTIFICIAL INTELLIGENCE: LISP and other programming languages – Introduction to LISP, Syntax and numerical function, LISP and PROLOG distinction, input, output and local vaRIables, interaction and recursion, property list and arrays alternative languages, formalized symbolic logics – properties of WERS, non-deductive inference methods.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE-4	**8 HOURS**
EXPERT SYSTEM: Expert system – Introduction, difference between expert system and conventional programs, basic activities of expert system – Interpretation, Prediction, Diagnosis, Design, Planning, MonitoRIng, Debugging, Repair, Instruction, Control.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE 5	**8 HOURS**
Basic aspects of expert system – Acquisition module, Knowledge base – Production rules, semantic net, frames. Inference engine – Backward chaining and forward chaining. Explanatory interface.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.
- Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
- Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
- Demonstrate proficiency developing applications in an 'AI language', expert system shell, or data mining tool.
- Demonstrate proficiency in applying scientific method to models of machine learning.
- Demonstrate an ability to share in discussions of AI, its current scope and limitations, and societal implications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. Marks scored out of 100 shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

TEXT BOOKS:

Artificial Intelligence Modern Approach : Russell Stuart, Norvig Peter , Pearson Education seRIes in AI 3rd Edition, 2010.

Introduction to Artificial Intelligence and Expert Systems : Dan.W.Patterson, PHI Learning 2009

REFERENCES

A guide to Expert Systems : Donald.A.Waterman, Pearson 2002

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_ge29/preview

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

- Application based basic prototypes built by students
- Group discussions

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

V SEMESTER

HYDRAULICS AND PNEUMATICS (IPCC)

Course Code	**21RI52**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

**** Additional one hour may be considered for Instructions if required***

Course objectives:

This course will enable students to:

- Gain knowledge of basics of hydraulic and pneumatic systems.
- Understanding the working principles of hydraulics and pneumatics components.
- Engineering application of hydraulic and pneumatic systems.

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8HOURS**

Introduction to Hydraulic Power: Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law.

The source of Hydraulic Power: Pumps Classification of pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors, problems on pumps.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration. 3. Chalk and Talk.

MODULE-2 **8 HOURS**

Hydraulic Actuators and Motors: Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors).

Control Components in Hydraulic Systems: Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration. 3. Chalk and Talk.

MODULE-3 **8 HOURS**

Hydraulic Circuit Design And Analysis: Control of Single and Double -Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Double Pump Hydraulic System, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Locked Cylinder using Pilot check Valve, Cylinder synchronizing circuit using different methods, factors affecting synchronization, Speed Control of Hydraulic Cylinder, Speed Control of Hydraulic Motors, Safety circuit, Accumulators, types, construction and applications with circuits. **Maintenance of Hydraulic System:**Hydraulic Oils - Desirable properties, general type of Fluids, Sealing Devices, Reservoir System, Filters and Strainers, wear of Moving Parts due to solid - particle Contamination, temperature control (heat exchangers), Pressure switches, trouble shooting.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration. 3. Chalk and Talk.
MODULE-4	**8 HOURS**
Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. Pneumatic Actuators: Linear cylinder - Types, Conventional type of cylinder- working, End position cushioning, seals, mounting arrangements- Applications. Rod - Less cylinders types, working, advantages, Rotary cylinders- types construction and application, symbols. **Pneumatic Control Valves:** DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and Exhaust air throttling and Exhaust air throttling.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration. 3. Chalk and Talk.
MODULE 5	**8 HOURS**
Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Time dependent controls principle, Construction, practical applications. Multi- Cylinder Application: Coordinated and sequential motion control, Motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves). **Electro- Pneumatic Control:** Principles - signal input and output, pilot assisted solenoid control of directional control valves, Use of relay and contactors. Control circuitry for simple signal cylinder application.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration. 3. Chalk and Talk.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Design and analysis of Hydraulic circuit for Speed Control of single and .double acting cylinders.
2	Sequencing of two Hydraulic cylinders using sequence valves.
3	Design of regenerative Hydraulic circuit.
4	Hydraulic circuit using counterbalance valve.
5	Design and analysis of synchronization circuit for two cylinders.

6	Controlling of hydraulic linear and rotory actuators using PLC.
7	Speed Control of hydraulic cylinders and motors using solenoid valves.
8	Design of simple Hydraulic circuit for Hydraulic Jack.
9	Pneumatic circuit for Speed Control of double acting cylinders.
10	Pneumatic circuit for Speed Control of Pneumatic motor.
11	Sequencing of two Pneumatic cylinders using sequence valves.
12	Sequencing of two Pneumatic cylinders using Proximity switches.
13	Pick and place operation using pneumatic power.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Have knowledge of hydraulic and pneumatic system and its components.
- Understand the working principle of various hydraulic and pneumatic components.
- Apply working principles of Hydraulic and Pneumatic Systems for various applications.
- Determine cause for hydraulic and pneumatic system break down and performance of hydraulic pumps, motors.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Textbooks

- Fluid Power with Applications, Anthony Esposit,Pearson Education Inc.,6th Edition 2000.
- Pneumatics and Hydraulics, Andrew Parr, Jaico Publishing Co, 1993.

Referencebooks

- Industrial Hydraulics, Pippenger Hicks, McGraw Hill, New York
- Hydraulic & Pneumatic Power for Production,HarryL. Stewart,Industrial Press US, 1997.
- Pneumatic Systems, S. R. Majumdar,TATA McGraw Hill Publish, 1995.
- Hydraulic & Pneumatics' CMTI Data Book.

Web links and Video Lectures (e-Resources):

- **https://onlinecourses.nptel.ac.in/noc22_me36/preview**
- VTU, E- learning
- MOOCS
- Open courseware

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

- **Course seminar**
- **Term project**

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

V SEMESTER

NATURAL LANGUAGE PROCESSING (PCC)

Course Code	**21RI53**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0*-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

Students will be able

- To learn the fundamentals of natural language processing
- To understand the use of CFG and PCFG in NLP
- To understand the role of semantics of sentences and pragmatics
- To apply the NLP techniques to IR applications

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

6. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
7. Chalk and Talk method for Problem Solving.
8. Adopt flipped classroom teaching method.
9. Adopt collaborative (Group Learning) learning in the class.
10. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Introduction

Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM - Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 **8 HOURS**

WORD LEVEL ANALYSIS

Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 **8 HOURS**

SYNTACTIC ANALYSIS Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs - Feature structures, Unification of feature structures.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE-4	**8 HOURS**
SEMANTICS AND PRAGMATICS Requirements for representation, First-Order Logic, description Logics – Syntax-driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and distributional methods.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE 5	**8 HOURS**
DISCOURSE ANALYSIS AND LEXICAL RESOURCES Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and CenteRIng algorithm – Co reference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, Word Net, PropBank, FrameNet, Brown Corpus, and British National Corpus (BNC).	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Course outcome (Course Skill Set) At the end of the course the student will be able to : • To tag a given text with basic Language feature • To design an innovative application using NLP components • To implement a rule based system to tackle morphology/syntax of a language • To design a tag set to be used for statistical processing for real-time application • To compare and contrast the use of different statistical approaches for different types of NLP applications.	

Assessment Details (both CIE and SEE)

The weight age of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. Marks scored out of 100 shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

TEXT BOOKS:

1. Daniel Jurafsky, James H. Martin—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.

2. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python‖, First Edition, O_Reilly Media, 2009.

REFERENCES

1. Breck Baldwin, —Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.

2. RIchard M Reese, —Natural Language Processing with Java‖, O_Reilly Media, 2015.

3. Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.

4. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information RetRIeval‖, Oxford University Press, 2008.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/106/105/106105158/
- VTU, E- learning
- MOOCS
- Open courseware

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- **Course seminar**
- **Term project**

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

V SEMESTER

ROBOT OPERATING SYSTEM (PCC)

Course Code	**21RI54**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0*-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course objectives:

Students will be able

- Discuss the fundamental concepts of Operating Systems.
- Explain the mechanisms of Operating Systems to handle processes, threads and their communication.
- Analyze the file structure and the protection and security mechanism.
- Explain the Memory management technique to improve the CPU utilization and its response speed.

