MOOGAMBIGAI CHARITABLE AND EDUCATIONAL TRUST

Rajarajeswari College of Engineering

(An Autonomous Institution under Visvesvaraya Technological University, Belagavi)
#14, Ramohalli Cross, Kumbalagodu, Mysore Road, Bengaluru–560074

Robotics and Automation

V & VI Semester Scheme and Syllabus

(2024 Scheme)

VISION

To empower young minds through technology, research and innovation, to produce technically competent and socially responsible professionals in higher education.

MISSION

1. To deliver excellence in education through innovative teaching, impactful research, and continuous skill development, preparing students to meet global challenges with technical expertise and ethical responsibility.
2. To foster a transformative learning environment that integrates technology, research and practical experience, empowering students to become skilled professionals and socially conscious leaders.
3. To cultivate a culture of lifelong learning and professional excellence by encouraging creativity, research, and community engagement, equipping students with the skills to thrive in a dynamic world.
4. To provide a holistic educational experience that combines advanced technology, hands-on research, and community-focused learning, shaping students into competent, ethical professionals who contribute positively to society.

QUALITY POLICY

Rajarajeswari College of Engineering is committed to imparting quality technical education that nurtures competent, ethical professionals with global relevance. We ensure academic excellence through a dynamic, outcome-based curriculum, experienced faculty, and cutting-edge infrastructure. Continuous improvement is driven by innovation, research and strong industry collaboration. We foster holistic development and a progressive environment that supports lifelong learning, teamwork, and professional growth.

CORE VALUES

Academic Excellence, Integrity, Innovation, Global Competence, Continuous Improvement.

Robotics and Automation

DEPARTMENT VISION

To develop technically skilled Robotics and Automation engineers with the systems & multidisciplinary approach in-line with the dynamic technologies for the competitive solution to the society.

DEPARTMENT MISSION

1. To provide a technical education through an effective teaching-learning process to meet the industry requirement.

2. To teach the process of designing, creating, and using robots to perform a certain task in problem-solving skills up-gradation of knowledge through a project-based approach in collaboration with industries.

PROGRAM OUTCOMES (POs)

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems /components / processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modeling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modeling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Develop skilled engineers with a solid foundation in Robotics and Automation, encompassing core competencies in diverse areas such as robotics programming, simulations, robot anatomy, and engineering principles.

PEO2: Thrive in their professional careers by delivering engineering solutions and showcasing technical expertise gained through continuous learning in the realm of robotics and automation.

PEO3: Create, design, and program robots for various engineering and societal applications using cutting-edge tools and technologies, while prioritizing solutions that are technologically advanced, economically viable, environmentally sustainable, and socially acceptable.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Develop Robotics and Automation systems that align with evolving industry demands, ensuring graduates are prepared to meet current and future industry requirements.

PSO2: Apply automation systems effectively in various domains such as manufacturing, healthcare, industrial engineering, and safety, addressing specific needs and enhancing efficiency and safety in these areas.

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V& VI Semester Common Courses

MOOGAMBIGAI CHARITABLE AND EDUCATIONAL TRUST

Rajarajeswari College of Engineering

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DEPARTMENT OF ROBOTICS AND AUTOMATION

Scheme of Teaching and Examinations -2024 Scheme

Outcome based Education (OBE) and Choice Based Credit System (CBCS) Effective from the Academic Year 2026-27

V Semester

S. No	Course Category and Course Code		Course Title	TD / PSB	Teaching Hours / Week				Examination				Credits
					Lecture	Tutorial	Practical	Self-Learning	CIE Marks	SEE Duration in Hrs	SEE Marks	Total Marks	
					L	T	P	S					
1.	HSMC	B24RA501	Managerial Economics for Robotics	RA	3	0	0	3	50	3	50	100	3
2.	IPCC	B24RA502	Hydraulics and Pneumatics	RA	3	0	2	3	50	3	50	100	4
3.	PCC	B24RA503	Robot Operating Systems	CS	3	0	0	3	50	3	50	100	3
4.	PCC	B24RA504	Artificial Intelligence for Automation	AI	3	0	0	3	50	3	50	100	3
5.	PCCL	B24RA505L	Virtual Instrumentation Lab-I	RA	0	0	2	0	50	3	50	100	1
6.	PEC	B24YY56X	Professional Elective Course - I	RA	3	0	0	3	50	3	50	100	3
7.	BSC	B24BEK507	Biology for Engineers	RA / Che	2	0	0	2	50	2	50	100	2
8.	AEC	B24YY58X	Ability Enhancement Course	RA	0	0	2	0	50	3	50	100	1
9.	NCMC	B24NCK59X	NSS / NCC / PE / Yoga / Music	HSS	2	0	0	0	100	-	-	100	PP
10.	NCMC	B24ESK510	Environmental Science and E-Waste Management	RA / CV	2	0	0	0	100	-	-	100	PP
11.	SDC	B24RAP511	Mini-Project	RA	0	0	4	0	50	3	50	100	2
								TOTAL	650		450	1100	22

BSC: Basic Science Course, HSMC: Humanity Social sciences including Management courses, IPCC: Integrated Professional Core Course, PCC: Professional Core Course, PCCL: Professional Core Course laboratory, NCMC: Non-Credit Mandatory Course, AEC: Ability Enhancement Course, PEC: Professional Elective Course, SDC- Skill Development Course, L: Lecture, T: Tutorial, P: Practical S: Self-Learning, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation. K: Indicates common course to all the streams of engineering, PP/NP: Pass/ Not Pass, YY: Programme Code (EC, CS, IS etc.,), X: 1/2/3/4.

Professional Elective Courses (PEC) - I			
B24EC561	Digital Image Processing	B24RA562	Wireless Sensor Networks for Robotics
B24RA563	Mechatronics	B24RA564	Design of Automation System
Ability Enhancement Course / Skill Enhancement Course (AEC/SEC) – V			
B24RA581	ML for Predictive Maintenance Lab	B24EC582	Digital Image Processing Lab
B24RA583	Robotic Operating System lab	B24RA584	Robotic Process Automation Lab
Non-Credit Mandatory Courses (NCMC)			
B24NCK591	National Service Scheme	B24NCK592	National Cadet Corps
B24NCK593	Physical Education	B24NCK594	Yoga
B24NCK595	Music		

National Service Scheme /National Cadet Corps/Physical Education/Yoga/Music: All the students have to register the same coursenamely National Service Scheme (NSS), National Cadet Corps(NCC), Physical Education (PE), Yoga (YOG) and Music (MUS) during the first week of III/IV/V/VI semesters. However, the option is given to students to change the activity. He/she may opt for the change of the course in ensuing semester. If the student is opting new course in V semester first time, he/she may take the basic modules from the syllabus to complete and if they repeat the same course in ensuing semester, subsequent modules can be offered.

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

Professional Elective Courses (PEC): A PEC 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. The minimum number of student's strength for offering a professional elective is 10. However, this condition shall not be applicable to cases where the admission to the programme is less than 10 students.

HoD **Dean-Academics** **Principal**

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					Lecture	Tutorial	Practical	Self-Learning	CIE Marks	SEE Duration Hrs	SEE Marks	Total Marks	
					L	T	P	S					
1.	PCC	B24RA601	Thermal Management of Electronic Systems	RA	3	0	0	3	50	3	50	100	3
2.	IPCC	B24RA602	Finite Element Analysis	RA	3	0	2	3	50	3	50	100	4
3.	PEC	B24YY63X	Professional Elective Course- II	RA	3	0	0	3	50	3	50	100	3
4.	OEC	B24YY64X	Open Elective Course - I	Any Dept	3	0	0	3	50	3	50	100	3
5.	PCCL	B24RA605L	Virtual Instrumentation Lab-II	RA	0	0	2	0	50	3	50	100	1
6.	AEC	B24RMK606	Research Methodology and IPR	RA	1	0	0	1	50	1	50	100	1
7.	SDC	B24PRJ607	Capstone Project work : Phase - I	RA	0	0	4	0	100	-	-	100	2
8.	AEC	B24YY68X	Ability Enhancement Course	RA	0	0	2	0	50	3	50	100	1
9.	NCMC	B24NCK69X	NSS / NCC / PE / Yoga / Music	HSS	2	0	0	0	100	-	-	100	PP
10.	HSMC	B24IKK610	Indian Knowledge System	RA	2	0	0	0	100	-	-	100	PP
								TOTAL	600		400	1000	18

HSMC: Humanity Social sciences including Management courses, IPCC: Integrated Professional Core Course, PCC: Professional Core Course, PCCL: Professional Core Course laboratory, NCMC: Non-Credit Mandatory Course, AEC: Ability Enhancement Course, PEC: Professional Elective Course, OEC: Open Elective Course, SDC- Skill Development Course, L: Lecture, T: Tutorial, P: Practical S: Self-Learning, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation. K: Indicates common course to all the streams of engineering, PP/NP: Pass/ Not Pass, YY: Programme Code (EC, CS, IS etc.,), X: 1/2/3/4

Professional Elective Courses (PEC) - II			
B24RA631	Humanoid Robots	B24RA632	Embedded Systems for Robotic Applications
B24EE633	PLC and SCADA	B24RA634	Additive Manufacturing
Open Elective Course (OEC)- I			
B24RA641	Automotive Electronics	B24RA642	Industrial Automation
B24RA643	Power Plant Engineering	B24RA644	Fundamentals of Robotics
Ability Enhancement Course (AEC) – VI			
B24RA681	Electro Pneumatics Lab	B24RA682	Computational Fluid flow andHeat Transfer Lab
B24RA683	PLC Lab	B24RA684	3D Printing Lab
Non Credit Mandatory Course (NCMC)			
B24NCK691	National Service Scheme	B24NCK692	National Cadet Corps
B24NCK693	Physical Education	B24NCK694	Yoga
B24NCK695	Music		

PROJECT WORK: **Phase – I:** 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 install 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: 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 the **Project Work Report, Project Reviews and Viva-Voce.** 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 Institution. The SEE marks awarded for the project work shall be based on the evaluation of **Project Demonstration, Project Presentation and Viva-Voce** in the ratio 20:60:20.

Open Elective Courses: Students belonging to a particular stream of Engineering are not entitled to the open electives offered by their parent department. However, they can opt for 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/ Mentor. The minimum number of students' for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

HoD **Dean-Academics** **Principal**

Semester-V					
Managerial Economics for Robotics **Category: PCC**					
Course Code	:	**B24RA501**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	Understand the intersection between managerial economics and robotic industry.
2.	To equip students with the skills and knowledge necessary to analyze economic principles in the context of robotics
3.	Understand the Fundamentals of Managerial Economics
4.	Analyze Economic Systems and Their Relationship with Robotics
5.	Conduct Cost Analysis and Production Planning in Robotics

Module – 1	**No.of Hours**
Introduction To Managerial Economics In Robotics: Overview of Managerial Economics: Definition, scope, and importance of Managerial Economics in Robotics, History and evolution of robotics ,Role of Managerial Economic in decision-making process in relevance to robotics and technology industries Economic Systems and Robotics: Capitalism, socialism, and mixed economies, Role of robotics in different economic systems, Service Industries and manufacturing.	9
Module – 2	**No.of Hours**
Cost Analysis And Production In Robotics: Cost Concepts and Classification: Fixed, variable, and marginal costs, Economies of scale in robotics manufacturing, Learning curve and cost reduction, Production function in robotics, Input-output analysis, Total, average, and marginal product concepts, Break-even Analysis: Cost-volume-profit analysis, Break-even point in robotics projects, Sensitivity analysis Capital Budgeting and Investment Decisions: Net present value (NPV), internal rate of return (IRR), and payback period, Risk and uncertainty in robotics investment.	9
Module – 3	**No.of Hours**
Market Structures And Pricing Strategies In Robotics: Market Structures: Perfect competition, monopolistic competition, oligopoly, and monopoly, Market structures in the robotics industry, Strategic behaviour in oligopolistic markets. Pricing Strategies: Cost-plus pricing, value-based pricing, and dynamic pricing, Pricing in technologydriven markets, Price discrimination in the robotics industry, Competitive strategies, Pricing wars, collusion, and cooperation. Regulation and Antitrust Issues: Government regulations in robotics, Antitrust laws and their impact on robotics companies.	9
Module – 4	**No.of Hours**
Innovation, R&D, And Intellectual Property In Robotics: Innovation and R&D in Robotics: Importance of innovation in the robotics industry process and management, Role of government and private sector in R&D funding Intellectual Property (IP) Rights: Types of IP: Patents, trademarks, and copyrights, IP strategy in the robotics industry, Licensing and technology transfer Economics of Innovation: Schumpeterian competition and creative destruction, Diffusion of innovation in robotics, Impact of robotics on productivity and economic growth.	9
Module – 5	**No.of Hours**
The Economic And Social Impact Of Robotics: Impact on Labor Markets: Automation and job displacement, Skill requirements in the robotic era, Policies to mitigate the impact on employment Robotics and Economic Growth: Contribution of robotics to GDP growth, Robotics in emerging vs. developed economies, Long-term economic forecasts Ethical and Social Considerations: Ethical dilemmas in robotics and AI, Social implications of widespread automation, Policy responses to technological unemployment Future Trends and Challenges: Future of work in a robotic economy, Robotics in sustainable development, Global competition in robotics and AI.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Define key concepts of managerial economics, including cost analysis, market structures, and innovation management, specifically within the context of the robotics industry.
CO2	Explain the role of managerial economics in decision-making processes relevant to the robotics and technology industries.
CO3	Apply cost-volume-profit analysis and capital budgeting techniques to evaluate the financial viability of

	robotics projects.
CO4	Analyze the impact of different market structures on the competitive strategies and pricing behaviors of robotics companies.
CO5	Evaluate the economic and social impacts of robotics on labor markets, including automation, job displacement, and the long-term growth of economies.

Text Books	
1.	"Managerial Economics: A Problem-Solving Approach" by Luke M. Froeb, Brian T. McCann, Michael R. Ward, and Mikhael Shor
2.	"Cost-Benefit Analysis: Concepts and Practice" by Anthony E. Boardman, David H. Greenberg, Aidan R. Vining, and David L. Weimer

Reference Text Books	
1.	Varian, H.R. "Intermediate Microeconomics"
2.	Besanko, D., & Braeutigam, R.R. "Microeconomics"
3.	Autor, D.H., "Why Are There Still So Many Jobs? The History and Future of Workplace Automation"

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	1	1	1	2	1	-	-	1	-
CO2	2	2	1	1	1	1	1	-	-	2	-
CO3	1	1	1	1	1	1	1	-	-	2	-
CO4	1	1	1	1	1	1	1	-	-	1	-
CO5	1	1	1	1	1	1	1	-	-	1	-

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester-V					
Hydraulics and Pneumatics **Category: IPCC**					
Course Code	:	**B24RA502**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:2:3	SEE	:	50 Marks
Total Hours	:	45+30	Total	:	100 Marks
Credits	:	4	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand the fundamental principles of hydraulic and pneumatic systems and its energy sources.
2.	To analyze the operations of various hydraulic and pneumatic components, such as actuators, valves.
3.	To design, construct, and simulate hydraulic, pneumatic, and electro-pneumatic circuits for industrial applications and troubleshoot and maintain these systems for efficient and reliable performance.
4.	To understand the components, actuators, control valves, symbols, and basic circuits used in pneumatic control systems.
5.	To understand pneumatic signal processing elements, logic gate applications, multi-cylinder control using cascading method, and basic electro-pneumatic control circuits.