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 INTRODUCTION TO OPERATING SYSTEMS 8 HOURS

Basic principles, Operating System Structures, System Calls & Types, Processes: Concept – Scheduling - Inter Process Communication, Introduction to distributed Operating System, Types of network based OS.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 OVERVIEW OF RTOS 8 HOURS

RTOS Task and Task State, Pre-emptive Scheduler, Process Synchronization, Message Queues, Mailboxes, Pipes, critical Section, Semaphores, Classical Synchronization Problem –Deadlocks.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 BOARD SUPPORT PACKAGES 8 HOURS

Inserting BSP in Kernel Build Procedure, Boot loader Interface, Memory Map, Interrupt Management, PCI Subsystem: Timers - UART- Power Management. Embedded Storage: MTD – MTD Architecture - MTD driver for NOR Flash - Flash Mapping driver

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4 EMBEDDED KERNEL & COMPONENTS 8 HOURS

Embedded File System: RAM Disk – RAMFS – CRAMFS, Journaling Flash File Systems: JFFS and JFSS2, NFS: PROC File system, Optimizing storage Space: Kernel space optimization - Application Space Optimization, Applications for Embedded Linux - Tuning kernel memory.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE- 5 Linux Devices Drivers	**8 HOURS**
Embedded Drivers: Linux Serial Driver - Ethernet Driver - I 2C Subsystem on Linux - USB Gadgets, Watchdog Timer, Kernel Modules.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Discuss the basic concepts of operating system and Distributed system
- Explain RTOS task scheduling, task synchronization and task communication mechanisms.
- Install Linux for specified configuration, develop Linux C programs and implement Linux file system**.**

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

Text Books:

- Silberschatz, Galvin, Gagne, "Operating System Concepts", 6th edition, John Wiley, 2003.
- Raj Kamal, "Embedded Systems -Architecture, Programming and Design", Tata McGraw Hill, 2006.
- P. Raghavan, Amol Lad, SRIram Neelakandan, "Embedded Linux System Design and development", Auerbach Publications 2005.
- Jonathan Corbet, Allesandro Rubini & Greg Kroah-Hartman, "Linux Device DRIvers", O'Reilly, 3rdedition, 2005.

Reference Books:

- LENTIN JOSEPH " Robot operating system (ROS) for absolute beginners". Released May 2018 Publisher(s): Apress ISBN: 9781484234051.
- Anis Koubaa Robot Operating System (ROS) The Complete Reference (Volume 6) https://doi.org/10.1007/978-3-030-75472-3 Springer Cham

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=PEzpOembKNc
https://www.youtube.com/watch?v=mCs21yByQqk
https://www.youtube.com/watch?v=hDn4hM148V8
https://www.classcentral.com/course/edx-hello-real-world-with-ros-robot-operating-system-11555
https://www.youtube.com/watch?v=PEzpOembKNc
https://www.youtube.com/watch?v=mCs21yByQqk
https://www.youtube.com/watch?v=hDn4hM148V8

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Presentations

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

V SEMESTER

VIRTUAL INSTRUMENTATION AND AUTOMATION LAB (PCCL)

Course Code	**21RIL55**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03

Course objectives:

Students will be able to

- Understanding Virtual Instrument concepts and data acquisition operation
- Creating Virtual Instruments for practical works

Sl.NO	Experiments
1	Creating Virtual Instrumentation for simple applications- Invert The State Of Boolean Indicator Twice A See Until Program Is Stopped By User.
2	Programming exercises for loops in virtual instrumentation-Continuous Monitoring of Temperature (Generated using Random no 0<t
3	Programming exercises for graphs- Display Random Number Into 3 different CHARTS (STRIP, SLOPE,SWEEP) and understand the difference between these in the UI. 4
4	Programming Exercises on case and sequence structures:-Design the simple Calculator, making use of the inherent GUI present in the virtual instrumentation software.
5	Programming Exercises on Arrays– Take a 2D array input from the user and perform various array(and matrix) manipulations on it
6	6. Programming Exercises on File Input output System – Read and write from ASCII and TDMS files.
	Demonstration Experiments (For CIE)
7	Real time temperature acquisition and continuous monitoring using Virtual Instrumentation
8	Developing voltmeter using DAQ cards – Acquiring a voltage and displaying it on a ‘meter’ indicator on the UI, thus designing a voltmeter
9	Developing Signal Generator using DAQ Card – Using analog output; amplitude, shape and frequency controlled by user
10	Data acquisition through Virtual Instrumentation – Read voltage and current of the 50 Hz supply to compute power and power factor
11	Design and Development of Filter Analysis using DAQ card – Acquire audio and filter out bands using different filters and compare effects
12	Real time sequential control of any batch process – Water level control or Temperature control

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Understand, design and develop data acquisition systems for Various Sensor using DAQ Cards.
- Analyze the importance & applications of LabVIEW in real time Environment.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- https://www.youtube.com/watch?v=ZHNlKyYzrPE
- https://www.ni.com/pdf/manuals/373427j.pdf

etc....

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

V SEMESTER

MEDICAL ROBOTICS (AEC-V)

Course Code	**21RI581**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1-0-0-0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Provide knowledge on the application of robotics in the field of health care
- Overview of the sensor requirements for localization and tracking in medical applications
- Understand the design aspects of medical robots

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the vaRIous course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1 **3 HOURS**

Introduction : Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2 **3 HOURS**

Localization And Tracking : Position sensors requirements - Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic - Impedance-based - In-bore MRI tracking - Video matching - Fiber optic tracking systems - HybRId systems.

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3 **3 HOURS**

Control Modes : Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4 **3 HOURS**

Rehabilitation : Rehabilitation for Limbs - Brin-Machine Interfaces - Steerable Needles – case studies.
Robots In Medical Care: Assistive robots –types of assistive robots – case studies

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5 **3 HOURS**

Design of Medical Robots : CharacteRIzation of gestures to the design of robots- Design methodologies- Technological choices - SecuRIty.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Discuss about the sensors used for localization and tracking
- SummaRIze the applications of surgical robotics
- Outline the concepts in Rehabilitation of limbs and brin machine interface
- Classify the types of assistive robots.
- Analyze the design characteRIstics, methodology and technological choices for medical robots.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5^{th} week of the semester
- Second test at the end of the 10^{th} week of the semester
- Third test at the end of the 15^{th} week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4^{th} week of the semester
- Second assignment at the end of 9^{th} week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13^{th} week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

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Suggested Learning Resources:

Books

1. Medical robotics- Minimally Invasive surgery Paula Gomes Woodhead, 2012

Reference

2. Daniel Faust Medical Robots Rosen Publishers 2016

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=ZM1GZSO7MYs

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

V SEMESTER

BASICS OF MATLAB (AEC-IV)

Course Code	**21RI582**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Credits	01	Exam Hours	02

**** Additional one hour may be considered for instructions, if required***

Course objectives:

1. To know about fundamentals of MATLAB tool.
2. To provide an overview to program curve fitting & solve Linear and Nonlinear Equations.
3. To understand the concept and importance of Fourier transforms.
4. To gain knowledge about MATLAB Simulink & solve Electrical engineering problems.

Sl.NO	Experiments
1 2	**Introduction to MATLAB Programming:** Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control, working with files: Scripts and functions**,** plotting and programming output, examples.
3 4	**Numerical Methods and their applications: Curve Fitting: Straight line fit, Polynomial fit.**
5 6	**Numerical Integration and Differentiation:** Trapezoidal method, Simpson method.
7 8	**Linear and Nonlinear Equations:** Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using Gauss-Siedal and Newton-Raphson method.
9 10	**Ordinary Differential Equations:** Introduction to ODE's, Euler's method, second order RungaKutta method, MATLAB ode45 algorithm in single variable and multivariables. **Transforms:** Discrete Fourier Transforms,
11 12 13	Application of MATLAB to analyse problems in basic engineering mechanics, mechanical vibrations, control system, statistics and dynamics of different circuits. **MATLAB Simulink:** Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Able to implement loops, branching, control instruction and functions in MATLAB programming environment.
- Able to program curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve electrical engineering problems.
- Able to understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB.
- Able to simulate MATLAB Simulink examples

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

Text Books:

1. Agam Kumar Tyagi, "**MATLAB and Simulink for Engineers**", OXFORD Higher Education.

2. Dr. Shailendra Jain, "**Modeling& Simulation using MATLAB – Simulink**", Wiley – India.

Reference Books:

1. Won Y.Tang, Wemun Cao, Tae-Sang Ching and John Morris, "**Applied Numerical Methods Using MATLAB**", A John Wiley & Sons.

2. Steven T. Karris, "**Introduction to Simulink with Engineering Applications**", Orchard Publications.

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VI SEMESTER

QUALITY CONTROL PROCESS AND MAINTAINENCE MANAGEMENT (HSMC)

Course Code	**21RI61**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

* Additional One hour may be considered for instructions if required

Course objectives:

Students will be able

- Learn basic principles of quality management and ISO standards
- Understand the concept of preventive maintenance and safety system.
- Assess how quality control and assurance takes place
- Evaluate and apply control charts and SQC/SPCs

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 8 HOURS

Quality management: Concepts, Definition, Philosophy, Interpretations, Quality in Design, Quality in Performance, Quality Characteristics.

Quality And ISO Standards And Certification: ISO 9000 Family, Requirements, Quality Management Principles, Registration and Accreditation

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 8 HOURS

Total Preventive Maintenance (TPM) Failure Patterns, Cost and Preventive Maintenance, Planning for Preventive Maintenance, Concept of Corrective and Preventive Maintenance, Concept of Six Sigma (Zero Defects)

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 8 HOURS

Safety and total quality management: Implementing and Safety System, Safety Practices, Safety Standards (National and International). Core Concept, Practices, Benchmarking, Cost of Quality, Quality Process, Continuous Improvement, PDCA Cycle

Teaching-	1. Power-point Presentation,

Learning Process	2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4 8 HOURS

Quality control Inspection, Quality Control and Quality Assurance

Quality assurance methods and standards Product Quality Value Analysis, Classification of Defects Procedure, Specification of Inspection Method and Setting Standard Quality Levels

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE- 5 8 HOURS

Statistical quality control / statistical process control (SQC/SPC) (7 hours) Introduction, Concepts and Relevance, Tools and Techniques, Control Charts, Process Variation, acceptance Sampling by Attributes

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Learn basic principles of quality management and ISO standards
- Understand the concept of preventive maintenance and safety system.
- Assess how quality control and assurance takes place
- Evaluate and apply control charts and SQC/SPCs

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour)

First test at the end of 5th week of the semester

Second test at the end of the 10th week of the semester

Third test at the end of the 15th week of the semester

Two assignments each of 10 Marks

First assignment at the end of 4th week of the semester

Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks (duration 01 hours)

At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

The question paper will have ten questions. Each question is set for 20 marks.
There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.
The students have to answer 5 full questions, selecting one full question from each module.
SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:
Books
Text Books:

1. Juran, J.M., 1992, "*Juran on Quality by Design*", the Free Press.
2. Stamatis, D.H., 1994, "*Failure Mode and Effect Analysis*", ASQC Press.
3. Taguchi, G., 1987, " *Quality Engineering*", APO.
4. Feigenbaum, A., 1983, "*Total Quality Control*", McGraw Hill.
5. Ishikawa, K., 1976, "*Guide to Quality Control*", APO.

Reference Books:

1. Montgomery, C., 2005, "*Introduction to Statistical Quality Control*", 5th edition, John Wiley & Sons.
2. Garvin, D.A, 1989, "*Managing Quality: Strategic and Competitive Edge*", the Free Press.
3. Banks Jerry, *"Principles of Quality Control"* , John Wiley & sons, New York 1989
4. Douglas L. Montgomery, *"Introduction to Statistical Quality Control",* John Wiley & Sons.
5. Ray Tricker, *"ISO 9000 for Small Business",* Butter Worth- Heine mann Linacre House, Jordan Hill Oxford 1997
6. William J. Stevensm, *"Production/Operations Management"* , Richard. D. IRWAN. Inc. Toppan Company 1988
7. V. Feigenbaum, *"Total Quality Control"* Mc.Graw Hill Book Company. 1986.
8. amitava Mitra, second edition, *"Fundamentals of Quality Control & Improvement"*, Prentice-Hall International, 1998.
9. Grant, Eugene L., Werth, Richards Leaven, sixth edition, *"Statistical quality control",* Graw Hill International

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/107/112107259/
-

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- QUIZ
- SEMINARS
- GROUP DISCUSSIONS

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VI SEMESTER

COMPUTER VISION SYSTEM (IPCC)

Course Code	**21RI62**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-2*-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	04	Exam Hours	03

* Additional One hour may be considered for instructions if required

Course objectives:

Students will be able

- Learn basic principles of image formation, image processing algorithms and different Algorithms for recognition from single or multiple images (video).
- Understand the core vision tasks of scene understanding and recognition.
- Applications to 3D modelling, video analysis, video surveillance, object recognition

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1	**8 HOURS**
Introduction and Image Formation: What is computer vision? A brief history, Geometric Primitives and transformations, photometric image formation, The digital camera. Pinhole Perspective, Weak Perspective, Cameras with Lenses, The Human Eye, intrinsic Parameters and extrinsic Parameters, geometric Camera Calibration	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2	**8 HOURS**
Early Vision – One Image: Linear Filters and Convolution, Shift invariant Linear Systems, Spatial Frequency and fourier Transforms, Sampling and Aliasing, Filters as Templates, Local Image Features, Texture	
Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3	**8 HOURS**
Early Vision – Multiple Images: Stereopsis and Structure from Motion	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4	**8 HOURS**
Mid-level Vision: Segmentation by clustering, Grouping and Model fitting, Tracking.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE- 5	**8 HOURS**
High-level Vision: Registration, Smooth Surface and their Outlines, Range Data Detecting Objects in Images, Recognition	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Implement fundamental image processing techniques required for computer vision

- Understand Image formation process
- Perform shape analysis
- Develop applications using computer vision techniques
- Understand video processing and motion computation

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 02/03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and

scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

17. The question paper will have ten questions. Each question is set for 20 marks. Marks scorded shall be proportionally scaled down to 50 Marks
18. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
19. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

Text Books:

1. Computer Vision: Algorithms and Applications (CVAA), Richardszeliski, Springer, 2nd edition, 2020, http://szeliski.org/Book/

2. Computer Vision – A modern approach, by D. Forsyth and J. Ponce, Prentice Hall, 2nd edition, 2012.

Reference Books:

1. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc., 1992.

2. D. H. Ballard, C. M. Brown. Computer Vision. Prentice-Hall, Englewood Cliffs, 1982.

3. Image Processing, Analysis, and Machine Vision. Sonka, Hlavac, and Boyle. Thomson.

4.Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University, Press, 2012

5.Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Publisher: Prentice Hall.

6. Building Computer Vision Applications Using Artificial Neural Networks - With Step-by-step Examples in Opencv And Tensorflow With Python, Shamshad AnsaRI, A press, 2020

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc19_cs58/preview

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- To create a program to display grayscale image using read and write operation
- To create a vision program to convert a 2D array into a grayscale image.
- To create a vision program to convert gray images into an array of numbers.
- To create a program to rotate an image.
- To create a vision program to find histogram value and display histograph of a grayscale and color image
- To create a vision program for Non-Linear Filtering technique using edge detection.
- To create a vision program to determine the edge detection of an image using different operators,.
- To create a program to discretize an image using Fourier transformation.
- To create a program to perform Discrete cosine transform on an image.
- To create a program to eliminate the high frequency components of an image.
- To create a color image and perform read and write operation.
- To create a vision program to convert a 2D array into a color image.