Module – 1	**No. of Hours**
Introduction to Hydraulic Power: Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, Numerical 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, Numerical problems on pumps.	9
Module – 2	**No. of Hours**
Hydraulic Actuators and Motors: Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, mounting arrangements, cylinder cushioning, special types of cylinders, Numerical problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic motor theoretical torque, power and flow rate, Numerical 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 and temperature compensated FCV, symbolic representation.	9
Module – 3	**No. of 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, Speed control of hydraulic cylinder, Speed control of hydraulic motors, Safety circuit, Accumulators, types, construction and applications with accumulator circuits. **Maintenance of Hydraulic System**: Hydraulic Oils Desirable properties, general type of Fluids, Sealing devices, Reservoir system, Filters and Strainers, causes of contamination of hydraulic fluid, temperature control (heat exchangers), pressure switches, trouble shooting of hydraulic systems.	9
Module – 4	**No. of Hours**
Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, characteristic of compressed air. Structure of pneumatic control system, fluid conditioners- dryer, filter, regulator, lubricator. **Pneumatic Actuators:** Linear cylinder types, Conventional type of Single and Double -Acting hydraulic cylinder working. Pneumatic cylinder end position cushioning, Pneumatic system seals, pneumatic cylinder mounting arrangements. Pneumatic cylinder applications. Special types of pneumatic cylinder such as rod - less cylinder, tandem cylinder, magnetic cylinder construction and working. Rotary cylinders- types construction and working. Pneumatics symbols. **Pneumatic Control Valves:** DCV such as poppet, spool, suspended seat type slide valve, pressure	9

control valves, flow control valves, types, construction and working, memory valve, quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. **Simple Pneumatic Control Circuits:** Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling.	
Module – 5	**No. of Hours**
Signal Processing Elements: Use of logic gates OR and AND gates in pneumatic applications circuits. Practical examples involving the use of logic gates, pressure dependent control valve-construction and working, time dependent controls- construction and working. **Multi-Cylinder Application:** Cascading method to control two pneumatic cylinders. **Electro- Pneumatic Control Circuits**: Principles of signal input and output, pilot assisted solenoid control of directional control valves, Use of relay and contactors. Control circuitry for simple signal cylinder application.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Understand the fundamental knowledge of hydraulic and pneumatic systems and their components.
CO2	Analyse the working principles of various hydraulic control valves.
CO3	Construct the hydraulic, pneumatic, and electro-pneumatic circuits for industrial applications and troubleshoot system faults to ensure efficient operation.
CO4	Understanding the working of pneumatic components, actuators, control valves, and design simple pneumatic circuits for cylinder actuation and speed control.
CO5	Construct the pneumatic and electro-pneumatic control circuits using logic gates, pressure and time control elements, and cascading methods for multi-cylinder applications

LABORATORY

Practical Component of IPCC (12 Experiments) (Using Automation Studio Software)

Sl. No	Name of the experiments
1.	Construct and simulate speed control of single and double acting cylinders using a hydraulic circuit.
2.	Construct and simulate a hydraulic circuit of sequencing of two hydraulic cylinders using sequence valves
3.	Construct and simulate regenerative hydraulic circuit.
4.	Construct and simulate hydraulic circuit using counterbalance valve.
5.	Construct and simulate synchronization hydraulic circuit for two cylinders.
6.	Construct and simulate controlling of hydraulic linear and rotary actuators using electro-pneumatic.
7.	Construct and simulate speed control of pneumatic cylinders and motors using solenoid valves.
8.	Construct and simulate a simple hydraulic circuit for hydraulic Jack.
9.	Construct and simulate pneumatic circuit for speed control of double acting cylinder.
10.	Construct and simulate pneumatic circuit for speed control of pneumatic motor.
11.	Construct and simulate sequencing of two Pneumatic cylinders using sequence valves.
12.	Construct and simulate for the sequence A+B+A-B-

Text Books:

1. Fluid Power with Applications by Anthony Esposito, 7th Edition, published by Pearson Education in 2014, is prescribed as a primary textbook for understanding the fundamentals of hydraulic and pneumatic systems, components, and applications.
2. Oil Hydraulics and Pneumatics by R. Yadav and R. L. Rathi, 6th Edition, published by Laxmi Publications in 2018, is recommended for its comprehensive coverage of system components, numerical problems, circuit analysis, and maintenance aspects.

Reference Books:

1. Industrial Hydraulics and Pneumatics by Andrew Parr, 3rd Edition, published by Butterworth-Heinemann

(Elsevier) in 2011, is recommended as a reference for practical system design, circuit analysis, and troubleshooting.
2. Hydraulics and Pneumatics by Jagadeesha T. and Eswara Prasad, 3rd Edition, published by I.K. International Publishing House in 2014, serves as a useful reference for conceptual clarity and problem-solving.
3. Pneumatic Control for Industrial Automation by S. R. Majumdar, 1st Edition, published by McGraw-Hill Education in 1997, is suggested as a reference for advanced pneumatic control, logic circuits, and electro-pneumatic applications.

Web links and Video lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/noc25_me58/preview?utm_source=chatgpt.com
2. https://archive.nptel.ac.in/courses/112/106/112106300/
3. https://www.digimat.in/nptel/courses/video/112106300/112106300.html?utm_source=chatgpt.com
4. https://engineeringvideolectures.com/mobile/15812?utm_source=chatgpt.com
5. https://www.youtube.com/c/lunchboxsessions?utm_source=chatgpt.com

ASSESSMENT DETAILS BOTH (CIE AND SEE)

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CONTINUOUS INTERNAL EVALUATION (CIE)

Component	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30** (Average of Best Two Assessments)	**50/2 = 25**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	Any One Assessments as per regulations	**20**	**20**	
Laboratory	**Lab conduction & Record**	Evaluating each expt. for 10 marks.	**05**	**25**
	Lab Internal Test	**50**	**20**	
Continuous Internal Evaluation (CIE)				**50**
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice. Students should answer five full questions, selecting one full question from each module.
5. Students have to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
6. The maximum marks from the practical component to be included in the SEE question paper is **16 marks.**
7. Question papers to be set as per the Blooms Taxonomy levels.
8. The laboratory component of the **integrated course** shall be CIE only. However, in SEE, the questions from the practical component shall be included.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	-	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-
CO3	2	3	3	2	-	-	-	-	-	-	-
CO4	2	3	2	3	-	-	-	-	-	-	-
CO5	2	3	2	3	-	-	-	-	-	-	-

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester - V					
Robot Operating Systems **Category: PCC**					
Course Code	:	**B24RA503**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand the architecture and communication framework of ROS.
2.	To develop and execute ROS-based programs for robotic applications.
3.	To model robotic systems using URDF and coordinate transformations.
4.	To analyze and visualize robot behavior using simulation and debugging tools.
5.	To apply ROS concepts for industrial and real-world robotic systems.

Module – 1	**No. of Hours**
Introduction to ROS: Introduction to ROS and ROS2, ROS2 architecture and design principles, Nodes, Topics, Services, Actions, ROS2 communication mechanisms (DDS overview), ROS2 workspace and file system, ROS2 command-line tools.	9
Module – 2	**No. of Hours**
ROS2 Programming: Creating ROS2 packages, Writing nodes in Python/C++, Publisher–Subscriber, implementation, Service–Client communication, Action servers and clients, Launch files and parameter handling, Custom messages and services	9
Module – 3	**No. of Hours**
Robot Modeling & Transformations: Introduction to robot modeling, URDF and Xacro, Robot kinematic structure (basic concepts), Coordinate frames and transformations (TF2), Visualization of robot models in RViz, Integration of sensors (basic concepts).	9
Module – 4	**No. of Hours**
Simulation and ROS Tools: RViz for visualization, Gazebo for simulation, Robot spawning and environment setup, Debugging tools (rqt_console, rqt_graph), Package management (rosdep, colcon), Performance monitoring and logging.	9
Module – 5	**No. of Hours**
Applications & Industrial ROS: Introduction to motion planning, MoveIt framework and workflow, ROS-Industrial: architecture and applications, Industrial robot integration concepts, Introduction to navigation and SLAM (conceptual), Case study: Pick-and-place / Mobile robot system.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Explain ROS2 architecture and communication mechanisms
CO2	Develop ROS2-based programs using nodes, topics, and services
CO3	Model robotic systems using URDF and transformation concepts
CO4	Analyze robot behavior using simulation and visualization tools
CO5	Design ROS-based solutions for industrial robotic applications

Text Books	
1.	Mastering ROS for Robotics Programming, Lentin Joseph, *Mastering ROS for Robotics Programming*, Packt Publishing, 2015.
2.	Robot Operating System (ROS): The Complete Reference, AnisKoubaa (Ed.), *Robot Operating System (ROS): The Complete Reference, Volume 7*, Studies in Computational Intelligence, Vol. 1051, Springer, 2023.
3.	Robot Operating System (ROS) for Absolute Beginners, Lentin Joseph and AleenaJohny, *Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy*, Apress, 2022.
4.	Mastering ROS for Robotics Programming Second Edition, Lentin Joseph and Jonathan Cacace,Mastering ROS for Robotics Programming, Second Edition: Design, Build, and Simulate Complex Robots Using ROS, Packt Publishing, 2018.

Reference Books / Online Resources	
1.	ROS2 Documentation, *ROS2 Official Documentation*, Available at: https://docs.ros.org (Accessed as required).

2.	Programming Robots with ROS, Morgan Quigley, Brian Gerkey, and William D. Smart, *Programming Robots with ROS: A Practical Introduction to the Robot Operating System*, O'Reilly Media, 2015.
3.	Learning ROS for Robotics Programming, Aaron Martinez and Enrique Fernandez, *Learning ROS for Robotics Programming*, Packt Publishing.

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2		-	-	-	-	-	-	-	-
CO2	3	3	2	-	2	-	-	-	-	-	-
CO3	3	2	3	-	2	-	-	-	-	-	-
CO4	2	3	2	3	3	-	-	-	-	-	-
CO5	3	3	3	2	3	-	-	-	2	2	-

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester-V					
Artificial Intelligence for Automation **Category: PCC**					
Course Code	:	**B24RA504**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3Hrs

Course Learning Objective is	
1.	To understand the fundamentals of Artificial Intelligence and its role in automation systems.
2.	To apply search strategies and knowledge representation techniques for intelligent decision-making.
3.	To understand machine learning concepts for automation, robotics and industrial applications.
4.	To analyze AI-based perception techniques using sensors, vision and data-driven methods.
5.	To apply AI techniques for planning, control, fault diagnosis and smart automation systems.

Module– 1	**No. of Hours**
Introduction to Artificial Intelligence and Automation: Introduction to Artificial Intelligence, need and importance of AI in automation, robotics and smart manufacturing. Characteristics of intelligent agents, structure of agents, rational agents, task environment and PEAS representation. Types of agents: simple reflex agents, model-based agents, goal-based agents, utility-based agents and learning agents. Applications of AI in industrial automation, robotic systems, autonomous vehicles, smart factories, process automation and Industry 4.0. Introduction to AI-based decision-making in automated systems.	9
Module– 2	**No. of Hours**
Problem Solving and Search Techniques: Problem formulation, state space representation and production systems. Uninformed search techniques: breadth-first search, depth-first search, depth-limited search and uniform-cost search. Informed search techniques: greedy best-first search and A* search algorithm. Heuristic functions and their importance in automation problems. Local search methods: hill climbing and simulated annealing. Applications of search techniques in robot path planning, automated material handling, scheduling and navigation.	9
Module– 3	**No. of Hours**
Knowledge Representation and Reasoning: Introduction to knowledge representation and reasoning. Propositional logic and predicate logic, facts, rules and inference. Semantic networks, frames and rule-based systems. Forward chaining and backward chaining. Expert systems: architecture, knowledge base, inference engine and explanation facility. Fuzzy logic concepts: fuzzy sets, membership functions, fuzzy rules and fuzzy inference system. Applications of knowledge-based and fuzzy systems in process control, robotic decision-making, fault diagnosis and automation.	9
Module– 4	**No. of Hours**
Machine Learning for Automation: Introduction to machine learning and its relevance to automation. Types of learning: supervised, unsupervised and reinforcement learning. Classification algorithms: decision tree, k-nearest neighbour, support vector machine and random forest. Regression techniques for prediction and control. Clustering techniques: k-means clustering and anomaly detection. Model training, testing, accuracy, confusion matrix and performance evaluation. Applications of machine learning in predictive maintenance, quality inspection, process optimization, robotic control and intelligent automation.	9
Module– 5	**No. of Hours**
AI-based perception in automation: Sensor data processing and intelligent interpretation of temperature, pressure, vibration, proximity and vision sensor data. Basics of computer vision for automation: image acquisition, preprocessing, object detection and visual inspection. Introduction to reinforcement learning for robotic control. AI-based planning and task scheduling for automated systems. Applications of AI in robotic pick-and-place, automated inspection, warehouse automation, autonomous mobile robots, smart manufacturing, digital twins and industrial fault diagnosis. Ethical and safety considerations in AI-enabled automation.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Explain the fundamentals of Artificial Intelligence and intelligent agents for automation systems.
CO2	Apply search algorithms for problem solving, path planning and decision-making in automation.

CO3	Use knowledge representation, reasoning and fuzzy logic techniques for intelligent control applications.
CO4	Apply machine learning algorithms for classification, prediction and anomaly detection in automation systems.
CO5	Analyze AI-based perception, planning and industrial automation applications.

Text Books	
1.	Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 4th Edition, Pearson Education, 2021/2022.
2.	AurélienGéron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd Edition, O'Reilly Media, 2022.

Reference Text Books	
1.	AnuradhaSrinivasaraghavan, Vincy Joseph "Machine Learning", Wiley, 2019
2.	Rajiv Chopra, "Deep Learning", 1st edition, Khanna Publishing House,2018.

Web links and Video lectures (e-Resources)

- **YouTube: Automation Systems Overview by Siemens**
- **YouTube: Python AI Programming by NPTEL**
- **YouTube: Bayesian Networks by NPTEL**
- **YouTube: Knowledge Representation in AI by NPTEL**
- **Coursera: Fundamentals of Automation**
- **Coursera: Machine Learning by Andrew Ng**

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and it carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2	1	1	1	-	-	-	-	2
CO2	2	1	2	1	1	1	-	-	-	-	2
CO3	2	2	2	1	1	-	-	-	-	-	1
CO4	2	2	1	1	-	-	-	-	-	-	2
CO5	2	2	2	2	2	2	-	-	-	-	2

Level 3 - High, Level 2 – Moderate, Level 1 - Low

Semester V					
Virtual Instrumentation Lab –I **Category: PCCL**					
Course Code	:	**B24RA505L**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	0 : 0 : 2: 0	SEE	:	50 Marks
Total Hours	:	30	Total	:	100 Marks
Credits	:	1	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand Virtual Instrument concepts and data acquisition operation.
2.	To creating Virtual Instruments for practical works.

Sl. No	**List of Experiments**
1.	Basic logical operations
2.	Basic arithmetic operations
3.	Sum/Factorial of ‘n’ numbers using ‘for’ loop
4.	Programming exercises for loops in virtual instrumentation-Continuous Monitoring of Temperature (Generated using Random no 0<t)
5.	Programming exercises for graphs- Display Random Number into 3 different CHARTS (STRIP, SLOPE, SWEEP) and understand the difference between these in the UI. 4
6.	Programming Exercises on case and sequence structures:-Design the simple Calculator(Boolean & arithmetic), making use of the inherent GUI present in the virtual instrumentation software.
7.	Programming Exercises on Arrays– Take a 2Darray input from the user and perform various array(and matrix) manipulations on it
8.	Create a VI to Read and write the ASCII file
9.	Create a VI to Read and write the TDMS file
10.	Real time temperature acquisition and continuous monitoring using Virtual Instrumentation
11.	Developing voltmeter using DAQ cards – Acquiring a voltage and displaying it on a ‘meter’ indicator on the UI, thus designing a voltmeter
12.	Developing Signal Generator using DAQ Card – Using analog output; amplitude, shape and frequency controlled by user

Course Outcomes: At the end of the course, the students will be able to	
CO1	To create data acquisition, analysis and display operations using LabVIEW
CO2	Create user interfaces with charts, graph and buttons
CO3	To develop the programming structures and data types that exist in LabVIEW
CO4	Use various editing and debugging techniques.

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course if the student secures 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	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Laboratory	**Lab Conduction & Record**	**Evaluating each expt. for 10 marks**	**20**	**50**
	Laboratory Test -1	**50**	**15**	
	Laboratory Test -2	**50**	**15**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. SEE marks for the practical course are 50 Marks. Practical examinations are to be conducted between the schedules mentioned in the academic calendar of the Institution.
2. All laboratory experiments are to be included for practical examination.
3. Evaluation of test write-up, conduction procedure, result and viva will be conducted jointly by examiners.
4. Rubrics suggested for SEE, 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.
5. Change of experiment is allowed only once and 15% of Marks allotted to the Conduction procedure part are to be made zero. The minimum duration of SEE is 03 hours.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	-	3	-	-	-	-	-	-	1
CO2	2	1	3	-	3	-	-	-	-	-	-	1
CO3	2	1	3	-	3	-	-	-	-	-	-	1
CO4	2	1	3	-	3	-	-	-	-	-	-	1
CO5	2	1	3	-	3	-	-	-	-	-	-	1

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester-V					
Digital Image Processing **Category: PEC-I**					
Course Code	:	**B24EC561**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand the fundamentals of digital image processing.
2.	To understand the image transform used in digital image processing.
3.	To understand the image enhancement techniques in spatial domain used in digital image processing.
4.	To understand the Color Image Processing and frequency domain enhancement techniques in digital image processing.
5.	To understand the image restoration techniques and methods used in digital image processing.

Module – 1	**No. of Hours**
Digital Image Fundamentals: What is Digital Image Processing? Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels.	9
Module – 2	**No. of Hours**
Image Transforms: Introduction, Two-Dimensional Orthogonal and Unitary Transforms, Properties of Unitary Transforms, Two-Dimensional DFT, cosine Transform, Haar Transform.	9
Module – 3	**No. of Hours**
Spatial Domain: Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters	9
Module – 4	**No. of Hours**
Frequency Domain: Basics of Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters. Color Image Processing: Color Fundamentals, Color Models, Pseudo-color Image Processing.	9
Module – 5	**No. of 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.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Analyze image formation and the role of human visual system plays in the perception of gray and color image data.
CO2	Compute various transforms on digital images.
CO3	Conduct an independent study and analysis of Image Enhancement techniques.
CO4	Apply image processing techniques in the frequency (Fourier) domain.
CO5	Apply image processing techniques for segmentation.

Text Books	
1.	Digital Image Processing- Rafael C Gonzalez and Richard E Woods, PHI, 3rd Edition 2010.
2.	Fundamentals of Digital Image Processing- A K Jain, PHI Learning Private Limited 2014.

Reference Text Books	
1.	Digital Image Processing- S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2014.
2.	Milan Sonka,"Image Processing, analysis and Machine Vision", Thomson Press India Ltd, 4th Edition.

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	1	-	-	-	2	1	-	-	-	2
CO2	1	2	-	-	-	2	1	-	-	-	2
CO3	1	1	-	-	-	2	2	-	-	1	1
CO4	1	2	-	-	-	1	2	-	-	1	1
CO5	1	2	-	-	-	1	2	-	-	1	1

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester - V					
Wireless Sensors Networks for Robotics **Category: PEC-I**					
Course Code	:	**B24RA562**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To know the basic knowledge about wireless sensor networks.
2.	To impart knowledge in networking using sensors
3.	To study about the tools used in networking
4.	To understand the basic in wireless architecture.
5.	To learn about the different techniques used in networking

Module – 1	**No. of Hours**
Overview of Wireless Sensor Networks: Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks. Types of wireless sensor networks. Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes	9
Module – 2	**No. of Hours**
Architectures: Network Architecture -Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts. Operating Systems and Execution Environments.	9
Module – 3	**No. of Hours**
Networking Sensors: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.	9
Module – 4	**No. of Hours**
Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.	9
Module – 5	**No. of Hours**
Sensor Network Platforms And Tools: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Recall the basic concepts and components of wireless sensor networks, including types of wireless sensor networks, single-node architecture, and network architecture.
CO2	Explain the functions of single-node architecture, network architecture, and MAC protocols in wireless sensor networks.
CO3	Apply the concepts of MAC protocols and energy-efficient routing to design a basic wireless sensor network architecture
CO4	Analyze the energy consumption patterns and optimization goals in different wireless sensor network architectures.
CO5	Evaluate the effectiveness of different MAC protocols and routing strategies in achieving energy efficiency in wireless sensor networks.

Text Books	
1.	Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005
2.	Feng Zhao & Leonidas J.Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

Reference Text Books	
1.	KazemSohraby, Daniel Minoli, &TaiebZnati, “Wireless Sensor Networks- Technology, Protocols, And Applications”, John Wiley, 2007
2.	Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	-	2	-	-	-	-	-	-	-	-
CO4	2	1	2	1	-	-	-	-	-	-	-
CO5	1	2	2	1	1	-	-	-	-	-	-

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester -V					
Mechatronics **Category: PEC-I**					
Course Code	:	**B24RA563**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand interdisciplinary nature of mechatronics systems.
2.	To study sensors and data acquisition systems used in robotics.
3.	To learn embedded controllers used in automation.
4.	To understand PLC-based industrial automation.
5	To study mechanical and electrical actuation systems.
6	To understand system integration using modern tools.

Module – 1	**No. of Hours**
Introduction to Mechatronics & Sensors: Definition of mechatronics, evolution of mechatronics, multidisciplinary engineering systems, mechatronics design process System approach in mechatronics, measurement systems in mechatronics, open loop and closed loop systems, applications in robotics and automation. **Sensors and Transducers:** Definition and classification of sensors, smart sensors, MEMS sensors, **Robotics Sensors -** position, velocity, acceleration, force and torque, temperature, and vision sensors. **Industrial Sensors & Interfacing:** Proximity, Hall Effect, photoelectric, ultrasonic, signal conditioning: amplifiers, filters, ADC basics, Sensor interfacing concepts.	9
Module – 2	**No. of Hours**
Embedded Systems & Microcontrollers: Definition, Embedded system architecture, Components of embedded systems, Microprocessor v/s Microcontroller comparison. Overview of classical microprocessors **Modern Microcontrollers:** Arduino architecture, ARM Cortex overview, ESP32 overview, GPIO concept, embedded development boards. **Embedded Programming:** Embedded C basics –Variables, Data types, Control statements, Python basics for robotics – Variables, Functions, Libraries (concept). **Communication Protocols:** Serial communication – UART, SPI, I2C, Introduction to real-time systems, Applications in robotics.	9
Module – 3	**No. of Hours**
PLC & Industrial Automation: PLC definition, PLC architecture, PLC components - CPU, power supply, Memory, I/O modules, PLC operation cycle. **PLC Programming:** Ladder diagrams, timers, counters, basic logic implementation. **Industrial Automation:** SCADA overview, Industrial robots - robot anatomy, robot configurations, Work envelope, Degrees of freedom, industrial communication – Modbus, CAN, industrial Ethernet, Industrial robot basics.	9
Module – 4	**No. of Hours**
Actuation Systems: Mechanical Systems: Gear systems, Belt drives, Chain drives, Lead screw mechanisms, Cam mechanisms. **Electrical Actuation:** DC motors, Stepper motors, Servo motors, BLDC motors, Comparison and applications**,** Motor drivers. **Actuator Selection:** Selection criteria – torque, speed, precision, power requirements. **Feedback & Control:** Encoders, tachometers, control systems - open loop control, closed loop control, PID control basics, and applications in robotics.	9
Module – 5	**No. of Hours**
Pneumatics, Hydraulics & Modern Tools: Pneumatic power systems, Components – Compressors, Air receivers, FRL unit, Pneumatic valves, Pneumatic cylinders. Basic pneumatic circuits. **Hydraulics:** Hydraulic systems. Components - Hydraulic pumps, Control valves, Hydraulic actuators. Hydraulic circuits. **Electro-Pneumatics & Automation:** Solenoid valves, PLC integration. Automation applications. **Modern Robotics Tools:** IoT basics - IoT architecture, sensors to cloud concept MQTT (concept). Simulation tools overview - MATLAB overview, simulink overview, Gazebo overview. Python	9

applications in robotics. Digital twin concept (introduction). **Case study: integrated mechatronics system.**	

Course Outcomes: At the end of the course, the students will be able to	
CO1	Explain architecture of mechatronics systems and sensor technologies.
CO2	Apply embedded controllers for automation applications.
CO3	Develop basic PLC programs for industrial control.
CO4	Select suitable actuators for robotic applications.
CO5	Explain integration of robotics with IoT and simulation tools.

Text Books	
1.	Mechatronics, by W. Bolton – 6th Edition (or latest), Pearson Education 2015 (or latest edition available), ISBN: 978-0-13-403723-5.
2.	Mechatronics System Design by DevdasShetty – 2nd Edition, published by Cengage Learning, 2011, ISBN: 978-1-111-56582-1.
Reference Text Books	
1.	Programmable Logic Controllers - Frank D. Petruzella, 5th Edition, Published by McGraw-Hill Education, 2016.
2.	The 8051 Microcontroller and Embedded Systems - Muhammad Ali Mazidi, Janice GillispieMazidi, 2nd Edition, Published by Pearson Education, 2007.
3.	Introduction to Robotics: Mechanics and Control by John J. Craig, 3rd Edition, PublishedPearson Education, 2005.

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	
CO1	3	2	2	-	2	-	-	-	-	-	1	-
CO2	3	3	2	-	3	-	-	-	-	-	2	-
CO3	3	2	2	-	2	-	-	-	1	-	1	-
CO4	3	3	2	-	3	-	-	-	-	-	2	-
CO5	3	2	2	-	2	-	-	-	-	-	2	-

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester -V					
Design of Automation System **Category: PEC-I**					
Course Code	:	**B24RA564**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand the fundamental concepts of industrial automation.
2.	To analyze and design transfer lines and automated assembly systems.
3.	To design basic mechatronic systems.
4.	To understand programmable automation in manufacturing systems.
5.	To apply design principles for high-speed automatic assembly.

Module – 1	**No. of Hours**
Fundamental Concepts of Industrial Automation: Fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, levels of automation	9
Module – 2	**No. of Hours**
Transfer Lines and Automated Assembly: General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines.	9
Module – 3	**No. of Hours**
Design of Mechatronic Systems: Stages in design, traditional and mechatronic design, possible design solutions. Case studies-pick and place robot, engine management system.	9
Module – 4	**No. of Hours**
Programmable Automation: Special design features of CNC systems and features for lathes and machining centres. Drive system for CNC machine tools. Introduction to CIM; condition monitoring of manufacturing systems.	9
Module – 5	**No. of Hours**
Design For High Speed Automatic Assembly: Introduction, Design of parts for high speed feeding and orienting, high speed automatic insertion. Analysis of an assembly. General rules for product design for automation.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Understand fundamental concepts of industrial automation.
CO2	Analyze transfer lines and automated assembly systems.
CO3	Understand design basic mechatronic systems.
CO4	Understand programmable automation in manufacturing systems.
CO5	Apply design principles for high-speed automatic assembly.

Text Books	
1.	Mikell P. Groover, Industrial Robots: Technology, Programming and Applications, McGraw-Hill, New York, USA, 2000.
2.	Steve F. Krar, Computer Numerical Control Simplified, Industrial Press, 2001.

Reference Text Books	
1.	Mikell P Groover, "Automation Production Systems and Computer- Integrated Manufacturing" Pearson Education, New Delhi, 2001.
2.	W. Bolton, *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, 7th Edition, Pearson Education (2018)
3.	Geoffrey Boothroyd, Peter Dewhurst, and Winston A. Knight, Product Design for Manufacture and Assembly, CRC Press, 2011.

Web links and Video lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/noc26_me39/preview?utm_source=chatgpt.com
2. https://fliphtml5.com/osspz/ufwp/Industriial_Automation_Textbook/?utm_source=chatgpt.com
3. https://mecsmart.com/linear-transfer-assembly-systems-assembly-automation/?utm_source=chatgpt.com
4. https://nraoiekc.blogspot.com/2020/12/automated-manufacturing-production.html?utm_source=chatgpt.com

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	Internal Assessment-1	50	30 (Average of Best two Assessments)	50
	Internal Assessment-2	50		
	Internal Assessment-3	50		
AAT	Two Assessments as per regulations	20	20	
SEE	Semester End Examination	100	50	50
Total Marks				100

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	–	1	–	–	–	–	–	3
CO2	3	3	3	2	2	–	–	–	–	–	3
CO3	3	3	3	2	2	–	1	–	–	–	3
CO4	3	2	2	2	3	–	–	–	–	–	3
CO5	3	3	3	2	3	–	1	2	2	–	3

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester-VI					
ML for Predictive Maintenance Lab **Category: AEC-V**					
Course Code	:	**B24RA581**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	0:0:2:0	SEE	:	50 Marks
Total Hours	:	30	Total	:	100 Marks
Credits	:	1	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To explain machine learning and problems relevant to machine learning.
2.	To discuss the fundamentals of Decision trees learning and its issues.
3.	To illustrate neural networks, Bayes classifier and k nearest neighbor for problems appearing in machine learning.
4.	To describe statistical analysis of machine learning techniques.

Sl. No.	**List of the experiment**
1.	**Predictive Maintenance Data Analysis:** Load and analyze machine condition monitoring data such as vibration, temperature, current, speed and load. Perform data inspection, descriptive statistics and visualization using Python.
2.	**Preprocessing of Industrial Sensor Data:** Perform missing value handling, noise removal, normalization, standardization and outlier detection on machine sensor datasets.
3.	**Feature Extraction from Vibration Signals:** Extract time-domain features such as mean, RMS, variance, standard deviation, skewness, kurtosis, peak value, peak-to-peak value and crest factor from vibration signals.
4.	**Decision Tree and Random Forest for Fault Classification:** Implement Decision Tree and Random Forest classifiers to classify machine conditions as normal, warning and faulty. Display accuracy, confusion matrix and classification report.
5.	**K nearest neighbour (KNN):** Implement and demonstrate the k-Nearest Neighbour algorithm (k-NN) to classify the iris data set. Display the Confusion matrix and classification report. Also, try the same algorithm of the social networks dataset to predict a customer can purchase an item or not.
6.	**Support Vector Machine (SVM):** Implement and demonstrate a Support vector machine classifier to classify the instances of any dataset. Display the classification results. Also, try the same algorithm to classify the instances for any given dataset.
7.	**Regression Model for Machine Health Prediction:** Implement linear regression or random forest regression to predict machine health parameters such as temperature, vibration level, current consumption or degradation index. Visualize actual and predicted values.
8.	**PCA for Dimensionality Reduction of Machine Health Data:** Apply Principal Component Analysis to reduce the dimensionality of sensor feature data. Visualize reduced features and study their usefulness for fault diagnosis.
9.	**K-Means Clustering:** Implement and demonstrate the k-means clustering algorithms. Visualize the results using graphs.
10.	**DBSCAN clustering:** Implement and demonstrate the hierarchical clustering algorithms. Visualize the results using graphs.

Course Outcomes: At the end of the course, the students will be able to	
CO1	Analyze machine condition monitoring data using Python-based tools.
CO2	Apply preprocessing and feature extraction techniques on industrial sensor data.
CO3	Develop machine learning models for machine fault detection and fault classification.
CO4	Apply clustering, dimensionality reduction and anomaly detection techniques for predictive maintenance.
CO5	Design a basic ML-based predictive maintenance solution for robotics and automation systems.

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course if the student secures 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	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Laboratory	**Lab Conduction & Record**	**Evaluating each expt. for 10 marks**	**20**	**50**
	Laboratory Test -1	**50**	**15**	
	Laboratory Test -2	**50**	**15**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. SEE marks for the practical course are 50 Marks. Practical examinations are to be conducted between the schedules mentioned in the academic calendar of the Institution.
2. All laboratory experiments are to be included for practical examination.
3. Evaluation of test write-up, conduction procedure, result and viva will be conducted jointly by examiners.
4. Rubrics suggested for SEE, 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.
5. Change of experiment is allowed only once and 15% of Marks allotted to the Conduction procedure part are to be made zero. The minimum duration of SEE is 03 hours.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	-	2	3	-	-	-	-	-	-
CO2	2	3	2	3	3	-	-	-	-	-	-
CO3	3	3	3	2	3	-	-	-	-	-	-
CO4	2	3	2	3	3	-	-	-	-	2	-
CO5	3	3	3	3	3	1	1	1	2	2	2

Level 3 – High, Level 2 – Moderate, Level 1 -Low

Semester-V					
Digital Image Processing Lab **Category: AEC-V**					
Course Code	:	**B24EC582**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	0:0:2:0	SEE	:	50 Marks
Total Hours	:	30	Total	:	100 Marks
Credits	:	1	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To develop problem-solving skills through hands-on experiments and real-world image processing applications.
2.	To understand the fundamentals of digital image representation, pixel relationships, and intensity transformations and Learn to implement basic and advanced image processing techniques using Python and standard libraries.
3.	To analyze images in spatial and frequency domains using mathematical and computational tools.
4.	To apply image enhancement techniques such as contrast stretching, histogram processing, smoothing, and sharpening.
5.	To implement image compression and restoration techniques for efficient storage and improved image quality.

Sl. No.	**Title of the program / list of the experiment** **{List of Programs to be implemented & executed using any programming languages like MATLAB/PYTHON/OCTAVE (but not limited to)}**
1.	Simulation and Display of an Image, Negative of an Image (Binary & Gray Scale).
2.	Implementation of Relationships between Pixels.
3.	Implementation of Transformations of an Image.
4.	Contrast stretching of a low contrast image, Histogram, and Histogram Equalization.
5.	Display of bit planes of an Image.
6.	Display of FFT (1-D & 2-D) of an image.
7.	Computation of Mean, Standard Deviation, Correlation coefficient of the given Image.
8.	Implementation of Image Smoothening Filters (Mean and Median filtering of an Image).
9.	Implementation of image sharpening filters and Edge Detection using Gradient Filters.
10.	Image Compression by DCT, DPCM, HUFFMAN coding.
11.	Implementation of image restoring techniques.
12.	Implementation of Image Intensity slicing technique for image enhancement.