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VI SEMESTER

INDUSTRY 4.0 & IIOT (PCC)			
Course Code	**21RI63**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course objectives:

Students will be able

- To understand the basic concepts of Industry 4.0
- To understand the Technologies & Framework for Industry 4.0.
- To understand the basic concepts in Industrial IOT
- To understand IOT technologies and key opportunities in the industry
- To understand IOT architecture and protocols

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the vaRIous course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1	**8 HOURS**
Introduction to Industry 4.0: Introduction, core idea of Industry 4.0,origin concept of industry 4.0,Industry 4.0 productionsystem, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0 **A Conceptual Framework for Industry 4.0:** Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2	**8 HOURS**
Industrial Internet – Key IIOT technologies – Innovation and the IIOT – Key oppurtunities and Benefits – The Digital and Human Workforce – Logistics and the Industrial Internet – IOT Innovations in Retail. Cyber Physical Systems (CPS) – IP Mobility – Network Virtualization – SDN (software Defined Networks) – The cloud and Fog – Role of Big Data in IIOT – Role of Machine learning and AI in IIOT.	
Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3	**8 HOURS**
Industrial Internet Architecture Framework (IIAF) - Industrial Internet Viewpoints – Architectural Topology: The Three – tier Topology – Key System Characteristics – Data Management – Advanced data Analytics.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4	**8 HOURS**
Legacy Industrial Protocols – Modern Communication Protocols – Proximity Network Communication Protocols – Wireless Communication Technologies – Gateways: Industrial gateways – CoAP (Constrained Application Protocol) – NFC	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE- 5	**8 HOURS**
Publish / Subscribe Pattern: MQTT, XMPP, AMQP, DDS – Middleware Architecture – SigFox – LoRaWAN – Augumented reality – Real World Smart Factories	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Gain the basic knowledge of industry 4.0
- Understand the various technologies of industry 4.0
- Learn the various technologies of IOT
- Able to implement Industrial application using sensors
- Identify the IOT related opportunities in industry

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

Text Books:

- Alp Ustundag and EmreCevikcan,"Industry 4.0: Managing the Digital Transformation".
- Bartodziej, ChristophJan,"The Concept Industry 4.0".

Reference Books:

- 1Gilchrist, Alasdair. Industry 4.0 The Industrial Internet of Things. Apress, 2017.
- Sabina Jeschke, Christian Brecher, Houbling Song,Danda B. Rawat. Industrial Internet Of Things: Cyber

- Manufacturing Systems. Springer 2017
- 3ZaighamMahmoodThe Internet of Things in the Industrial Sector: Security and Device connectivity, smart
- environments and Industry 4.Springer 2019

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc20_cs69/preview
- https://archive.nptel.ac.in/courses/106/105/106105195/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. To create a program to display grayscale image using read and write operation
2. To create a vision program to convert a 2D array into a grayscale image.
3. To create a vision program to convert gray images into an array of numbers.
4. To create a program to rotate an image.
5. To create a vision program to find histogram value and display histograph of a grayscale and color image
6. To create a vision program for Non-Linear Filtering technique using edge detection.
7. To create a vision program to determine the edge detection of an image using different operators,.
8. To create a program to discretize an image using Fourier transformation.
9. To create a program to perform Discrete cosine transform on an image.
10. To create a program to eliminate the high frequency components of an image.
11. To create a color image and perform read and write operation.
12. To create a vision program to convert a 2D array into a color image.

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VI SEMESTER

NEURAL NETWORK & FUZZY LOGIC SYSTEMS (PEC-I)

Course Code	**2RI641**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0*-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course objectives:

Students will be able

- To expose the students to the concepts of feed forward neural networks.
- To provide adequate knowledge about feedback networks.
- To teach about the concept of fuzziness involved in vaRIous systems.
- To provide adequate knowledge about fuzzy set theory

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the vaRIous course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Introduction. – Neural Networks, Application Scope of Neural Networks, Fuzzy Logic, GeneRIcAlgoRIthm, HybRId Systems, Soft Computing. Artificial Neural Network: An Introduction. – Fundamental Concept, Evolution of Neural Networks, Basic models of Artificial Neural Networks (ANN), Important Technologies of ANNs, McCulloch-Pitts Neuron, Linear Separability.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 **8 HOURS**

Hebb Network and simple problems, Supervised Learning Network – Introduction -Perceptron Networks, Adaptive Linear Neuron (Adaline), Multiple Adaptive Linear Neurons.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 **8 HOURS**

Back -Propagation Network. – Theory, Architecture, Flowchart for training process, Training algorithm, Learning Factors of Back-Propagation Network, Testing algorithm of Back-Propagation Network. Radial Basis Function Network, Time Delay Neural Network, Functional Link Networks, Tree Neural Networks, wavelet neural network.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4 **8 HOURS**

Introduction to Fuzzy Logic, Classical sets and Fuzzy sets. Introduction to Fuzzy Logic, Classical sets (cRIsp sets) – Operations on Classical sets, Properties of Classical sets, Function of Mapping of Classical sets. Fuzzy sets – Fuzzy set operations, Properties of fuzzy sets. Simple Problems Classical Relations and Fuzzy Relations – Introduction, Cartesian Product of Relation, Classical Relation, Fuzzy Relation, Tolerance and Equivalence Relations, Non-interactive Fuzzy sets, Simple Problems.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE 5 **8 HOURS**

Membership Functions – Introduction, Features of the Membership functions, Fuzzication, Methods of Membership Value Assignments, Simple Problems Defuzzification- Introduction, Lamba-cuts for Fuzzy sets (Alpha-Cuts), Lamba-Cuts for Fuzzy Relation, Defuzzification Methods. Fuzzy Logic Control Systems – Introduction, Control System Design, Architecture and Operation of FLC system, FLC system Models, Application of FLC systems.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Compare and contrast the biological neural network and ANN.
- Discuss the ANN for pattern classification.
- Develop and configure ANN'swith different types of functions and learning algoRIthms.
- Apply ANN for real world problems.
- Discuss the fundamentals of fuzzy logic, implementation and their functions
- Apply fuzzy logic concepts in building automated control systems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

Text Books:

S. N. Sivanandam and S.N. Deepa, PRInciples of Soft Computing, 2nd Edition, Wiley India Pvt. Ltd.-2014.

Timothy J. Ross, Fuzzy logic with engineeRIng applications, McGraw Hill International Edition, 1997

Reference Books:

Simon Haykin, Neural Networks: A comprehensive foundation, 2nd Edition, PHI, 1998.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_ge04/preview
- http://www.scholarpedia.org/article/Fuzzy_neural_network
- https://www.tutorialspoint.com/fuzzy_logic/fuzziness_in_neural_networks.htm

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VI SEMESTER

MICRO ROBOTICS (PEC-I)

Course Code	**21RI642**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- Provide brief introduction to micromachining and the principles of Microsystems
- Understand the various flexures, actuators and sensor systems.
- Discuss the methods of implementation of micro robots.

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction

MST (Micro System Technology) – Micromachining - Working principles of Microsystems - Applications of Microsystems.

Scaling Laws and Materials for MEMS

Introduction - Scaling laws - Scaling effect on physical properties, scaling effects on Electrical properties, scaling effect on physical forces. Physics of Adhesion - Silicon-compatible material system - Shape memory alloys - Material properties: Piezoresistivity, Piezoelectricity and Thermoelectricity.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

Flexures, Actuators and Sensors

Elemental flexures - Flexure systems - Mathematical formalism for flexures. Electrostatic actuators, Piezo-electric actuators, Magneto-strictive actuators. Electromagnetic sensors, Optical-based displacement sensors, Motion tracking with microscopes.

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3

Micro robotics

Introduction, Task specific definition of micro-robots - Size and Fabrication Technology based definition of micro robots - Mobility and Functional-based definition of micro-robots - Applications for MEMS based micro-robots.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4

Implementation of Micro robots

Arrayed actuator principles for micro-robotic applications – Micro-robotic actuators - Design of locomotive micro-robot devices based on arrayed actuators. Micro-robotics devices: Micro-grippers and other micro-tools - Micro conveyors - Walking MEMS Micro-robots – Multi-robot system: Micro-robot powering, Micro-robot communication.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5

Micro fabrication and Micro Assembly:

Micro fabrication principles- Design selection criteria for micromachining – Packaging and Integration aspects – Micro – assembly platform and manipulators.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Describe the principles of microsystems and micromachining.
- Analyze the effects of scaling laws on physical and electrical properties and the materials to be used to MEMS.
- Specify the characteristics of various flexures, actuators and sensor systems
- Provide a task specification of micro robots and its applications based on the knowledge about micro robots
- Outline the various methods of implementation of micro robots.
  Discuss about the principle of micro fabrication and micro assembly.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

- The MEMS Handbook, Mohamed Gad el-Hak, CRC Press, New York, 2002
- Microrobotics Methods and Applications Yves Bellouard CRC Press, MassachusettS, 2011
- An Introduction to Microelectromechanical systems Engineering NadimMaluf and Kirt Williams, Artech House, MA 2002
- Microsensors: Principles and Applications Julian W Gardner, John Wiley & Sons, 1994
- Microsystem Technology and MicroroboticsSergejFatikow, Ulrich Rembold Springer 2013

Web links and Video Lectures (e-Resources):

- . https://ieeexplore.ieee.org/document/7090614
- https://www.robotpark.com/academy/all-types-of-robots/micro-robots-microbotics/
- https://www.micro.seas.harvard.edu/research

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VI SEMESTER

DATA STRUCTURE & ALGORITHM (PEC-I)

Course Code	**2RI643**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0*-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course objectives:

Students will be able

- Assess how the choice of data structures and algorithm design methods impacts the performance of programs.
- Choose the appropriate data structure and algorithm design method for a specified application.
- Write programs using object-oriented design principles.
- Solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, tournament trees, binary search trees, and graphs and writing programs for these solutions.
- Solve problems using algorithm design methods such as the greedy method, divide and conquer, dynamic programming, backtracking, and branch and bound and writing programs for these solutions.

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

6. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
7. Chalk and Talk method for Problem Solving.
8. Adopt flipped classroom teaching method.
9. Adopt collaborative (Group Learning) learning in the class.
10. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Introduction to C, constants, variables, data types, input output operations, operators and expressions, control statements, arrays, strings, built-in functions, user defined functions, structures, unions and pointers

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 **8 HOURS**

Algorithms, Asymptotic notations, Introduction to data structures, Types of data structures, Arrays.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 **8 HOURS**

Linked Lists:

Definition, Representation of linked lists in Memory, Memory allocation; Garbage Collection. Linked list operations: Traversing, Searching, Insertion, and Deletion. Doubly Linked lists, Circular linked lists, and header linked lists. Linked Stacks and Queues. Applications of Linked lists – Polynomials, Sparse matRIx representation.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4 **8 HOURS**

Trees: Terminology, Binary Trees, Properties of Binary trees, Array and linked Representation of Binary Trees, Binary Tree Traversals - Inorder, postorder, preorder; Additional Binary tree operations. Threaded binary trees, Binary Search Trees – Definition, Insertion, Deletion, Traversal, Searching, Application of Trees-Evaluation of Expression, Programming Examples

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE 5 **8 HOURS**

Graphs, Sorting /selection, insertion, bubble, quick)and searching(Linear, Binary, Hash)

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Identify different data structures in C programming language
- Apprise the use of data structures in problem solving
- Implement data structures using C programming language.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

Text Books:

1. Data structures using C , E Balagurusamy, McGraw Hill education (India) Pvt. Ltd, 2013.

Reference Books:

1. Ellis Horowitz and SartajSahni, Fundamentals of Data Structures in C, 2nd Ed, Universities Press, 2014.
2. Seymour Lipschutz, Data Structures Schaum's Outlines, Revised 1st Ed, McGraw Hill, 2014.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/106/106/106106127/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VI SEMESTER

FUNDAMENTAL OF ROBOTICS (OEC-I)

Course Code	**21RI651**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To gain knowledge on basics of Robotics
- To understand End effectors and robot controls
- To understand Robot Transformations and Sensors
- To gain knowledge on Robot cell design and applications
- To relate the knowledge on Micro/Nano robotic systems

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through Power Point presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information

Module-1 **8 HOURS**

INTRODUCTION

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics- Accuracy and repeatability of Robotics-Simple problems-Specifications of Robot- Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems-Hydraulic, Pneumatic and Electric system.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration 3. Chalk and Talk are used for Problem Solving (In-general).

Module-2 **8 HOURS**

END EFFECTORS AND ROBOT CONTROLS

Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration

	3. Chalk and Talk are used for Problem Solving (In-general).

Module-3

8 HOURS

ROBOT TRANSFORMATIONS AND SENSORS

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors – Robotic vision sensor-Force sensor-Light sensors, Pressure sensors.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration 3. Chalk and Talk are used for Problem Solving (In-general).

Module-4

8 HOURS

ROBOT CELL DESIGN AND APPLICATIONS

Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software Introductions-Robot applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and undersea robot.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration 3. Chalk and Talk are used for Problem Solving (In-general).

Module-5

8 HOURS

MICRO/NANO ROBOTICS SYSTEM

Micro/Nanorobotics system overview-Scaling effect-Top down and bottom up approach- Actuators of Micro/Nano robotics system-Nanorobot communication techniques-Fabrication of micro/nano grippers-Wall climbing micro robot working principles-Biomimetic robot-Swarm robot-Nanorobot in targeted drug delivery system.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration 3. Chalk and Talk are used for Problem Solving (In-general).

Course outcome (Course Skill Set)

At the end of the course the student will be able:

CO 1. To understand the basics of robotics, sensors, Programming and Applications of Robots

CO 2. To illustrate the different applications of robotics in Industries

CO 3. To analyze simple robot kinematics and dynamics

CO 4. To design general robot cell layouts

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Deb .S.R, "Robotics Technology and flexible automation", Tata McGraw-Hill Education, 2009.
2. Mikell P Groover& Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, "Technology Programming and Applications", McGraw Hill, 2012.
3. Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", Phi Learning., 2009.
4. Francis N. Nagy, AndrasSiegler, "Engineering Foundation of Robotics", Prentice Hall Inc., 1987.
5. Janaki Raman .P.A, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.
6. Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University Press, 2008.
7. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book co, 1987.
8. Craig. J. J. "Introduction to Robotics Mechanics and Control", Addison- Wesley, 1999.
9. Ray Asfahl. C., "Robots and Manufacturing Automation", John Wiley & Sons Inc.,1985.
10. Bharat Bhushan., "Springer Handbook of Nanotechnology", Springer, 2004.
11. Julian W. Gardner., "Micro sensor MEMS and Smart Devices", John Wiley & Sons, 2001.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Industrial visit to understand the importance of robots in Industries

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VI SEMESTER

SERVICE ORIENTED ARCHITECTURE (OEC-I)

Course Code	**2RI652**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0*-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course objectives:

Students will be able

- Compare vaRIous architecture for application development
- Illustrate the importance of SOA in Application Integration
- Learn web service and SOA related tools and governance

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the vaRIous course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

SOA BASICS: Software Architecture; Need for Software Architecture, Objectives of Software Architecture, Types of IT Architecture, Architecture Patterns and Styles, **Service Oriented Architecture;** Service orientation in Daily Life, Evolution of SOA, Drives for SOA, Dimension of SOA, Key components, perspective of SOA, **Enterprise-wide SOA;** Considerations for Enterprise-Wide SOA, Strawman Architecture For Enterprise-Wide-SOA-Enterprise, SOALayers, Application Development Process, SOA Methodology Enterprise

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 **8 HOURS**

Enterprise Applications; Architecture Considerations, Solution Architecture for enterprise application, **Software platforms for enterprise Applications;** Package Application Platforms, Enterprise Application Platforms, **Service-Oriented-Enterprise Applications;** Considerations for Service-oriented Enterprise Applications, Patterns for SOA, Pattern-Based Architecture for