Course Outcomes: At the end of the course, the students will be able to	
CO1	Simulate, display, and manipulate digital images using Python programming tools.
CO2	Implement image intensity transformations including image negatives, pixel relationships, and intensity slicing for image enhancement.
CO3	Analyze image characteristics by computing statistical measures such as mean, standard deviation, correlation coefficient, and bit-plane representation.
CO4	Apply image enhancement techniques including contrast stretching, histogram generation, histogram equalization, smoothing, and sharpening filters
CO5	Analyze images in the frequency domain by implementing and interpreting 1-D and 2-D FFTs, and image compression and restoration techniques such as DCT, DPCM, Huffman coding, and image restoring filters for improving image quality and reducing data size

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course if the student secures 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	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Laboratory	**Lab Conduction & Record**	**Evaluating each expt. for 10 marks**	**20**	**50**
	Laboratory Test -1	**50**	**15**	
	Laboratory Test -2	**50**	**15**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. SEE marks for the practical course are 50 Marks. Practical examinations are to be conducted between the schedules mentioned in the academic calendar of the Institution.
2. All laboratory experiments are to be included for practical examination.
3. Evaluation of test write-up, conduction procedure, result and viva will be conducted jointly by examiners.
4. Rubrics suggested for SEE, 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.
5. Change of experiment is allowed only once and 15% of Marks allotted to the Conduction procedure part are to be made zero. The minimum duration of SEE is 03 hours.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	–	–	3	_	_	_	_	_	_
CO2	3	3	2	–	3	–	–	–	–	–	–
CO3	3	3	–	2	3	–	–	–	–	–	–
CO4	3	3	2	2	3	–	–	–	–	–	–
CO5	3	3	2	2	3	–	–	–	–	–	2

Level3 –High, Level2–Moderate, Level1 -Low

Semester-VI					
Robot Operating System Lab **Category: AEC-V**					
Course Code	:	**B24RA583**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	0:0:2:0	SEE	:	50 Marks
Total Hours	:	30	Total	:	100 Marks
Credits	:	1	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To introduce the architecture and core concepts of ROS 2.
2.	To develop modular robotic applications using ROS 2 communication mechanisms.
3.	To enable simulation-based robot control and visualization.
4.	To provide hands-on experience in integrating ROS 2 components for autonomous robotic applications.

Sl. No.	**List of the experiment**
1.	Installation and verification of ROS 2 Humble and execution of basic ROS commands.
2.	Creation and building of ROS 2 packages using colcon.
3.	Implementation of publisher–subscriber communication using ROS 2.
4.	Development of service–client and action server–client nodes.
5.	Robot motion control using Turtlesim and ROS 2 topics.
6.	Parameter tuning and execution of multi-node systems using launch files.
7.	Robot modeling using URDF and Xacro and visualization in RViz2.
8.	Visualization and debugging of robot coordinate frames using TF2.
9.	Sensor Integration and Data Handling.
10.	Autonomous Task Integration

Course Outcomes: At the end of the course, the students will be able to	
CO1	Understand the architecture and environment setup of ROS 2.
CO2	Implement inter-node communication using ROS 2 topics, services, and actions.
CO3	Control and configure simulated robots using ROS 2 tools.
CO4	Model and visualize robots using ROS 2.
CO5	Integrate ROS 2 components to implement basic autonomous robotic systems.

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course if the student secures 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	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Laboratory	**Lab Conduction & Record**	**Evaluating each expt. for 10 marks**	**20**	**50**
	Laboratory Test -1	**50**	**15**	
	Laboratory Test -2	**50**	**15**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. SEE marks for the practical course are 50 Marks. Practical examinations are to be conducted between the schedules mentioned in the academic calendar of the Institution.
2. All laboratory experiments are to be included for practical examination.
3. Evaluation of test write-up, conduction procedure, result and viva will be conducted jointly by examiners.
4. Rubrics suggested for SEE, 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.
5. Change of experiment is allowed only once and 15% of Marks allotted to the Conduction procedure part are to be made zero. The minimum duration of SEE is 03 hours.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	1	3	-	-	-	1	1	-
CO2	3	-	-	1	3	-	-	-	1	1	-
CO3	3	3	3	2	3	-	-	-	1	1	-
CO4	3	3	3	3	3	-	-	-	1	1	-
CO5	3	-	-	3	3	-	-	-	1	1	-

Level 3 – High, Level 2 – Moderate, Level 1 -Low

Semester-V					
Robotic Process Automation Lab **Category: AEC-V**					
Course Code	:	**B24RA584**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	0:0:2:0	SEE	:	50 Marks
Total Hours	:	30	Total	:	100 Marks
Credits	:	1	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand the concept of Robotics Process Automation in business application.
2.	To know about the utilization of Robotics Process Automation in any organization
3.	To utilize the RPA knowledge and provide the cost effective solution
4.	To understand business functionalities in Robotics Process Automation
5.	To learn Skills in cost efficiencies of various RPA solutions

Sl. No.	**List of the experiment**
1.	Download, Install and Activate Ui-Path Studio. Working with Automation Projects in UiPath Studio, Creating an Automation project, Understand Automation Debugging.
2.	Understand Layout Diagrams Understand Type of Decisions Switch Activity.
3.	Implement control statements such as if-activity, switch – activity.
4.	Implement while activity, do-while activity, for-each activity in any application
5.	Implement Flowchart and Sequence activity on Scalar and collection variables
6.	Develop: i) build a data table(static) ii) build a data table using data scraping (Dynamically)
7.	Create a simple calculator using a separate workflow and arguments
8.	Develop clipboard management. (Suggested Hint: open Notepad, write some data into it, and then copy the data to the clipboard. Later extract the data from the clipboard)
9.	Perform the following operations on an Excel file: i) Read cell ii) Write cell iii) Read range iv) Write range v) Append range
10.	Implement Arithmetic operations in 2 Excel files.
11.	Perform read operations on Excel file and creating a data table by using data from the Excel file
12.	Create and extract Email Address

Course Outcomes: At the end of the course, the students will be able to	
CO1	Implement basic and arithmetic operations using different data types
CO2	Validation of data input and outputs
CO3	Develop real time application using Excel file
CO4	Develop and deploy ready bots using UiPath platform
CO5	Students will analyze visual workflow automation straightforward and intuitive

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course if the student secures 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	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Laboratory	**Lab Conduction & Record**	**Evaluating each expt. for 10 marks**	**20**	**50**
	Laboratory Test -1	**50**	**15**	
	Laboratory Test -2	**50**	**15**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. SEE marks for the practical course are 50 Marks. Practical examinations are to be conducted between the schedules mentioned in the academic calendar of the Institution.
2. All laboratory experiments are to be included for practical examination.
3. Evaluation of test write-up, conduction procedure, result and viva will be conducted jointly by examiners.
4. Rubrics suggested for SEE, 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.
5. Change of experiment is allowed only once and 15% of Marks allotted to the Conduction procedure part are to be made zero. The minimum duration of SEE is 03 hours.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	3	3	-	-	-	-	-	-
CO2	3	3	-	3	3	-	-	-	-	-	-
CO3	1	2	-	3	3	-	-	-	-	2	-
CO4	2	3	-	3	3	-	-	-	-	2	-
CO5	3	2	-	3	3	-	-	-	-	-	-

Level 3 – High, Level 2 – Moderate, Level 1 -Low

Semester -V					
Mini - Project **Category: SDC**					
Course Code	:	**B24RAP511**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	0:0:4:0	SEE	:	50 Marks
Total Hours	:	60	Total	:	100 Marks
Credits	:	2	SEE Duration	:	3 Hrs

Mini-Project Work Evaluation:

Mini Project is a hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small applications etc. Based on the ability/abilities of the student/s and recommendations of the supervisor, 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 the **Project Reviews, Project report and Viva-Voce in the ratio of 60:20:20**. The marks awarded for the project report shall be the same for all the batches mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

CIE Evaluation: The CIE marks awarded for the Mini-project, shall be based on the evaluation of the **Project Reviews, Project report and Viva-Voce in the ratio of 60:20:20**. The marks awarded for the project report shall be the same for all the batches mates.

SEE Evaluation: SEE for project work will be conducted by the two examiners appointed by the Principal / CoE. The SEE marks awarded for the project work shall be based on the evaluation of **Write-up, Presentation Skills, Project Demonstration and Viva-Voce** in the ratio of 20:60:20

Rubrics for Mini-Project

Sl. No	**Criteria**	**Scale of Assessment**		
		Satisfactory (0-5)	**Good (6-8)**	**Excellent (9-10)**
1	Objective, Existing method with proposed method	Incomplete justification to the objectives proposed; Steps are mentioned but unclear; without justification to objectives	Good justification to the objectives; Methodology to be followed is specified but detailing is not done	All objectives of the proposed work are well defined. Steps to be followed to solve the defined problem are clearly specified.
2	Analysis/Description of the project	Incomplete explanation of the key concepts and in-sufficient description of the technical requirements of the project	Complete explanation of the key concepts but in-sufficient description of the technical requirements of the project	Complete explanation of the key concepts and strong description of the technical requirements of the project

3	Result Analysis	• All defined objectives are achieved. • Modules are working well in isolation and properly demonstrated • Modules of project are not properly integrated.	• All defined objectives are achieved. • Each module working well and properly demonstrated. • Integration of all modules not done and system working is not very satisfactory.	• All defined objectives are achieved. • Each module working well and properly demonstrated • All modules of project are well integrated and system working is accurate
4	Project Report	• Project report is according to the specified format but some mistakes. • In-sufficient references	• 1. Project report is according to the specified format. • References are appropriate but not mentioned well.	• Project report is according to the specified Format. • References are appropriate and well mentioned
5	Queries	Lacks sufficient knowledge and awareness	Fair knowledge and awareness related to the project.	Extensive knowledge and awareness related to the project

Semester -VI					
Thermal Management of Electronic Systems **Category: PCC**					
Course Code	:	**B24RA601**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand semiconductor technology and the importance of thermal management in electronics.
2.	To study various thermal transfer process and properties of the surfaces affecting the thermal management.
3.	To apply advanced cooling methodologies and thermal design, to improve system reliability.
4.	To perform and analyze computer simulations for solution of real-world thermal management problems.

Module-1	**No. of Hours**
Introduction: Semiconductor Technology Trends, Temperature –Dependent Failures, Importance of heat transfer in electronics. Thermal design process. Heat Transfer mechanisms.	9
Module-2	**No. of Hours**
Heat Conduction Equation-Fins and Heat sinks Radiation Heat Transfer: General heat Conduction equation. Boundary and initial conditions. Steady state, Transient heat, Micro scale heat conduction. Fin equation, Heat sinks, Blackbody radiation, and Radiation heat transfer from plate-fin heat sinks.	9
Module-3	**No. of Hours**
Convective Heat Transfer: Velocity and thermal boundary layer, Friction coefficient, Heat transfer coefficient. External and Internal flows, Natural convection heat transfer.	9
Module–4	**No. of Hours**
Advanced Cooling Technologies: Experimental Techniques and Thermal design: Heat pipes, Heat pipe selection and modeling, Jet impingement on flat surfaces and heat sinks, Liquid immersion cooling, Thermo-syphons, Loop heat pipes, Thermoelectric coolers, cooling using phase change–cooling with PCM materials, piezoelectric fans, Electro hydrodynamic flow, Synthetic Jets, Single phase and two-phase flow micro channels- Thermal design.	9
Module–5	**No. of Hours**
Temperature measurement: Thermocouples, overview, reference junction, proper connections, types, special limits of error wire, time constants, sheathing, potential problems, DAQ setup. RTDs: overview, bridges, calibration, accuracy, response time, potential problems Thermistors: Infrared Thermometry fundamentals, emissivity determination, field of view, Other Non-electronic measurement, thin-film heat flux gauge Temperature Controllers How to Choose; Standards, cost, accuracy, stability, sensitivity, size, contact/non-contact, temperature range, fluid type Thermal interface materials, types, ideal and actual TIM, TIM test methods	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Apply advanced heat transfer principles to design and optimize thermal management solutions for electronic components, devices, and systems to enhance performance and reliability
CO2	Apply the concept of thermal resistance in designing and optimizing thermal management systems to improve heat dissipation and component efficiency.
CO3	Interpret first-order analyses of heat transfer from electronic systems to develop effective cooling strategies and improve system performance.
CO4	Evaluate advanced cooling technologies, discussing their impact on electronic system efficiency and thermal management.
CO1	Compare various temperature measurement instruments and thermal interface materials to select and implement optimal solutions for precise temperature control and effective thermal management..

Text Books	
1.	ShabanyYounes “Heat Transfer-Thermal Management in Electronics”, CRC Press, First Edition, 2010
2.	Steinberg, Dave S., “Cooling Techniques for Electronic Equipment”, John Wiley & Sons, 1991
3.	Ravi Kandasamy and Arun S. Mujumdar, Thermal Management of Electronic Components, Lambert Academic Publishing, 2010.

Reference Text Books	
1.	G N Ellison, Van Nostrand Reinhold, "Thermal Computations for Electronic Equipment", First Edition, 1984
2.	A D Kraus and A Bar Cohen, "Thermal Analysis and Control of Electronic Equipment", McGraw Hill, Hemisphere, Second Edition, 1983

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	1	1	1	1	-	-	1	-
CO2	3	2	1	1	1	1	1	-	-	1	-
CO3	3	2	1	1	1	1	1	-	-	1	-
CO4	3	2	1	1	1	1	1	-	-	1	-
CO5	3	2	1	1	1	1	1	-	-	1	-

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester- VI					
Finite Element Analysis **Category: IPCC**					
Course Code	:	**B24RA602**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:2:3	SEE	:	50 Marks
Total Hours	:	45+30	Total	:	100 Marks
Credits	:	4	SEE Duration	:	3Hrs

Course Learning Objective is	
1.	To learn basic principles of finite element analysis procedure.
2.	To learn the theory and characteristics of finite elements that represent engineering structures.
3.	To learn and apply finite element solutions to structural problems
4.	To learn and apply finite element solutions to thermal and heat transfer problems
5.	To learn and apply finite element solutions to dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.

Module– 1	**No. of Hours**
Introduction to FEM: Introduction to FEM, engineering applications, advantages, General steps, Element types, Convergence criteria, Coordinate systems, commercial packages preprocessor, solver and post processor. Principles of Elasticity: Strain displacement relations, Stress strain relations for 1D, 2D, and 3D cases, Plain stress and Plain strain conditions, Introduction to Numerical Methods, Potential energy method, Rayleigh Ritz method and Galerkin method (No numerical problems)	9
Module– 2	**No. of Hours**
One Dimensional Element: Formulation of a linear bar element, Shape Functions Polynomial, The Potential Energy Approach, derivation of stiffness matrix, Properties of stiffness matrix, Boundary conditions elimination method and penalty method. Numerical Problems on straight and stepped bars. (Problems with 2 elements only).	9
Module– 3	**No. of Hours**
Trusses and Beams: Formulation plane trusses element, Stiffness matrix (No derivation), Numerical Problems on point load, Formulation beam element, derivation of Hermite shape functions, stiffness matrix and load vector (No derivations), Numerical Problems on beams carrying concentrated, UDL (Problems with 2 elements only).	9
Module– 4	**No. of Hours**
Two-dimensional Element: Formulation of triangular and quadrilateral elements. Displacement models and shape functions for linear and higher order elements, Iso parametric – sub parametric – super parametric elements, Introduction to axisymmetric– triangular elements. (No numerical problems)	9
Module– 5	**No. of Hours**
Dynamic considerations and Heat Transfer: Dynamic considerations: Formulation for point mass and distributed masses, Consistent mass matrices for 1D bar element, computation of eigen values and eigen vectors. Heat Transfer Problems: Steady state heat transfer, 1D heat conduction governing equation.	9

LABORATORY

Practical Component of IPCC (12 Experiments)

Sl. No	**List of experiments**
1.	Bars of constant cross section area, tapered cross section area
2.	Stepped bar with different materials
3.	Trusses – (Minimum 1 exercises of different areas of cross sections of links)
4.	Trusses – (Minimum 1 exercises of different supports such as fixed support, rolling support)
5.	Beams – Simply supported, cantilever (Minimum 1 exercises)

6.	Beams with point load, UDL (Minimum 1 exercises)
7.	Stress analysis of a rectangular plate with a circular hole
8.	Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Heat transfer through composite section) Minimum of 1exercises
9.	Natural frequency of beam with fixed –fixed end condition
10.	Response of beam with fixed – fixed end conditions subjected to forcing function
11.	Demonstrate the use of graphics standards (IGES, STEP etc) to import the model from modeler to solver

Course Outcomes: At the end of the course, the students will be able to	
CO1	Understand the concepts behind formulation methods in FEM.
CO2	Identify the application and characteristics of FEM elements such as bars, beams, plane and iso parametri elements.
CO3	Develop element characteristic equation and generation of global equation.
CO4	Apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axi symmetric and dynamic problems.
CO5	Solving of displacements, stress and strains induced problems.

Text Books	
1.	Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
2.	Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.