Service-oriented Enterprise Application(java reference model only).Composite

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 **8 HOURS**

SOA ANALYSIS AND DESIGN; Need For Models, Principles of Service Design, Design of Activity Services, Design of Data services, Design of Client services and Design of business process services, **Technologies of SOA;** Technologies For Service Enablement, Technologies For Service Integration, Technologies for Service orchestration.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE-4	**8 HOURS**
Business case for SOA; Stakeholder OBJECTIVES, Benefits of SOA, Cost Savings, Return on Investment, SOA Governance, **Security and implementation;** SOA Governance, SOA Security, approach for enterprise wide SOA implementation, **Trends in SOA;** Technologies in Relation to SOA, Advances in SOA.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE 5	**8 HOURS**
SOA Technologies-PoC; Loan Management System(LMS), PoC-Requirements Architectures of LMS **SOA based integration;** integrating existing application, **SOA best practices,** Basic SOA using REST. Role of WSDL,SOAP and JAVA/XML Mapping in SOA.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Understand the different IT architectures
- Explain SOA based applications
- Illustrate web service and realization of SOA
- Discuss restful services

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

Text Books:

1. Service–ORIented Architecture for Enterprise Applications: Shankar Kambhampaly, Wiley, Second Edition, 2014
2. SOA using Java Web Services: Mark D. Hansen, Practice Hall 2007

Reference Books:

1. SOA-Based Enterprise Integration: Waseem Roshen, Tata McGraw-HILL, 2009.

Web links and Video Lectures (e-Resources):

- https://www.coursera.org/learn/service-oriented-architecture
- http://www.nitttrc.edu.in/nptel/courses/video/106105167/L10.html
-

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VI SEMESTER

FINITE ELEMENT ANALYSIS LAB (PCCL)

Course Code	**21RIL66**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0-0-2*-0	SEE Marks	50
Credits	01	Exam Hours	03

**** Additional one hour may be considered for instructions if required.***

Course objectives:

The students will be able

- To understand the basic procedure of Finite element Analysis.
- To acquire the technique of static analysis of bars, beams, trusses and plates.
- To solve the 1D and 2D heat transfer problem through FEA.
- To have the acquaintance of 1D modal and harmonic FEA.

Sl.NO	**Experiments**
1	Basics of FEM theory and FEA software.
2	Static Structural analysis of 1D bar elements of uniform cross sectional area, stepped bar and also tapered bars with point load.
3	Analysis of trusses having 3 members and 4 members.
4	Analysis of cantilever and simply supported beams with point load, uniformly distributed load, uniformly varying load and moment.
5	
6	Stress analysis of a rectangular plate with a circular hole. Modal analysis of beams.
7	Harmonic analysis of beams with fixed-fixed boundary condition.
8	Harmonic analysis of stepped bars.
9	Thermal analysis: 1D and 2D conduction problems with convective boundary conditions.
10	
	Demonstration Experiments (For CIE)
11	Demonstration of importing the file formats like iges, step and parasolid followed by meshing and analyzing in a FEA software.
12	Demonstration of one example of contact stress analysis.
13	Demonstration of structural analysis of composite plate with 2D Shell element.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Compute the stress, strain and deformation of 1D bar elements with stepped and tapered cross section.
- Draw the shear force and bending moment diagrams for beams, compute the bending stresses, deformation and slope.
- Analyse the member forces and deformation in a truss structure.
- Compute the natural frequency of beams and also obtain the time-displacement plot for beams and bars with forcing functions.
- Obtain the temperature distribution in 1D and 2D heat transfer problems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks)

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

- All laboratory experiments are to be included for practical examination.

- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours
Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VII SEMESTER

INDUSTRIAL ROBOTICS (PCC)

Course Code	**21RI71**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- Todemonstrateknowledgeofdifferenttypesofactuatorsusedinroboticsystems.
- To analyze the position and velocity kinematics of a robot arm, in 2D.
- To analyze the dynamics of a robot arm, implement in 2D.
- To analyze sensor signals to implement real-time control algorithms.
- To demonstrate knowledge of error propagation in electrical, mechanical and computational systems.
- To construct, program, and test the operation of a robotic system to perform a specified task.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Arrange visits to show the live working models other than laboratory topics.
- Adopt collaborative (Group Learning) Learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information

Module-1

8 HOURS

Introduction: Automation and Robotics, Robot anatomy configuration, motions joint motion and notation, work volume, robot drive system, control system and dynamic performance, precision of movement.

Control System and Components: basic concept and modals controllers control system analysis, robot actuators and feedback components (sensors): Internal & External Sensors, Positions sensors, velocity sensors - Desirable features, tactile, proximity and range sensors, uses sensors in robotics, Power Transmission Systems.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration 3. Chalk and Talk are used for Problem Solving (In-general).

Module-2

8 HOURS

Motion Analysis and Control: Manipulator kinematics, position representation Homogeneous transformation, D-H Notation, D-H Transformation Matrix, Forward & Inverse transformations, problems on planar & spatial manipulators, Differential Kinematics, Jacobian Formulation, problems, manipulator path control: Slew, Joint Interpolated & Straight line motions, trajectory planning: Joint space scheme, Cartesian space scheme, Cubic Polynomial fit without and with via point, blending.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration 3. Chalk and Talk are used for Problem Solving (In-general).

Module-3

8 HOURS

Robot Dynamics: Lagrange – Euler & Newton - Euler formulations, problems on two link planar manipulators, configuration of robot controller.

End Effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design.

Machine Vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, Image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration 3. Chalk and Talk are used for Problem Solving (In-general).

Module-4

8 HOURS

Robot Programming: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINGNAL AND DELAY commands, Branching capabilities and Limitations.

Robot Languages: Textual robot languages, Generation, Robot language structures, Elements and functions.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration 3. Chalk and Talk are used for Problem Solving (In-general).

Module-5

8 HOURS

Robot Cell Design and Control: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work cell design, Work cell control, Inter locks, Error detection, Work cell controller.

Robot Applications: Material transfer, Machine loading/unloading. Processing operations, Assembly and Inspection, Future Applications.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration 3. Chalk and Talk are used for Problem Solving (In-general).

Course outcome (Course Skill Set)

At the end of the course the student will be able:

CO 1. Understand the evolution, classification, structures and drives for robots.

CO 2. Teach the students about the kinematic arrangement of robots and its applications in the area of manufacturing Sectors.

CO 3. Expose the students to build a robot for any type of application.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
  The students have to answer 5 full questions, selecting one full question from each module
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

TEXT BOOKS:

1. Introduction to Robotics Mechanics & Control by John J. Craig, Pearson
2. Industrial robotics by Mikell P. Groover, McGraw Hill.

REFERENCE BOOKS:

3. Industrial robotics by Mikell P. Groover, McGraw Hill
4. Robotics by K.S.Fu, McGraw Hill.
5. Introduction to Robotics Mechanics & Control by John J. Craig, Pearson
6. Robot Analysis by Lung Wen Tsai, John Wiley & Sons
7. Robot Analysis and Control by Asada H. and J. E. Slotin, Wiley, New York

http://www.nitttrc.edu.in/nptel/courses/video/112101099/lec1.pdf
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Industrial visit to understand the importance of robots in Industries

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VII SEMESTER

CONTROL ENGINEERING (PCC)

Course Code	**21RI72**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	02	Exam Hours	03

Course objectives:

- To develop comprehensive knowledge and understanding of modern control theory, industrial automation, and systems analysis.
- To model mechanical, hydraulic, pneumatic and electrical systems.
- To represent system elements by blocks and its reduction techniques.
- To understand transient and steady state response analysis of a system.
- To carry out frequency response analysis using polar plot, Bode plot.
- To analyse a system using root locus plots.
- To study different system compensators and characteristics of linear systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Modelling of Systems and Block diagram: Introduction to Control Systems, Types of Control Systems, with examples. Concept of mathematical modelling of physical systems- Mechanical, Translational (Mechanical accelerometer, systems excluded), and Rotational systems, Analogous systems based on force voltage analogy and force current analogy. Introduction to Block diagram algebra. Numerical problems on all topics.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

Signal Flow graph: Introduction to Signal Flow graph, Mason's gain formula. Obtaining Transfer functions for the given SFG using Mason's gain formula.

Time response analysis: Introduction. Standard test signals, response of first order & second order systems for unit step input. Steady state errors & Error constants. Numerical problems on all topics.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3

Concepts of stability: The Concept of stability. Necessary conditions for stability. Hurwitz stability criterion. Routh stability criterion. Relative stability analysis using RH Criterion. **Frequency domain Analysis:** Introduction to frequency domain analysis, Correlation between time & frequency response	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-4	
The Root Locus Technique: Introduction. Root locus concepts. Construction of root loci. Stability analysis using Root locus Technique Numerical problems on all topics. **Frequency domain Analysis:** Introduction to frequency domain analysis Bode plots	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5	
State space Analysis: Concept of state, state variables and state model. State diagrams and State models for Linear continuous-time systems (Electrical systems): State space representation using Physical and Phase variables. Derivation of transfer functions from the state model. Numerical problems on all topics. **Solution of state equations:** Solutions of homogeneous and Nonhomogeneous state equations. Properties of state transition matrix, computation of state transition matrix by matrix exponential and Laplace transform method. Numerical problems	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

1. Demonstrate the concepts of Control systems and its Specifications for mathematical modelling, feedback control and stability analysis in Time and Frequency domains
2. Express and solve system equations in state-variable form (state variable models), Identify open and closed loop control system to Solve Signal Flow graph and reduction of Block diagram
3. Apply root-locus and Routh–Hurwitz stability criterion technique to analyse and design control systems
4. Determine the time and frequency-domain responses of first and second-order systems to step and sinusoidal (and to some extent, ramp) inputs Formulate mathematical modelling of physical systems(Mechanical and Electrical System)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1 Automatic Control Systems Farid G., Kuo B. C McGraw Hill Education 10th Edition,2018
2 Control Systems Engineering IjNagrath, M Gopal New Age International (P) Ltd 2018
3 Control systems Manik D. N Cengage 2017

Reference Books

1 Modern control Engineering K. Ogata Pearson 5th Edition, 2010
2 Control Systems Engineering Norman S Nice Fourth Edition, 2007
3 Modern control Systems Richard C Dorf Pearson 2017
4 Control Systems Engineering S Palani Tata McGraw Hill Publishing Co Ltd ISBN-13 9780070671935

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/108/106/108106098/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VII SEMESTER

TOTAL QUALITY MANAGEMENT (PEC-II)

Course Code	**21RI731**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0*-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course objectives:

Students will be able

- To introduce the main principles of business and social excellence
- To generate knowledge and skills of students to use models and quality management methodology for the implementation of total quality management in any sphere of business and public sector.

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Introduction: The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems.

Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs. Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 **8 HOURS**

Customer Focus and Satisfaction: Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships.

Bench Marking: Evolution of Bench Marking, meaning of bench marking, benefits of bench marketing, the bench marking procedure, pitfalls of bench marketing.

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 **8 HOURS**

Organizing for TQM: The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organization, Quality Circles, seven Tools of TQM: Startification, check sheet, Scatter diagram, lshikawa diagram, paneto diagram; Kepner&Tregoe Methodology.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE-4	**8 HOURS**
The Cost of Quality: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost information, Accounting Systems and Quality Management	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE 5	**8 HOURS**
ISO 9000: Universal Standards of Quality: ISO around the world, The ISO 9000 ANSI/ASQC Q- 90. Series Standards, benefits of ISO 9000 certification, the third party audit, Documentation ISO9000 and services, the cost of certification implementing the system.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Identify data mining problems and implement the data warehouse
- Write association rules for a given data pattern.
- Choose between classification and clustering solution.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

Text Books:

1. Total Quality Management by Joel E. Ross.
2. P.N. Mukherjee, PHI publications.

Reference Books:

1. Beyond TQM by Robert L. Flood
2. Statistical Quality Control by E.L. Grant.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_mg03/preview

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VII SEMESTER

DATA MINING & DATA WARE HOUSE (PEC-II)

Course Code	**21RI732**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0*-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course objectives:

Students will be able

- Define multi-dimensional data models.
- Explain rules related to association, classification and clustering analysis.
- Compare and contrast between different classification and clustering algorithms

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Data Warehousing & modelling: Basic Concepts: Data Warehousing: A multitier Architecture, Data warehouse models: Enterprise warehouse, Data mart and virtual warehouse, Extraction, Transformation and loading, Data Cube: A multidimensional data model, Stars, Snowflakes and Fact constellations: Schemas for multidimensional Data models, Dimensions: The role of concept Hierarchies, Measures: Their categorization and computation, Typical OLAP Operations

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 **8 HOURS**

Data warehouse implementation& Data mining: Efficient Data Cube computation: An overview, Indexing OLAP Data: Bitmap index and join index, Efficient processing of OLAP Queries, OLAP server Architecture ROLAP versus MOLAP Versus HOLAP. **:** Introduction: What is data mining, Challenges, Data Mining Tasks, Data: Types of Data, Data Quality, Data Pre-processing, Measures of similarity and dissimilarity.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 **8 HOURS**

Association Analysis: Association Analysis: Problem Definition, Frequent Item set Generation, Rule generation. Alternative Methods for Generating Frequent Item sets, FP Growth algorithm, Evaluation of Association Patterns	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE-4	**8 HOURS**
Classification : Decision Trees Induction, Method for comparing Classifiers, Rule Based Classifiers, Nearest Neighbour Classifiers, Bayesian Classifiers.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE 5	**8 HOURS**
Clustering Analysis: Overview, K-Means, Agglomerative Hierarchical clustering, DBSCAN, Cluster Evaluation, Density-Based Clustering, Graph-Based Clustering, Scalable Clustering algorithms.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Course outcome (Course Skill Set) At the end of the course the student will be able to : • Identify data mining problems and implement the data warehouse • Write association rules for a given data pattern. • Choose between classification and clustering solution.	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

Text Books:

1. Introduction to Data Mining: Pang-Ning Tan, Michael Steinbach, Vipinkumar, Pearson, First edition, 2014.
2. Data Mining -Concepts and techniques: Jiawei Han, MichelineKamber, Jian Pei, Morgan Kaufmann Publisher, 3rd Edition 2012

Reference Books:

1. Data Warehousing in the Real world, Sam Anahory, Dennis Murray, Pearson, Tenth Impression,2012
2. MasteRIng Data Mining: Michael.J.Berry,Gordon, Wiley Edition, second edtion,2012

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc20_cs12/preview

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VII SEMESTER

MOTORS, DRIVES & POWER ELECTRONICS (PEC-III)

Course Code	**21RI741**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0*-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course objectives:

Students will be able

- To understand and acquire knowledge about various power semiconductor devices.
- To prepare the students to analyze and design different power converter circuits

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Elements and Dynamics of Electric Drive Systems

Basic components of an Electric drive system: Mechanical loads, electric motors, power sources, converters and controllers. Moment of inertia, basic concept of Traveling time, gears and belts, traveling time of dc motors and traveling time of induction motors.