Reference Text Books	
1.	J.N.Reddy, "Finite Element Method" McGraw Hill International Edition.Bathe K. J. Finite Elements Procedures, PHI.
2.	C.S.Krishnamoorty, Finite Element Analysis, Tata McGrawHill

Web links and Video lectures (e-Resources)

- http://icas.bf.rtu.lv/doc/Book.pdf
- http://www.adina.com/MITRES2_002S10_linear.pdf
- https://www.edx.org/course/finiteelementmethodfemanalysistsinghuax70120073x

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

Component	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30** (Average of Best Two Assessments)	**50/2 = 25**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	Any One Assessments as per regulations	**20**	**20**	
Laboratory	**Lab conduction & Record**	Evaluating each expt. for 10 marks.	**05**	**25**
	Lab Internal Test	**50**	**20**	
Continuous Internal Evaluation (CIE)				**50**
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice. Students should answer five full questions, selecting one full question from each module.
5. Students have to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.
6. The maximum marks from the practical component to be included in the SEE question paper is **16 marks.**
7. Question papers to be set as per the Blooms Taxonomy levels.
8. The laboratory component of the **integrated course** shall be CIE only. However, in SEE, the questions from the practical component shall be included.

CO-PO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	2
CO2	2	3	3	-	-	-	-	-	-	-	2
CO3	3	2	3	3	2	-	-	-	-	-	2
CO4	2	3	3	2	3	-	-	-	-	-	2
CO5	3	3	2	2	-	2	2	-	-	-	2

Level 3 - High, Level 2 - Moderate, Level 1 – Low

Semester- VI					
Humanoid Robots **Category: PEC-II**					
Course Code	:	**B24RA631**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3Hrs

Course Learning Objective is	
1.	To understand the fundamental principles and design aspects of humanoid robots
2.	To explore the mechanical, electrical, and software components involved in humanoid robot construction
3.	To analyze the dynamics, kinematics, and control strategies specific to humanoid robots
4.	To develop and implement algorithms for motion planning, perception, and interaction in humanoid robots
5.	To examine the ethical, social, and practical implications of deploying humanoid robots in real-world scenarios

Module– 1	**No. of Hours**
Introduction to Humanoid Robots: History and Evolution of Humanoid Robots, Milestones in humanoid robotics development. Design and Architecture of Humanoid Robots, Anatomy of humanoid robots: head, torso, limbs. Actuators and sensors used in humanoid robots. Overview of popular humanoid robots (ASIMO, Atlas, NAO). Applications of Humanoid Robots, Use cases in healthcare, education, entertainment, and manufacturing. Ethical considerations of Robots.	9
Module– 2	**No. of Hours**
Kinematics and Dynamics of Humanoid Robots: Forward and Inverse Kinematics, Mathematical modeling of humanoid robot joints and limbs. Dynamics of Humanoid Robots, Newton-Euler and Lagrangian dynamics for humanoids, Stability and balance control. ZMP (Zero Moment Point) and its role in stable walking.	9
Module– 3	**No. of Hours**
Control Systems for Humanoid Robots: Motion Control and Path Planning**,** PID control, adaptive control, and hybrid control techniques. Balance and Posture Control, Real-time balance control systems, Posture optimization for humanoid robots. Sensor Integration and Feedback Control, Use of IMUs, force sensors, and vision systems in control loops. Sensor fusion techniques for accurate perception.	9
Module– 4	**No. of Hours**
Perception and AI in Humanoid Robots: Sensory Systems in Humanoid Robots, Visual, auditory, and tactile sensors network and data processing. Computer Vision and Object Recognition, Image processing techniques for humanoids, Object detection and recognition using machine learning. Artificial Intelligence in Humanoid Robots, Natural language processing and speech recognition, Human-robot interaction and decision-making systems.	9
Module– 5	**No. of Hours**
Future Trends in Humanoid Robots: Human-Robot Collaboration, Techniques for safe and efficient human-robot interaction. Challenges in Humanoid Robotics, Energy efficiency, durability, and reliability issues, Social and legal challenges in deploying humanoid robots. Advances in AI, materials, and actuation technologies.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Understand the fundamental concepts and design principles of humanoid robots
CO2	Analyze the kinematics, dynamics, and control systems used in humanoid robots
CO3	Design and implement motion planning and control algorithms for humanoid robots
CO4	Explore the sensory systems, perception, and AI integration in humanoid robots
CO5	Evaluate the applications, challenges, and future trends of humanoid robots in various domains.

Text Books	
1.	"Humanoid Robotics: A Reference" by Prahlad Vadakkepat and Aurobinda Routray (Indian Authors).
2.	"Introduction to Humanoid Robotics" by Shuuji Kajita, Hirohisa Hirukawa, Kensuke Harada, and Kazuhito Yokoi

Reference Text Books	
1.	"Humanoid Robots: Modeling and Control" by Dragomir N. Nenchev, Atsushi Konno, and Yoshihiko Nakamura.
2.	"Humanoid Robotics and Neuroscience: Science, Engineering and Society" by Gordon Cheng

Web links and Video lectures (e-Resources)
• **"Humanoid Robotics" by Lecture Snippets, https://www.youtube.com/user/LectureSnippets**

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2	2	-	-	-	-	-	-	1
CO2	2	2	2	-	-	-	-	-	-	-	1
CO3	2	2	1	-	-	-	-	-	-	-	1
CO4	2	2	1	-	1	-	-	-	-	-	2
CO5	-	1	-	-	-	-	-	-	-	-	1

Level 3 - High, Level 2 – Moderate, Level 1 - Low

Semester-VI					
Embedded Systems for Robotic Applications **Category: PEC-II**					
Course Code	:	**B24RA632**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To identify various components, their purpose, and their application to the embedded system'sapplicability.
2.	To understand to design, analyze, and optimize embedded systems through integrated hardware and software co-design methodologies for efficient and reliable system performance..
3.	To understand the embedded system's real-time operating system and its application in IoT
4.	To understand the fundamentals of ARM-based systems, including architecture and its units likeregisters , debug interface, stack, MPU, Interrupts etc
5.	To use the various instructions to program the ARM controller.

Module– 1	**No. of Hrs**
Introduction to Embedded System: What is an Embedded Systems? Embedded systems Vs Generalcomputing systems, History of Embedded Systems, Classification of Embedded systems, Purpose of Embedded Systems, The Typical EmbeddedSystem, Microprocessor Vs Microcontroller, Differences between RISC and CISC, Harvard V/s Von-Neumann Processor/Controller Architecture, Big-endian V/s Little-endian processors **Embedded System Design Concepts:** Characteristics and Quality Attributes of Embedded Systems, Operational and non-operational quality attributes, Embedded Systems-Application and Domain specific	9
Module– 2	**No. of Hrs**
Hardware Software Co-Design: Embedded firmware design approaches, computational models, embeddedfirmware development languages, Integration and testing of Embedded Hardware and firmware, Components inembedded system development environment(IDE),Files generated during compilation, simulators, emulators and debugging.	9
Module– 3	**No. of Hrs**
Rtos And Ide for Embedded System Design: Operating System basics, Types of operating systems,Task, process and threads (Only POSIX Threads with an example program), Thread preemption, Preemptive Task scheduling techniques, Task Communication, Task synchronization issues – Racing and Deadlock. How to choose an RTOS, Integration and testing of Embedded hardware and firmware,	9
Module– 4	**No. of Hrs**
Arm Embedded Systems: Introduction, RISC design philosophy, ARM design philosophy, Embedded system hardware – AMBA busprotocol, ARM bus technology, Memory, Peripherals, Embedded system software – Initialization (BOOT)code, Operating System, Applications.ARM Processor Fundamentals, ARM core dataflow model, registers, current program status register,Pipeline, Exceptions, Interrupts and Vector Table, Core extensions	9
Module– 5	**No. of Hrs**
Introduction to the Arm Instruction Set: Introduction, Data processing instructions, Load – Storeinstruction, Software interrupt instructions, Program status register instructions, Loading constants,ARMv5E extensions, Conditional Execution. **C Compilers and Optimization :**Basic C Data Types, C Looping Structures, Register Allocation, Function Calls, Pointer Aliasing	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Identify the various components of an embedded system, explain their purpose, and analyze their applicability in real-world embedded system applications
CO2	Understand the fundamental concepts and design flow of hardware–software co-design in embedde systems.
CO3	Explain the concepts of real-time operating systems (RTOS) used in embedded systems and analyze

	their applications in Internet of Things (IoT) systems
CO4	Understand the fundamentals of ARM-based systems, including ARM architecture and core units such as registers, stack, memory protection unit (MPU), interrupt handling, and debug interfaces.
CO5	Apply ARM instruction sets to develop, program, and debug applications using ARM-based controllers.

Text Books	
1	Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education
2	Andrew N Sloss, Dominic System and Chris Wright, "ARM System Developers Guide", Elsevier,Morgan Kaufman publisher, 1st Edition, 2008.
3.	Peckol, "Embedded System Design", John Wiley & Sons, 2010.
Reference Text Books	
1	Raj Kamal, "Embedded Systems: Architecture and Programming", Tata McGraw Hill, 2008.
2	Tammy Noergaard, "Embedded System Architecture, A comprehensive Guide for Engineers and Programmers", Elsevier, 2006
3	Lyla B Das," Embedded Systems-An Integrated Approach",Pearson2013

Web links and Video lectures (e-Resources)
1. https://archive.nptel.ac.in/courses/106/105/106105193/
2. https://developer.arm.com/documentation/dui0068/b/ARM-Instruction-Reference
3. https://www.udemy.com/course/introduction-to-arm-cortex-m3-and-m4-processors/
4. www.Nuvoton .com/websites on Advanced ARM Cortex Processors
5. https://alison.com/tag/embedded-systems

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	3	-	-	-	-	3	1	3
CO2	3	3	3	1	3	-	-	-	-	2	1	3
CO3	3	3	3	1	3	-	-	-	-	2	1	3
CO4	3	3	3	1	3	-	-	-	-	2	1	3
CO5	3	3	3	1	3	-	-	-	-	2	1	3

Level 3- High, Level 2- Moderate, Level 1-Low

Semester - VI					
PLC and SCADA **Category: PEC-II**					
Course Code	:	**B24EE633**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand PLC hardware components, operating modes, and basic programming.
2.	To develop basic PLC wiring diagrams and ladder logic programs.
3.	To explain the operation of various PLC program control instructions.
4.	To understand data transfer, data compare instructions, and basic PLC closed-loop control.

Module – 1	**No. of Hours**
Programmable Logic Controllers: Introduction, Parts of a PLC, Principles of Operation, PLCs versus Computers, PLC Size and Application. **PLC Hardware Components:** The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs) **Basics of PLC Programming**: Processor Memory Organization, Program Scan, PLC Programming Languages, Relay-Type Instructions, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Entering the Ladder Diagram, Modes of Operation.	9
Module – 2	**No. of Hours**
Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs: Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description. **Programming Timers:** Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers.	9
Module – 3	**No. of Hours**
Programming Counters: Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions. **Program Control Instructions:** Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry	9
Module – 4	**No. of Hours**
Data Manipulation Instructions: Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control. **Math Instructions:** Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions, File Arithmetic Operations	9
Module – 5:	**No. of Hours**
Sequencer and Shift Register Instructions: Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Bit Shift Registers, Word Shift Operations. **Process Control, Network Systems, and SCADA:** Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control, Data Communications, Supervisory Control and Data Acquisition (SCADA).	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Describe the hardware components of PLC: I/O modules, CPU, memory devices, other support devices, operating modes and PLC programming.

CO2	Develop Fundamental PLC Wiring Diagrams and Ladder Logic Programs
CO3	Describe the operation of different program control instructions.
CO4	Discuss the execution of data transfer instructions, data compare instructions and the basic operation of PLC closed-loop control system
CO5	Describe the operation of mechanical sequencers, bit and word shift registers, processes and structure of control systems and communication between the processes.

Text Books	
1.	Programmable Logic Controllers, Frank D Petruzella, McGraw Hill, 4th Edition, 2011

Reference Text Books	
1.	Programmable Logic Controllers an Engineer's Guide, E A Parr Newnes, 3rd Edition, 2013
2.	Introduction Programmable Logic Controllers, Gary Dunning, Cengage, 3rd Edition, 2006

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	Internal Assessment-1	50	30 (Average of Best two Assessments)	50
	Internal Assessment-2	50		
	Internal Assessment-3	50		
AAT	Two Assessments as per regulations	20	20	
SEE	Semester End Examination	100	50	50
Total Marks				100

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	–	3	–	–	–	–	–	1
CO2	3	2	2	–	3	1	–	–	–	–	1
CO3	3	3	3	1	3	2	–	1	–	–	2
CO4	3	2	3	–	3	1	–	1	1	–	2
CO5	3	3	3	2	3	2	–	1	1	2	3

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester - VI					
Additive Manufacturing **Category: PEC-II**					
Course Code	:	**B24RA634**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand fundamentals and processes of additive manufacturing
2.	To learn design principles and materials used in AM
3.	To develop practical exposure through simple experiments
4.	To apply AM in robotics and automation applications.
5.	To analyze industrial applications and future trends.

Module – 1	**No. of hours**
Fundamentals of Additive Manufacturing: Introduction to Additive Manufacturing and Rapid Prototyping, Evolution and need of AM, Conventional v/s Additive manufacturing, AM process chain and workflow, Classification of AM processes (ASTM classification), File formats: STL, AMF, 3MF, Basic CAD modeling for AM, Applications in robotics and automation.	9
Module – 2	**No. of hours**
Polymer Based Additive Manufacturing: Fused Deposition Modeling (FDM) – working and components, Vat Photo polymerization (SLA, DLP), Material Jetting process, Materials used: PLA, ABS, resins, Process parameters and print settings, Defects in printed parts and remedies, Safety precautions in AM lab.	9
Module – 3	**No. of hours**
Metal & Powder Based Additive Manufacturing: Powder Bed Fusion: SLS, SLM, Electron Beam Melting (EBM), Directed Energy Deposition (DED), Metal powders and properties, Post-processing methods (heat treatment, finishing), Inspection and quality control, Industrial applications	9
Module – 4	**No. of hours**
Design for Additive Manufacturing (DAM): Design guidelines for AM, Part orientation and support structures, Slicing software and tool path generation, Infill patterns and density, Topology optimization basics, Reverse engineering and 3D scanning, CAD modeling of simple robotic parts, Assembly printing concepts.	9
Module – 5	**No. of hours**
Applications & Industry 4.0: AM applications in robotics and automation, Rapid prototyping and tooling, Medical, aerospace and automotive applications, Cost analysis of AM, AM in Industry 4.0 and smart manufacturing, Sustainability and environmental aspects, Future trends and research directions, Case studies.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Explain fundamentals and processes of additive manufacturing.
CO2	Describe polymer and metal AM techniques.
CO3	Apply design principles for additive manufacturing.
CO4	Perform basic AM experiments and modeling.
CO5	Analyze applications of AM in robotics and industry.

Text Books	
1.	Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
2.	Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing”, Hanser Publisher, 2011.
3.	Khanna Editorial, “3D Printing and Design”, Khanna Publishing House, Delhi.

Reference Text Books	
1.	CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.
2.	J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in MaterialScience, 2013.
3.	L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	2
CO2	3	3	2	-	-	-	-	-	-	-	2
CO3	2	3	3	2	3	-	-	-	-	-	2
CO4	2	2	3	3	2	-	-	-	-	-	2
CO5	3	3	2	2	-	2	2	-	-	-	2

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester -VI					
Automotive Electronics **Category: OEC-I**					
Course Code	:	**B24RA641**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand the Evolution and Fundamentals of Automotive Electronics
2.	To analyze the Basics of Electronic Engine Control Systems
3.	To explore Automotive Sensors and Actuators
4.	To examine Digital Engine Control Systems and Networking
5.	To evaluate Automotive Diagnostics and Future Technologies

Module – 1	**No. of Hours**
Automotive Fundamentals Overview: Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine - Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System-Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System, Starter Battery --Operating principle **The Basics of Electronic Engine Control:** Motivation for Electronic Engine Control- Exhaust Emissions, Fuel Economy, Concept of an Electronic Engine control system, Definition of General terms, Definition of Engine performance terms, Engine mapping, Effect of Air/Fuel ratio, spark timing and EGR on performance, Control Strategy, Electronic Fuel control system, Analysis of intake manifold pressure, Electronic Ignition.	9
Module – 2	**No. of Hours**
Automotive Sensors: Automotive Control System applications of Sensors and Actuators - Variables to be measured, Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor (TAS), Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (02/EGO) Lambda Sensors, Piezoelectric Knock Sensor. **Automotive Engine Control Actuators-**Solenoid, Fuel Injector, EGR Actuator, Ignition System	9
Module – 3	**No. of Hours**
Digital Engine Control Systems: Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control -Closed loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System- Secondary Air Management, Evaporative Emissions Canister Purge, Automatic System Adjustment, System Diagnostics. **Control Units-**Operating conditions, Design, Data processing, Programming, Digital modules in the Control unit, Control unit software.	9
Module – 4	**No. of Hours**
Automotive Networking: Bus Systems- Classification, Applications in the vehicle, Coupling of networks, Examples of networked vehicles, Buses - CAN Bus, UN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces. **Vehicle Motion Control:** Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS).	9
Module – 5	**No. of Hours**
Automotive Diagnostics: Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics, Expert Systems, Occupant Protection Systems -Accelerometer based Air Bag systems. **Future Automotive Electronic Systems:** Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Heads Up display, Speech Synthesis, Navigation - Navigation Sensors - Radio Navigation, Signpost navigation, dead reckoning navigation, Voice Recognition Cell Phone dialing, Advanced Cruise Control, Stability Augmentation, Automatic Driving Control.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Describe the basics of automobile dynamics and design electronics
CO2	Acquire an overview of automotive components, subsystems, and basics of Electronic Engine Control in today's automotive industry.
CO3	Use available automotive sensors and actuators while interfacing with microcontrollers/microprocessors during automotive system design
CO4	Understand the networking of various modules in automotive systems, communication protocols and diagnostics of the sub systems.
CO5	Design and implement the electronics that attribute the reliability, safety, and smartness to the automobiles, providing add-on comforts and get fair idea on future Automotive Electronic Systems.

Text Books	
1.	William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing.

Reference Text Books	
1.	Robert Bosch GmbH (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley & Sons Inc., 2007.

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	1	1	1	1	-	-	1	-
CO2	3	2	1	1	1	1	1	-	-	1	-
CO3	3	2	1	1	1	1	1	-	-	1	-
CO4	3	2	1	1	1	1	1	-	-	1	-
CO5	3	2	1	1	1	1	1	-	-	1	-

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester -VI					
Industrial Automation **Category: OEC-I**					
Course Code	:	**B24RA642**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To introduce the fundamentals of electrical control and the architecture, operation, and applications of Programmable Logic Controllers (PLCs) in industrial automation.
2.	To develop the ability to program PLCs using ladder logic, timers, counters, subroutines, and analog modules for machine, process, and motion control applications..
3.	To provide knowledge of Human-Machine Interface (HMI) and SCADA systems, their programming, and integration with PLCs for industrial monitoring and supervisory control.
4.	To explain the principles, components, and operation of hydraulic and pneumatic drives, actuators, and control valves, and to design fluidic circuits for industrial automation.
5.	To enable students to design, implement, and integrate industrial automation systems, including PLCs, HMI/SCADA, and fluidic power systems, for applications in Industry 4.0 and smart manufacturing environments

Module – 1	**No. of Hours**
PLC Basics: Basics of Electrical control-Parts of a PLC -Principles of Operation –Advantages and Disadvantages of PLC - PLC Size and Application- The I/O Section -Discrete I/O Modules Analog I/O Modules-Special I/O Modules – I/O Specifications-Scanning cycle of PLC-The CPU-Memory Design-Memory Types- Processor Memory Organization-I/O Interfacing.	9
Module – 2	**No. of Hours**
Programming PLC: PLC Programming Languages- PLC Modes of Operation - Relay-Type Instructions- Instruction Addressing-Branch Instructions Internal Relay Instructions Programming EXAMINE IF CLOSED and EXAMINE IF OPEN Instructions - Designing a Ladder Diagram for large process –Programming Timers-Programming Counters - High Speed Counter-Subroutine and Interrupt -programming Analog module - Developing a PLC program for Machine, Process and Motion control.	9
Module – 3	**No. of Hours**
HMI and SCADA: HMI programming-Interfacing PLC with HMI. Basics of SCADA system SCADA key features - Remote terminal units (RTUs)-Typical requirements for an RTU system - PLCs used as RTUs-Consideration and benefits of SCADA system-SCADA software package- Selection of Profibus, Profinet, Sercos, Ethernet and OPC/UA	9
Module – 4	**No. of Hours**
Fluidic Power Automation: Fundamentals of hydraulic and pneumatic drives-basic definitions and principles-benefits of fluidic drives-components of fluidic drive systems. Actuators-Control valves Classification- Directional, Pressure, Flow, Proportional and servo valves- Electro pneumatic circuit - Fluidic sequential circuit design using classical, cascade and step counter methods	9
Module – 5	**No. of Hours**
Industrial Applications: Role of PLC in Industry 4.0 application, Application of Wireless Networks for Industrial automation, Application of Pneumatic, Hydraulic circuits in Industrial automation.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Explain the selection and programming methods of different automation components like PLC, SCADA, DCS and communication buses.
CO2	Explain the construction, working and control strategies of different industrial drives and valves
CO3	Design pneumatic and hydraulic circuits for industrial applications
CO4	Construct a program using PLC to solve problems pertaining to Manufacturing industries
CO5	Design an automation system by interconnecting work cell devices through an industrial network

Text Books	
1.	Frank D Petruzella, Programmable logic controllers, Fourth edition, McGraw Hill higher education ,2016

2.	Fluid power with applications by Antony Esposito ,Pearson publications,2017 x
3.	Rajesh Mehra, Vikrant Vij, PLCs & SCADA: Theory and Practice, Laxmi Publications-2016

Reference Text Books	
1.	Steve Mackay ,Edwin Wright MIPENZ, Deon Reynders, John Park "Practical Industrial Data Networks - Design, Installation, trouble shooting" ,IDC Technologies, Australia
2.	Frank D petruzella, Electrical Motor and control systems, McGraw Hill higher education ,2010
3.	Krishna Kant -Computer Based Industrial Control, EEE-PHI, 2nd edition, 2010
4.	Garry Dunning-Introduction to Programmable Logic Controllers, 2nd edition, Thomson, ISBN: 981-240-625-5
5.	W.Bolton- Programmable Logic Controllers, Sixth Edition (Paperback) ISBN-13: 978-0128029299, 2012

Web links and Video lectures (e-Resources):

1. https://www.nielit.gov.in/content/online-course-industrial-automation-plc-scada?utm_source=chatgpt.com
2. https://www.learnvern.com/industrial-automation-with-scada?utm_source=chatgpt.com
3. https://www.udemy.com/course/learn-industrial-marine-factory-automation-iiot-course-training-free/?utm_source=chatgpt.com
4. https://www.udemy.com/course/hmi-interfacing-with-plc/?utm_source=chatgpt.com

ASSESSMENT DETAILS BOTH (CIE AND SEE)

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CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	Internal Assessment-1	50	30 (Average of Best two Assessments)	50
	Internal Assessment-2	50		
	Internal Assessment-3	50		
AAT	Two Assessments as per regulations	20	20	
SEE	Semester End Examination	100	50	50
Total Marks				100

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	2	-	-	-	-	-	2
CO2	3	2	2	1	2	-	-	-	-	-	2
CO3	3	3	3	2	3	-	-	-	-	-	2
CO4	3	3	3	3	3	-	-	-	-	-	2
CO5	3	3	3	3	3	-	-	-	-	-	2

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester -VI					
Power Plant Engineering **Category: OEC-I**					
Course Code	:	**B24RA643**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To learn the construction and working of steam generators and their accessories.
2.	To gain the knowledge of renewable energy sources and their utilization.
3.	To understand principles of energy conversion from wind, geothermal, ocean, biomass, nuclear, hydel and tidal.
4.	To explore the energy conversion from wind.
5.	To analyze the energy conversion from geothermal, ocean, biomass, nuclear, hydel and tidal.

Module – 1	**No. of Hours**
Steam Generators; Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures, LaMount, Benson, Velox, Loeffer, Schmidt steam generators, Cooling towers and Ponds, Accessories such as Superheaters, De-superheater, Economizers, Air preheaters	9
Module – 2	**No. of Hours**
Solar Energy: Introduction, Solar radiation at the earth's surface, Solar radiation measurements, Flat plate collectors, Focussing collectors, Solar pond, Solar electric power generation-Solar photovoltaics. **Biomass Energy:** Photosynthesis, photosynthetic oxygen production, energy plantation. Bio Chemical Route: Biogas production from organic wastes by anaerobic fermentation, Bio gas plants-KVIC, Janta, Deenbhandu models, factors affecting bio gas generation. Thermal gasification of biomass, updraft and downdraft.	9
Module – 3	**No. of Hours**
Geothermal Energy: Forms of geothermal energy, Dry steam, wet steam, hot dry rock and magmatic chamber systems. **Tidal Energy:** Tidal power, Site selection, Single basin and double basin systems, Advantages and disadvantages of tidal energy. **Wind Energy:** Wind energy-Advantages and limitations, wind velocity and wind power, Basic components of wind energy conversion systems, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor, Applications of wind energy.	9
Module – 4	**No. of Hours**
Hydroelectric plants: Advantages & disadvantages of water power, Hydrographs and flow duration curvesnumericals, Storage and pondage, General layout of hydel power plants- components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants, water hammer. **Ocean Thermal Energy:** Ocean thermal energy conversion, Principle and working of Rankine cycle, Problems associated with OTEC.	9
Module – 5	**No. of Hours**
Nuclear energy: Principles of release of nuclear energy-Fusion and fission reactions. Nuclear fuels used in the reactors, Chain reaction, Moderation, breeding, Multiplication and thermal utilization factors. General components of a nuclear reactor and materials, Brief description-Pressurized water reactor, Boiling water reactor, Sodium graphite reactor, Fast Breeder reactor, Homogeneous graphite reactor and gas cooled reactor, Radiation hazards, Shielding, Nuclear waste, Radioactive waste disposal	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Understand the construction and working of steam generators and their accessories
CO2	Identify renewable energy sources and their utilization
CO3	Understand principles of energy conversion from wind, geothermal, ocean, biomass, nuclear, hydel and tidal.
CO4	Understand principles of energy conversion from wind.
CO5	Identify the energy conversion from geothermal, ocean, biomass, nuclear, hydel and tidal.

Text Books	
1.	Power Plant Engineering P. K. Nag Tata McGraw Hill Education Private Limited, New Delhi Third Edition, 2012
2.	Power Plant Engineering Arora and Domkundwar Dhanpat Rai & Co. (P) Ltd. Sixth Edition, 2012

Reference Text Books	
1.	Power Plant Engineering R. K. Rajput Laxmi publication New Delhi
2.	Principles of Energy conversion A. W. Culp Jr McGraw Hill 1996
3.	Power Plant Technology M.M. EL-Wakil McGraw Hill International 1994

ASSESSMENT DETAILS BOTH (CIE AND SEE)

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CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	2	-	1	-	-	-	-	-
CO2	3	-	-	2	-	1	-	-	-	-	-
CO3	3	-	-	2	-	1	-	-	-	-	-
CO4	3	-	-	2	-	1	-	-	-	-	-
CO5	3	-	-	2	-	1	-	-	-	-	-

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester-VI					
Fundamentals of Robotics **Category: OEC-I**					
Course Code	:	**B24RA644**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	3:0:0:3	SEE	:	50 Marks
Total Hours	:	45	Total	:	100 Marks
Credits	:	3	SEE Duration	:	3Hrs

Course Learning Objective is	
1.	To understand and discuss the fundamental elementary concepts of Robotics.
2.	To provide insight into different types of robots.
3.	To explain intelligent module for robotic motion control.
4.	To educate on various path planning techniques.
5.	To illustrate the working of an innovative robotic device.

Module– 1	**No. of Hours**
Introduction to Robotics and Automation: laws of robot, brief history of robotics, basic components of robot, robot specifications, classification of robots, human system and robotics, safety measures in robotics, social impact, Robotics Market and the future prospects, advantages and disadvantages of robots.	9
Module– 2	**No. of Hours**
Anatomy of a Robot, Robot configurations: polar, cylindrical, Cartesian, and jointed arm configurations, Robot links and joints, Degrees of freedom: types of movements, vertical, radial and rotational traverse, roll, pitch and yaw, Wok volume/envelope, Robot kinematics: Introduction to direct and inverse kinematics.	9
Module– 3	**No. of Hours**
Robot drive systems: Hydraulic, Pneumatic and Electric drive systems, classification of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive gripper, 1DoF, 2DoF, multiple degrees of freedom robot hand, tools as end effectors, Robot control types: limited sequence control, point-to- point control.	9
Module– 4	**No. of Hours**
Definition Joint space technique: Use of P degree polynomial Cubic, polynomial Cartesian space technique, parametric descriptions, straight line and circular paths, position and orientation planning.	9
Module– 5	**No. of Hours**
Pick and place, palletizing and depalletizing: machining loading and unloading, welding & assembly, Medical, agricultural and space applications, unmanned vehicles: ground, Ariel and underwater applications, Types of robots: Legged robot, wheeled robot, aerial robots, Industrial robots, Humanoids, Autonomous robots, and Swarm robots.	9

Course Outcomes: At the end of the course, the students will be able to	
CO1	Understand the significance, social impact and future prospects of robotics and automation in various engineering applications.
CO2	Identify and describe the components and anatomy of robotic system.
CO3	Know about various path planning techniques and analyze different motions of robotics system
CO4	Use the suitable drives and end- effectors for a given robotics application.
CO5	Apply robotics concept to automate the monotonous and hazardous tasks and categorize various types of robots based on the design and applications in real world scenarios.

Text Books	
1.	S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education, 2009.
2.	Mikell P.Grooveret.al., "Industrial Robots Technology, Programming and Applications", McGraw Hill, Special Edition, (2012).

Reference Text Books	
1.	Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering–An Integrated Approach", Eastern Economy Edition, PrenticeHallofIndiaPvt.Ltd.,2006.

2.	Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.https://www.robots.com/applications.

Web links and Video lectures (e-Resources)
• **https://roboticscasual.com/ros-tutorial-pick-and-place-task-with-the-moveit-c-interface/** • **https://roboticscasual.com/ros-tutorial-simulate-ur5-robot-in-gazebo-urdf-explained/** • **https://roboticscasual.com/the-best-degrees-to-work-in-robotics/** • **https://roboticscasual.com/robotics-tutorials/** • **https://www.ieee-ras.org/educational-resources-outreach/educational-material-in-robotics-andautomation/** • **https://www.isa.org/**

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of continuous Internal Evaluation (CIE) is 50% and for the Semester End Examination (SEE) is 50%. The minimum passing mark for the CIE is 40% of maximum marks (20 marks out of 50). The minimum passing mark for SEE is 35% of maximum marks (18 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. Student has to secure a minimum 40% (40 marks out of 100) in the total of the CIE and SEE together.

CONTINUOUS INTERNAL EVALUATION (CIE)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. The question paper shall be set for 100 marks and duration of SEE is 3 hours.
2. The question paper will have two parts: Part-A and Part-B.
3. **Part-A** should contain minimum **Two or Four** quiz questions from each module of 02 marks/ 01 marks each. **Part-A is Compulsory** and carries 20 Marks.
4. **Part-B** contains total 10 questions.
5. Two questions of 16 marks (with minimum of 3 sub questions) from each module with internal choice.
6. Students should answer five full questions, selecting one full question from each module.
7. Question papers to be set as per the Blooms Taxonomy levels.

CO-PO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	1	2	-	-	3	2
CO2	3	1	-	-	-	3	1	-	-	2	2
CO3	3	2	-	-	-	1	2	-	-	2	1
CO4	1	1	-	-	-	1	2	-	-	2	1
CO5	1	1	-	-	-	1	2	-	-	1	1

Level 3 - High, Level 2 – Moderate, Level 1 - Low

Semester-VI					
Virtual Instrumentation Lab –II **Category: PCCL**					
Course Code	:	**B24RA605L**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	0 : 0 : 2:0	SEE	:	50 Marks
Total Hours	:	30	Total	:	100 Marks
Credits	:	1	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To develop Arduino interfacing for real-world applications.
2.	To use basic LabVIEW skills to make advanced programs with DAQ and Arduino.
3.	To enable data acquisition with DAQ and sensors.

Sl. No	**List of Experiments**
1.	Build a VI that simulates traffic light signal control system.
2.	Build a VI to implement student database with name, ID, 5 subject marks and modified marks to his/her record.
3.	Build a VI that simulates a water level controller.
4.	Build a VI to control buzzer using DAQ card
5.	Data acquisition using LABVIEW for temperature measurement using thermistor
6.	Interface LEDs to DAQ output & implement counter.
7.	Build a VI for LED blinking control using DAQ card
8.	Build a VI to illustrate the working of PIR sensor by interfacing with Arduino.
9.	Build a VI to illustrate the working of temperature sensor by interfacing with Arduino.
10.	Build a VI to measure distance of object using ultrasonic sensor by interfacing with Arduino.
11.	Build a VI to measure the moisture in soil using soil moisture sensor by interfacing with Arduino.
12.	Build a VI to control DC motor using touch sensor by interfacing with Arduino.