Braking of electric motors

DC shunt and series motors: Regenerative, dynamic, and concurrent braking. Induction motors: Regenerative , dynamic and concurrent braking

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 **8 HOURS**

Power electronic devices

Ratings of power electronic devices, Characteristics of : power diodes, power transistors, power mosfets, triac and IGBT. Thyristors (SCR): static VI characteristics, turn on methods, switching characteristics, gate characteristics, two transistor model, di/dt and dv/dt protection. Firing circuits for SCRs

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 **8 HOURS**

Solid state switching circuits

Single- phase , half-wave, ac/dc conversion for resistive loads, Single- phase , full-wave, ac/dc conversion for resistive loads, Single- phase , half-wave, ac/dc conversion for inductive loads without/with freewheeling diode, single phase dc/ac converter, voltage, frequency and sequence control and PWM,. Current source Inverter.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4 **8 HOURS**

Speed –torque characteristics of electric motors

Joint Speed-Torque Characteristics of Electric Motors and Mechanical Loads DC motors: separately excited motors, shunt motors, series motors and compound motors, Induction motors: equivalent circuit, power flow, torque characteristics, starting procedure ,Damage to electric machines.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE 5 **8 HOURS**

Speed Control of Electric motors

Speed control of shunt or separately excited DC motors: by adding resistance, adjusting armature voltage, adjusting field voltage and solid-state control, Speed control of DC series motor: by adding resistance to armature circuit , adjusting armature voltage, and by adjusting field current, speed control of induction motors: by rotor resistance, by slip energy recovery method, by adjusting the stator voltage, adjusting the supply frequency, voltage/frequency(V/F) control.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Acquire knowledge about fundamental concepts and techniques used in power electronics.
- Ability to analyze various single phase and three phase power converter circuits and understand their applications.
- Foster ability to identify basic requirements for power electronics based design application.
- To develop skills to build, and troubleshoot power electronics circuits.
- Foster ability to understand the use of power converters in commercial and industrial applications

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

Text Books:

1. Gopal K Dubey, Fundamental of electric drives, Second, Narosa publication,2005
2. P.S Bhimbhra, Power Electronics, Khanna,2007
3. Mohammed A Sharkawi, Fundamental of electric drives, Fourth, Brooks/Cole, 2007

Reference Books:

1. Rashid M H,Power Electronics Circuits,devicesand applications,Second, PHI,2007

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_ee94/preview
- https://archive.nptel.ac.in/courses/108/104/108104140/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VII SEMESTER

DIGITAL IMAGE PROCESSING (PEC-III)

Course Code	**21RI742**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0*-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course objectives:

Students will be able

- Define the fundamental concepts in image processing
- Evaluate techniques followed in image enhancements
- Illustrate image segmentation and compression algorithms

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Introduction: Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Sampling and Quantization, Representing Digital Images (Data structure), Some Basic Relationships Between Pixels- Neighbors and Connectivity of pixels in image, Applications of Image Processing: Medical imaging, Robot vision, Character recognition, Remote Sensing.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 **8 HOURS**

Image Enhancement In The Spatial Domain: Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 **8 HOURS**

Image Enhancement In Frequency Domain: Introduction, Fourier Transform, Discrete Fourier Transform (DFT), properties of DFT , Discrete Cosine Transform (DCT), Image filtering in frequency domain.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE-4	**8 HOURS**
Image Segmentation: Introduction, Detection of isolated points, line detection, Edge detection, Edge linking, Region based segmentation- Region growing, split and merge technique, local processing, regional processing, Hough transform, Segmentation using Threshold.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE 5	**8 HOURS**
Image Compression: Introduction, coding Redundancy , Inter-pixel redundancy, image compression model, Lossy and Lossless compression, Huffman Coding, Arithmetic Coding, LZW coding, Transform Coding, Sub-image size selection, blocking, DCT implementation using FFT, Run length coding.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Course outcome (Course Skill Set) At the end of the course the student will be able to : • Explain fundamentals of image processing • Compare transformation algorithms • Contrast enhancement, segmentation and compression techniques	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

Text Books:

1. Digital Image Processing , Rafael C G., Woods R E. and Eddins S L, Prentice Hall, 3rd edition,2008

Reference Books:

2. Image Processing, analysis and Machine Vision, Milan Sonka, Thomson Press India Ltd, Fourth Edition.
3. Fundamentals of Digital Image Processing, Anil K. Jain, Prentice Hall of India, 2nd Edition
4. Digital Image Processing, S. Sridhar, Oxford University Press, 2nd Ed, 2016.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc19_ee55/preview

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Group Discussion
- Seminars

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VII SEMESTER

INTRODUCTION TO MOBILE ROBOT (OEC-II)

Course Code	**21RI751**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- Design and kinematic modeling of mobile robots
- Basic control algorithms involved in mobile robots
- Various sensors used for perception
- The localization and mapping
- Various algorithms in path planning and navigation

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the vaRIous course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1 **8 HOURS**

INTRODUCTION TO MOBILE ROBOTS

Introduction to Mobile robots - Locomotion, Classification - Legged, Wheeled, Aerial. Key issues in locomotion. Mobile Robot Kinematics - Kinematic model- Forward Kinematic model, Representing position, Wheel kinematic constraints. Motion control.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2 **8 HOURS**

CONTROL OF MOBILE ROBOTS

Control theory - Control design basics, Cruise-Controllers, Performance Objectives. Simple robot – State space model, Linearization, LTI system, stability. PID control, basic control algorithms

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3 **8 HOURS**

PERCEPTION

Sensors for mobile robots – Classification, performance, uncertainty in sensors, wheel sensor, heading sensor, accelerometers, inertial measurement, motion sensor, range sensors. Vision sensor- Basics of computer vision, image processing techniques, feature extraction – image, range data location recognition.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4 **8 HOURS**

LOCALIZATION

Major challenges, localization based navigation. Belief representation, map representation, probabilistic Map. Examples of localization systems. Autonomous map building

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5 **8 HOURS**

PLANNING AND NAVIGATION

Planning and Reaction- Path Planning – graph search, D* algorithm, Potential field. Obstacle avoidance – bug algorithm, histogram, curvature velocity techniques. Navigation architecture. Case studies

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Design and kinematic modeling of mobile robots
- Understand Basic control algorithms involved in mobile robots
- Design Various sensors used for perception
- Execute localization and mapping
- Plan Various algorithms in path planning and navigation

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

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- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
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- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

- Siciliano. et al, "Robotics: Modelling, Planning and Control", 3rd Edition, Springer, 2009.
- Choset. et al, "Principles of Robot Motion: Theory, Algorithm & Implementations", MIT Press, 2005.
- Thrun, Burgard, Fox, "Probabilistic Robotics", MIT Press, 2005.

Reference

- Siegwart, Nourbakhsh, "Introduction to Autonomous Mobile Robots", MIT Press, 2004.
- Siciliano, Khatib, Eds, "Handbook of Robotics", Springer, 2008.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/106/112106298/
- https://onlinecourses.nptel.ac.in/noc21_me44/preview
- https://www.digimat.in/nptel/courses/video/112106298/L15.html
- https://www.youtube.com/watch?v=-DY2L8E4hJY

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Group discussions
- Quiz

Robotics & Artificial Intelligence

Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

VII SEMESTER

INTRODUCTION TO AI (OEC-II)

Course Code	**21RI752**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0*-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course objectives:

Students will be able

- Define the fundamental concepts in image processing
- Evaluate techniques followed in image enhancements
- Illustrate image segmentation and compression algorithms

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

What is artificial intelligence? , Problems, Problem Spaces and search

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 **8 HOURS**

Knowledge Representation Issues, Using Predicate Logic, Representing knowledge using Rules,

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 **8 HOURS**

Symbolic Reasoning under Uncertainty, Statistical reasoning, Weak Slot and Filter Structures.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4 **8 HOURS**

Strong slot-and-filler structures, Game Playing.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE- 5 **8 HOURS**

Natural Language Processing, Learning, Expert Systems.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Identify the AI based problems
- Apply techniques to solve the AI problems
- Define learning and explain various learning techniques
- Discuss on expert systems

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

Text Books:

1. E. RIch , K. Knight & S. B. Nair - Artificial Intelligence, 3/e, McGraw Hill.

Reference Books:

1. Artificial Intelligence: A Modern Approach, Stuart Rusell, Peter Norving, Pearson Education 2nd Edition.
2. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems – Prentice Hal of India.
3. G. Luger, "Artificial Intelligence: Structures and Strategies for complex problem Solving", Fourth Edition, Pearson Education, 2002.
4. Artificial Intelligence and Expert Systems Development by D W Rolston-McGraw hill.
5. N.P. Padhy "Artificial Intelligence and Intelligent Systems" , Oxford University Press-2015

Web links and Video Lectures (e-Resources):

- **https://onlinecourses.nptel.ac.in/noc22_cs56/preview**

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Seminars