Course Outcomes: At the end of the course, the students will be able to	
CO1	Design advanced LabVIEW apps with DAQ/Arduino for controls
CO2	Interface and measure sensors with Arduino/LabVIEW.
CO3	Control devices like motors via sensors

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course if the student secures 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	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Laboratory	**Lab Conduction & Record**	**Evaluating each expt. for 10 marks**	**20**	**50**
	Laboratory Test -1	**50**	**15**	
	Laboratory Test -2	**50**	**15**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. SEE marks for the practical course are 50 Marks. Practical examinations are to be conducted between the schedules mentioned in the academic calendar of the Institution.
2. All laboratory experiments are to be included for practical examination.
3. Evaluation of test write-up, conduction procedure, result and viva will be conducted jointly by examiners.
4. Rubrics suggested for SEE, 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.
5. Change of experiment is allowed only once and 15% of Marks allotted to the Conduction procedure part are to be made zero. The minimum duration of SEE is 03 hours.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	-	3	-	-	-	-	-	-	1
CO2	2	1	3	-	3	-	-	-	-	-	-	1
CO3	2	1	3	-	3	-	-	-	-	-	-	1
CO4	2	1	3	-	3	-	-	-	-	-	-	1
CO5	2	1	3	-	3	-	-	-	-	-	-	1

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester-VI					
Electro Pneumatics Lab **Category: AEC-VI**					
Course Code	:	**B24RA681**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	0:0:2:0	SEE	:	50 Marks
Total Hours	:	30	Total	:	100 Marks
Credits	:	1	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand the basic components and working principles of electro-pneumatic systems such as cylinders, solenoid valves, sensors, timers, and control elements.
2.	To apply electro-pneumatic principles to construct control circuits for single acting and double acting cylinder operations.
3.	To demonstrate the use of ON-delay and OFF-delay timers in controlling solenoid valve actuation in pneumatic circuits.
4.	To implement automation circuits using industrial sensors such as inductive, capacitive, photoelectric, and pressure sensors.
5.	To design multi-cycle electro-pneumatic control systems using limit switches, counters, and sequential logic.

Sl. No.	**List of the experiment**
1.	Simulate a single cycle on delay operation of a single acting cylinder using single solenoid valve (use on delay timer for solenoid actuation)
2.	Simulate a single cycle off delay operation of a single acting cylinder using single solenoid valve (use off delay timer for solenoid actuation)
3.	Simulate a double acting cylinder using single solenoid valve (direct actuation of solenoid)
4.	Simulate a single cycle on and off delay operation of a double acting cylinder using double solenoid valve (use on and off delay timer for solenoid actuation)
5.	Simulate a double acting cylinder using single solenoid valve. Forward stroke should be manual and return stroke should be automatic as it reaches forward end
6.	Simulate a multi cycle operation of a double acting cylinder using double solenoid valve and electrical limit switch
7.	Simulate a double acting cylinder using double solenoid valve with capacitive sensor (Use plastic or metal cam for sensing)
8.	Simulate a double acting cylinder using double solenoid valve with inductive sensor (Use metal cam for sensing)
9.	Simulate a double acting cylinder using double solenoid valve with photo electric sensor (Use plastic or metal cam for sensing)
10.	Simulate a multi cycle operation of a double acting cylinder using double solenoid valve and electrical limit switch for the sequence A+B+B-A-
11.	Simulate a double acting cylinder using double solenoid valve and lamp using pressure sensor
12.	Simulate an auto-reset after the operation of a double acting cylinder for ‘n’ cycles using double solenoid valve with counter and buzzer (use metal cam and inductive sensor for cyclic counting)

Course Outcomes: At the end of the course, the students will be able to	
CO1	Explain the components and working principles of electro-pneumatic systems including cylinders, solenoid valves, sensors, timers, and control elements.

CO2	Construct the electro-pneumatic control circuits for single acting and double acting cylinder operations.
CO3	Apply ON-delay and OFF-delay timers for controlling solenoid valve actuation in pneumatic circuits.
CO4	Implement automation circuits using industrial sensors such as inductive, capacitive, photoelectric, and pressure sensors.
CO5	Design multi-cycle electro-pneumatic control systems using limit switches, counters, and sequential logic.

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course if the student secures 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	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Laboratory	**Lab Conduction & Record**	**Evaluating each expt. for 10 marks**	**20**	**50**
	Laboratory Test -1	**50**	**15**	
	Laboratory Test -2	**50**	**15**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. SEE marks for the practical course are 50 Marks. Practical examinations are to be conducted between the schedules mentioned in the academic calendar of the Institution.
2. All laboratory experiments are to be included for practical examination.
3. Evaluation of test write-up, conduction procedure, result and viva will be conducted jointly by examiners.
4. Rubrics suggested for SEE, 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.
5. Change of experiment is allowed only once and 15% of Marks allotted to the Conduction procedure part are to be made zero. The minimum duration of SEE is 03 hours.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	-	2	-	-	1	-	-	1
CO2	3	2	1	1	2	-	-	-	-	-	1
CO3	2	3	3	2	3	1	-	1	-	-	1
CO4	2	3	3	3	2	1	-	2	1	1	2
CO5	2	3	2	3	3	1	1	1	1	1	3

Level 3 – High, Level 2 – Moderate, Level 1 -Low

Semester-VI					
Computational Fluid Flow and Heat Transfer Lab **Category: AEC-VI**					
Course Code	:	**B24RA682**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	0:0:2:0	SEE	:	50 Marks
Total Hours	:	30	Total	:	100 Marks
Credits	:	1	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To impart the fundamental knowledge on using various analytical tools like MATLAB, ANSYS, FLUENT, etc., for Engineering Simulation.
2.	To gain knowledge in generating geometry and meshing
3.	To impart the fundamental knowledge on simulating different types of fluid flows
4.	To analyze and validate the results

Sl. No.	**List of the experiment**
1.	Numerical methods in fluid mechanics and use of CFD software.
2.	Couette flow
3.	Channel flow
4.	Flow over a flat plate
5.	Flow through circular pipe
6.	Flow through Non-circular pipes
7.	Flow over an aerofoil Flow over an aerofoil Flow over an aerofoil
8.	Flow over Cylinder
9.	Flow over Sphere
10.	Analysis of parallel flow double pipe heat exchanger
11.	Analysis of counter flow double pipe heat exchanger
12.	Compressible flow through nozzles

Course Outcomes: At the end of the course, the students will be able to	
CO1	Simulate the fluid flow concepts using CFD software
CO2	Apply the convergence techniques to refine the solution
CO3	Interpret the results to arrive reasonable conclusions
CO4	Document the results generated in a systematic manner.
CO5	Analyze and validate the results

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course if the student secures 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	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Laboratory	**Lab Conduction & Record**	**Evaluating each expt. for 10 marks**	**20**	**50**
	Laboratory Test -1	**50**	**15**	
	Laboratory Test -2	**50**	**15**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. SEE marks for the practical course are 50 Marks. Practical examinations are to be conducted between the schedules mentioned in the academic calendar of the Institution.
2. All laboratory experiments are to be included for practical examination.
3. Evaluation of test write-up, conduction procedure, result and viva will be conducted jointly by examiners.
4. Rubrics suggested for SEE, 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.
5. Change of experiment is allowed only once and 15% of Marks allotted to the Conduction procedure part are to be made zero. The minimum duration of SEE is 03 hours.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	-	3	3	-	-	-	-	-	-
CO2	2	2	-	3	3	-	-	-	-	-	-
CO3	1	3	-	3	3	-	-	-	-	2	-
CO4	1	3	-	3	3	-	-	-	-	2	-
CO5	2	2	-	3	3	-	-	-	-	-	-

Level 3 – High, Level 2 – Moderate, Level 1 -Low

Semester-VI					
PLC Lab **Category: AEC-VI**					
Course Code	:	**B24RA683**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	0:0:2:0	SEE	:	50 Marks
Total Hours	:	30	Total	:	100 Marks
Credits	:	1	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand the architecture, hardware components, and programming environment of Programmable Logic Controllers (PLCs).
2.	To develop and implement basic PLC programs using ladder logic, timers, counters, and logical instructions.
3.	To design PLC-based control systems for motors, pneumatic actuators, and sequential operations.
4.	To apply PLC programming techniques to industrial automation applications such as conveyor systems.

Sl. No.	**List of the experiment**
1.	Basic PLC Programming using Ladder Logic (Start/Stop Circuit)
2.	PLC Programming using Logic Gates (AND, OR, NOT Functions)
3.	PLC Program for Forward and Reverse Control of a Motor
4.	PLC Program using Timers (ON Delay and OFF Delay)
5.	PLC Program using Counters (Up Counter and Down Counter)
6.	Sequential Control of a Single Acting Cylinder using PLC
7.	Sequential Control of a Double Acting Cylinder using PLC
8.	Single and Continuous Cycle Operation of a Double Acting Cylinder using PLC
9.	PLC-Based Control of Two Cylinders in Sequence: A+ B+ A− B−
10.	PLC-Based Control of Two Cylinders in Sequence: A+ B+ B− A−
11	PLC-Based Control of Three Cylinders in Sequence: A+ B+ C+ C− B− A−
12	PLC-Based Conveyor Belt Control System

Course Outcomes: At the end of the course, the students will be able to	
CO1	Identify and explain the functions of PLC hardware components, input/output modules, and programming software.
CO2	Develop ladder logic programs using basic instructions, timers, counters, and logical operations to solv industrial control problems.
CO3	Implement PLC-based motor control and pneumatic actuator sequencing for automated manufacturing processes.
CO4	Design and execute PLC programs for sequential control of multiple cylinders and cyclic operations.
CO5	Develop PLC-based automation solutions for industrial applications such as conveyor systems.

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course if the student secures 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	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Laboratory	**Lab Conduction & Record**	**Evaluating each expt. for 10 marks**	**20**	**50**
	Laboratory Test -1	**50**	**15**	
	Laboratory Test -2	**50**	**15**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. SEE marks for the practical course are 50 Marks. Practical examinations are to be conducted between the schedules mentioned in the academic calendar of the Institution.
2. All laboratory experiments are to be included for practical examination.
3. Evaluation of test write-up, conduction procedure, result and viva will be conducted jointly by examiners.
4. Rubrics suggested for SEE, 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.
5. Change of experiment is allowed only once and 15% of Marks allotted to the Conduction procedure part are to be made zero. The minimum duration of SEE is 03 hours.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	-	2	3	-	-	-	-	-	-
CO2	2	3	2	3	3	-	-	-	-	-	-
CO3	3	3	3	2	3	-	-	-	-	-	-
CO4	2	3	2	3	3	-	-	-	-	2	-
CO5	3	3	3	3	3	1	1	1	2	2	2

Level 3 – High, Level 2 – Moderate, Level 1 -Low

Semester-VI					
3D Printing Lab **Category: AEC-VI**					
Course Code	:	**B24RA684**	CIE	:	50 Marks
Teaching Hours L:T:P:S	:	0:0:2:0	SEE	:	50 Marks
Total Hours	:	30	Total	:	100 Marks
Credits	:	1	SEE Duration	:	3 Hrs

Course Learning Objective is	
1.	To understand the fundamental principles and evolution of Additive Manufacturing (AM) technologies.
2.	To explore various AM processes, including Vat Photo polymerization, Material Jetting, and Binder Jetting.
3.	To learn about the material science aspects and post-processing techniques in AM
4.	To analyze the role of CAD in AM, including data formats and process selection.
5.	To investigate the application of AM across different industry domains, such as aerospace and healthcare

Sl. No.	**List of the experiment**
1.	3D Modelling of a single component
2.	Assembly of CAD modelled Components
3.	Exercise on CAD Data Exchange
4.	Generation of .stl files
5.	Simulation using CURA software
6.	Identification of a product for Additive Manufacturing and its AM process plan
7.	Printing of identified product on an available AM machine
8.	Post processing of additively manufactured product
9.	Can be Demo experiments for CIE Inspection and defect analysis of the additively manufactured product.
10.	Can be Demo experiments for CIE Comparison of Additively manufactured product with conventional manufactured counterpart
11.	Can be Demo experiments for CIE Explore how topology optimization can be used in additive manufacturing to reduce weight while maintaining structural integrity
12.	Can be Demo experiments for CIE Study the microstructure of metal parts produced by additive manufacturing.

Course Outcomes: At the end of the course, the students will be able to	
CO1	Understand the working principle and process parameters of AM processes
CO2	Explore the applications of AM processes in various fields
CO3	Select the suitable material and process for fabricating a given product
CO4	Apply the knowledge in Material science in Additive Manufacturing components
CO5	Design and develop a product for AM Process

ASSESSMENT DETAILS BOTH (CIE AND SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course if the student secures 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	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Laboratory	**Lab Conduction & Record**	**Evaluating each expt. for 10 marks**	**20**	**50**
	Laboratory Test -1	**50**	**15**	
	Laboratory Test -2	**50**	**15**	
SEE	**Semester End Examination**	**100**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE)

1. SEE marks for the practical course are 50 Marks. Practical examinations are to be conducted between the schedules mentioned in the academic calendar of the Institution.
2. All laboratory experiments are to be included for practical examination.
3. Evaluation of test write-up, conduction procedure, result and viva will be conducted jointly by examiners.
4. Rubrics suggested for SEE, 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.
5. Change of experiment is allowed only once and 15% of Marks allotted to the Conduction procedure part are to be made zero. The minimum duration of SEE is 03 hours.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	-	2	-	-	1	-	-	1
CO2	3	2	1	1	2	-	-	-	-	-	1
CO3	2	3	3	2	3	1	-	1	-	-	1
CO4	2	3	3	3	2	1	-	2	1	1	2
CO5	2	3	2	3	3	1	1	1	1	1	3

Level 3 – High, Level 2 – Moderate, Level 1 -Low

MOOGAMBIGAI CHARITABLE AND EDUCATIONAL TRUST

Rajarajeswari College of Engineering

(An Autonomous Institution under Visvesvaraya Technological University, Belagavi)
#14, Ramohalli Cross, Kumbalagodu, Mysore Road, Bengaluru–560074

Common Courses

V & VI Semester

UG – B.E (2024 Scheme)

INDEX

Semester-V					
Biology for Engineers **Category: BSC** **(Common to All)**					
Course Code	:	**B24BEK507**	CIE	:	50 Marks
Teaching Hours L : T : P : S	:	2:0:0:2	SEE	:	50 Marks
Total Hours	:	30	Total	:	100 Marks
Credits	:	2	SEE Duration	:	2 Hrs

Course Learning Objective is	
1.	To familiarize the students with the basic biological concepts and their engineering applications.
2.	To enable the students with an understanding of biodesign principles to create novel devices and structures.
3.	To provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems.
4.	To motivate the students to develop interdisciplinary vision of biological engineering.

Module– 1	**No. of Hours**
Introduction to Biology: The cell: the basic unit of life, Structure and functions of a cell. The Plant Cell and animal cell, Prokaryotic and Eukaryotic cell, Stem cells and their application. **Biomolecules:** Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules; Enzymes (Classification (with one example each), Properties and functions), vitamins and hormones.	6
Module– 2	**No. of Hours**
Application of Biomolecules: Carbohydrates in cellulose-based water filters production, PHA and PLA in bio plastics production, Nucleic acids in vaccines and diagnosis, Proteins in food production.	6
Module– 3	**No. of Hours**
Adaptation of Anatomical Principles for Bioengineering Design: Brain as a CPU system. Robotic arms for prosthetics. Engineering solutions for Parkinson's disease. Eye as a Camera system, bionic eye. Heart as a pump system, pace makers, defibrillators. Lungs as purification system, Heart-lung machine. Kidney as a filtration system, dialysis systems.	6
Module– 4	**No. of Hours**
Nature-Bioinspired Materials and Mechanisms: Echolocation, Photosynthesis. Bird flying, Lotus leaf effect, Shark skin, Kingfisher beak. Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs).	6
Module– 5	**No. of Hours**
Trends in Bioengineering: DNA origami and Biocomputing, Bioprinting techniques and materials. Bioimaging and Artificial Intelligence for disease diagnosis. Bioconcrete. Biomining.	6

Course Outcomes: At the end of the course, the students will be able to	
CO1	Elucidate the basic biological concepts via relevant industrial applications and case studies.
CO2	Evaluate the principles of design and development, for exploring novel bioengineering projects.
CO3	Corroborate the concepts of biomimetics for specific requirements.
CO4	Think critically towards exploring innovative biobased solutions for socially relevant problems.

Text Books	
1.	Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.
2.	Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022

Web links and Video Lectures (E-Resources)
• https://nptel.ac.in/courses/121106008 • https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009

• https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006 • https://www.coursera.org/courses?query=biology	
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1.	Group Discussion of Case studies.
2.	Model Making and seminar/poster presentations.
3.	Design of novel device/equipment like Cellulose-based water filters, Filtration system.

ASSESSMENT DETAILS (BOTH CIE AND SEE)

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage. To qualify and become eligible to appear for SEE, in the CIE, a student must score at least 40% of 50 marks, i.e., 20 marks. To pass the SEE, a student must score at least 35% of 50 marks, i.e., 18 marks. Notwithstanding the above, a student is considered to have passed the course, provided the combined total of CIE and SEE is at least 40 out of 100 marks.

CONTINUOUS INTERNAL EVALUATION (CIE):

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment1**	**50**	**30**	**50**
	Internal Assessment2	**50**	**(Average of Best two**	
	Internal Assessment3	**50**	**Assessments)**	
AAT	**Any Two Assessments as per Regulations**	**20**	**20**	
SEE	**Semester End Examination**	**50**	**50**	**50**
Total Marks				**100**

SEMESTER END EXAMINATION (SEE):

1. The Question paper shall be set for 50 marks and duration of SEE is 2 Hours.
2. Two questions of 10 marks (with minimum two sub questions) from each module with internal choice.
3. Students should answer five full questions, selecting one full question from each module.
4. Mention COs, POs, Bloom's Taxonomy levels in the question paper.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO8	PO11
CO1	1	-	-	-	-	1	1	-	1	1	1
CO2	1	-	-	-	-	1	-	1	-	1	1
CO3	1	-	-	-	-	1	-	1	-	1	1
CO4	1	-	-	-	-	1	2	-	2	1	1
CO5	1	-	-	-	-	1	2	2	1	2	1

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester-V					
Environmental Science and E-Waste Management **Category: NCMC** **(Common to All)**					
Course Code	:	**B24ESK510**	CIE	:	100 Marks
Teaching Hours L : T : P : S	:	2:0:0:0	SEE	:	-
Total Hours/Semester	:	30	Total	:	100 Marks
Credits	:	PP	SEE Duration	:	-

Course Learning Objective is	
1.	To identify the major challenges of environment issues.
2.	To develop skills, critical thinking and demonstrate socio-economic skills for Environmental protection.
3.	To analyze the impact of issues w. r. t. waste management.

Module– 1	**No. of Hours**
Ecosystem and Sustainability: Ecosystems: Structure of Ecosystem, Types: Forest, Desert, Wetlands, Riverine, Oceanic ecosystems. **Sustainability:** 17SDG targets and possible actions.	6
Module– 2	**No. of Hours**
Natural Resources and Energy: Natural Resources: Water resources-Availability & Quality aspects, Water borne diseases & water induced diseases, Fluoride problem in drinking water. **Energy:** Different types of energy, Conventional sources & Non-Conventional sources of energy, solar energy. Wind energy, Hydrogen as an alternative energy.	6
Module– 3	**No. of Hours**
Environmental Pollution: Water Pollution, Noise pollution, Air pollution (Sources, Impacts, Preventive measures and public Health Aspects. **Global Environmental Concerns (Concept, policies and case-studies):** Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.	6
Module– 4	**No. of Hours**
Waste management: Solid Waste Management, types and sources, functional elements of SWM, Biomedical Waste Management-Sources, Characteristics. **Environmental Legislation:** Solid Waste Management Rules, 2016, Biomedical Waste Management Rules, 2016.	6
Module– 5	**No. of Hours**
E-Waste Management: E-waste; composition and generation. Global context in e-waste; E-Waste pollutants, E-waste hazardous properties, Effects of pollutant (E-waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Component of E Waste management. E-waste (Management and Handling) Rules, 2011; and E-waste (Management) Rules, 2022-Salient Features and its implications.	6

Course Outcomes: At the end of the course, the students will be able to	
CO1	Comprehend the principles of ecology and environmental issues pertaining to air, land and water on a global scale.
CO2	Acquire observation skills for solving problems related to the environment.
CO3	Conduct survey to describe the realities of waste management system.

Text Books	
1.	S M Prakash, "Environmental Studies" 3rd Edition, Elite Publishing House, Mangalore, 2018.
2.	Hester R.E., and Harrison R.M, Electronic Waste Management. Science, 2009.

Reference Text Books	
1.	Benny Joseph (2005), "Environmental Studies" , Tata McGraw – Hill Publishing Company Limited.
2.	Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi.

Web links and Video Lectures (e-Resources):	
1.	https://www.youtube.com/playlist?list=PLXTQoJ3yDR1Tp9O8R7RZGmm_GdheHqM2w
3.	https://sdgs.un.org/goals
4.	https://kspcb.karnataka.gov.in/waste-management/biomedical-waste
5.	E Waste (Management) Rules, 2022: https://kspcb.karnataka.gov.in/sites/default/files/inlinefiles/ E%20Waste%20%28Management%29%20Rules%2C%202022.pdf

ASSESSMENT DETAILS (CIE only)

The weightage of Continuous Internal Evaluation (CIE) is 100%. The minimum passing mark for the CIE is 40% of the maximum marks (40 marks out of 100).

CONTINUOUS INTERNAL EVALUATION (MCQs)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**50 (Average of Best two Assessments)**	**100**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per Regulations**	**50**	**50**	
Total Marks				**100**

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	0	0	0	0	3	2	0	0	0	0
CO2	0	0	0	0	0	1	1	0	0	0	1
CO3	0	0	0	0	0	2	2	0	0	0	2

Level 3 - High, Level 2 - Moderate, Level 1 - Low

Semester-V					
Research Methodology & IPR (RMIPR) **Category: AEC**					
Course Code	:	**B24RMK606**	CIE	:	50 Marks
Teaching Hours L:T: P : S	:	1 : 0 : 0 : 3	SEE	:	50 Marks
Total Hours/Semester	:	15	Total	:	100 Marks
Credits	:	1	SEE Duration	:	1 Hours

Course Learning Objective is	
1.	To understand the fundamentals of research, types of research methodologies, and ethical practices involved in engineering research.
2.	To develop the ability to conduct effective literature review, technical reading, and identify research gaps for problem formulation.
3.	To design research methodologies, apply appropriate sampling techniques, and perform data collection and hypothesis testing.
4.	To analyze, interpret, and present research findings through structured technical reports and research papers using standard tools and formats.
5.	To understand Intellectual Property Rights (IPR), patenting processes, and their role in innovation, society, and sustainable development.

Module – 1	**No. of Hours**
Introduction to Research & Research Methodology: Meaning, Objectives of Engg. Research & Characteristics of good research, Research Methods v/s Research Methodology, Types of engineering research, Descriptive v/s Analytical, Applied v/s Fundamental, Quantitative v/s Qualitative, Conceptual v/s Empirical, Research, Criteria of good research, Developing a research plan, Ethics & plagiarism in Engineering Research with Research Practice for different types of Research Misconducts, Case Study and Practice Sessions	3
Module – 2	**No. of Hours**
Literature Review and Technical Reading: What is literature review or survey, New & Existing Knowledge, Bibliographic Databases, Search Engines, Google & Google Scholar, Effective Search, Conceptualizing Research Reviews, Gaps in research, Critical and Creative Reading, Taking Notes While Reading, Defining research problems, Datasheets, Importance of literature review in defining a problem, Primary and secondary sources of info - Review articles, treatise, monographs, papers from conferences & journals, case-studies, reports, patents, web and net searching ; Identifying gap areas from literature review, Citations, Acknowledgments, Case Studies and Practice sessions.	3
Module – 3	**No. of Hours**
Research Design and Methods: Research design, Basic Principles, Need for research design, Features of good design, Development of Models, Developing a research plan, Exploration, Description, Diagnosis, Simulation and Experimentations, Determining experimental and sample designs, Sampling design, Steps in sampling design, Characteristics of a good sample design, Types of sample designs, Measurement and scaling techniques, Methods of data collection, Collection of primary & secondary data, Data collection instruments, Hypothesis - Basic Concepts, Testing of hypotheses, flow diagram for hypotheses testing, Case Study and Practice Sessions.	3
Module – 4	**No. of Hours**
Technical Report & Paper Writing: Interpretation and report writing, Techniques of interpretations, Structure and components of scientific reports, Different steps in the report preparation – Layout, organization, structure and language of the report, Illustrations and tables with result analysis (simulation or experimentation), Types of reports, technical reports, project reports (mini & major) and research thesis, Research tools for writing, Conclusions, Future works, Flow of a research article, Research paper writing for conference & journals, text-books, Case Study and Practice Sessions.	3
Module – 5	**No. of Hours**
IPRs & Copyrights: Intellectual Property, what are patents & copyrights in IP? Role of IP in the Economic and Cultural Development of the Society, IP Governance, Invention and Creativity, Importance and Protection of Intellectual Property Rights (IPRs), A brief summary of - Patents, Monographs, Copyrights ©, Registered Firms ®, Trademarks ™, Industrial Designs (Design Patent,	3

Utility Patent, Granted Patent, Commercialized Patent) – Indian &Foreign Patents, Steps in Patenting — Application and Procedures with Searches, Case Study and Practice Sessions.	

Course Outcomes: At the end of the course, the students will be able to	
CO1	Explain research fundamentals, methodologies, and ethical practices in engineering research.
CO2	Perform literature review, identify research gaps, and formulate research problems.
CO3	Design research experiments, collect data, and apply hypothesis testing methods.
CO4	Analyze results and prepare technical reports and research papers.
CO5	Apply IPR concepts including patents, copyrights, and trademarks in research and innovation.

Research Papers & Technical References (Web-links & Video Resources)

- IEEE Xplore – https://ieeexplore.ieee.org
- Scopus – https://www.scopus.com
- Science Direct – https://www.sciencedirect.com
- Google Scholar – https://scholar.google.com
- Research Gate – https://www.researchgate.net

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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 (MCQs)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	Internal Assessment-1	50	30 (Average of Best two Assessments)	50
	Internal Assessment-2	50		
	Internal Assessment-3	50		
AAT	Two Assessments as per regulations	20	20	
SEE	Semester End Examination	50		50
Total Marks				100

SEMESTER END EXAMINATION (SEE)

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

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	1	-	-	2	-	-	-	2
CO2	3	3	-	2	1	-	1	1	1	-	2
CO3	2	3	3	3	2	-	1	2	-	-	2
CO4	2	2	3	3	3	-	1	2	3	1	2
CO5	1	1	-	-	1	3	3	1	2	2	2

L = Low (**1**), M = Medium (**2**), H = High (**3**) - Blank = No significant mapping correlation levels

Semester - VI					
Capstone Project Work: Phase - I **Category: SDC**					
Course Code	:	**B24PRJ607**	CIE	:	100 Marks
Teaching Hours L:T:P:S	:	0:0:4:0	SEE	:	-
Total Hours	:	60	Total	:	100 Marks
Credits	:	2	SEE Duration	:	-

Capstone Project: Phase -I and Phase - II

The Capstone project is a comprehensive, year-long project carried out in two phases during **6th and 7th** semesters of the undergraduate program. It integrates knowledge and skills acquired from multiple courses and disciplines to address a complex, real-world problem.

This project provides students with an opportunity to apply scientific principles, engineering methodologies, and technological tools to conceive, design, implement and evaluate an engineering solution.

It serves as a culminating academic experience to demonstrate program outcomes, including problem-solving ability, teamwork, communication skills, and practical application of engineering principles. Students can take up project individually or in a group not exceeding 4 students. The group may have students from the same discipline and drawn from different disciplines.

Types of Capstone Projects: Capstone projects undertaken for one year may fall into one or more of the following categories:

a) Research-Oriented Projects :
   • Focus on investigating new concepts, theories, or technologies.
   • Aim to generate new knowledge or contribute to academic research.

b) Experimental/Analytical Projects
   • Based on laboratory or field experiments to validate a hypothesis or study a phenomenon.
   Simulation/ Modelling Projects
   • Including detailed data collection, analysis, and interpretation.
   • Use computational tools to model, simulate, and predict system behavior.
   • Reduce the need for physical prototyping in the initial stages.

c) Industrial/Industry-Sponsored Projects
   • Carried out in collaboration with an industry partner.
   • Address real-world engineering problems faced by the organization.

d) Interdisciplinary/Multidisciplinary Projects
   • Combine knowledge and techniques from multiple engineering domains or other fields such as management, medicine, or environmental sciences.

e) Entrepreneurial/Innovation Projects
   • Focus on product or service innovation with potential for commercialization.

- Phase I Evaluation: Capstone Project Phase-I shall have only Continuous Internal Evaluation (CIE).
- In case disciplinary capstone project, the CIE shall be conducted by the Departmental Project Review Committee, which consists of a Senior Professor, the Project Guide, and one additional faculty member appointed by the principal for projects within the parent discipline.
- For Interdisciplinary Projects, the Project Review Committee will consist of one Senior Professor, the department and interdepartmental Project Guides and one faculty member from a department related to the interdisciplinary project. The committee members are appointed by the principal of the college.
- Phase I evaluation shall be based on rubrics designed to measure graduate attributes defined by NBA. Successful completion of Phase-I allows the student to proceed to Phase-II.
- Phase II Evaluation: CIE of Phase shall be evaluated as indicated with phase -I evaluation. The SEE shall be conducted by two examiners. The assessment shall be based on rubrics designed to measure graduate attributes.

Review #	**Agenda**	**Assessment**	**Review Assessment Weightage**
Review1	Project Synopsis / Proposal Evaluation	Rubric R1	15
Review2	Mid-Term Project Evaluation	Rubric R2	30
Review3	End Semester Project Evaluation	Rubric R3	30
Review4	Project Report Evaluation	Rubric R4	15
Review5	Evaluation by Guide	Rubric R5	10
Continuous Internal Evaluation (CIE)			100
Total Marks			100

Rubric #R1: Project Synopsis / Proposal Evaluation Maximum Marks: 15

		Excellent (5 Marks)	Good (4 Marks)	Average (3 Marks)	Acceptable (2 Marks)	Unacceptable (1 Marks)
a	**Identification of Problem Domain and Detailed Analysis**	Detailed and extensive explanation of the purpose and need of the project	Good explanation of the purpose and need of the project	Average explanation of the purpose and need of the project	Moderate explanation of the purpose and need of the project	Minimal explanation of the purpose and need of the project
b	**Study of the Existing Systems and Feasibility of Project Proposal**	Detailed and extensive explanation of the specifications and the limitations of the existing systems	Collects a great deal of information and good study of the existing systems	Moderate study of the existing systems; collects some basic information	Explanation of the specifications and the limitations of the existing systems not very satisfactory; limited information	Minimal explanation of the specifications and the limitations of the existing systems; incomplete information
c	**Objectives and Methodology of the Proposed Work**	All objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are clearly specified	Good justification to the objectives; Methodology to be followed is specified but detailing is not done	Incomplete justification to the objectives proposed; Steps are mentioned but unclear; without justification to objectives	Only Some objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are not specified properly	Objectives of the proposed work are either not identified or not well defined; Incomplete and improper specification

Rubric #R2: Mid-term Project Evaluation Maximum Marks: 30

		Level of Achievement				
		Excellent(10)	**Good (8)**	**Average(6)**	**Acceptable(4)**	**Unacceptable (2)**
a	**Design Methodology**	• Division of problem in to modules and good selection of computing framework. • Appropriate design methodology and properly justification.	• Division of problem into modules and good selection of computing frame work. • Design methodology not properly justified.	• Division of problem into modules but in appropriate selection of computing framework. • Design methodology not defined properly.	• Partial division of problem into modules and inappropriate selection of computing framework. • Design methodology not defined properly.	• Modular approach not adopted. • Design methodology not defined.
b	**Planning of Project Work and Team Structure**	• Time frame properly specified and being followed. • Appropriate distribution of project work.	• Time frame properly specified and being followed. • Distribution of project work inappropriate.	• Time frame properly specified, but not being followed. • Distribution of project work un-even.	• Time frame properly specified, but not being followed. • Un-even distribution of Project work and no synchronization.	• Time frame not properly specified. • In-appropriate distribution of project work.

c	**Demonstration and Presentation**	• Objectives achieved as per time frame. • Contents of presentations are appropriate and well arranged. • Proper eye contact with audience and clear voice with good spoken language.	• Objectives achieved as per time frame • Contents of presentations are appropriate but not well arranged Satisfactory demonstration, clear voice with good spoken language but eye contact not proper	• Objectives achieved as per time frame. • Contents of presentations are appropriate but not well arranged. • Presentation not satisfactory and average demonstration	• Objectives not achieved as per time frame. • Contents of presentations are not appropriate. • Eye contact with few people and unclear voice.	• No objectives achieved. • Contents of Presentations are not appropriate and not well delivered. • Poor delivery of presentation.

Rubric #R3: End Semester Internal Project Evaluation Maximum Marks: 30

		Excellent(10)	Good (8)	Average(6)	Acceptable(4)	Unacceptable (2)
a	**Incorporation of Suggestions**	Changes are made as per modifications suggested during midterm evaluation and new innovations added	Changes are made as per modifications suggested during mid-term evaluation and good justification	All major changes are made as per modifications suggested during midterm evaluation	Few changes are made as per modifications suggested during midterm evaluation	Suggestions during mid-term evaluation are not incorporated
b	**Project Demonstration**	• All defined objectives are achieved. • Each module working well and properly demonstrated. • All modules of project are well integrated and system working is accurate.	• All defined objectives are achieved. • Each module working well and properly demonstrated. • Integration of all modules not done and system working is not very satisfactory.	• All defined objectives are achieved. • Modules are working well in isolation and properly demonstrated. • Modules of project are not properly integrated.	• Some of the defined objectives are achieved. • Modules are working well in isolation and properly demonstrated • Modules of project are not properly integrated.	• Defined objectives are not achieved. • Modules are not in proper working form that further leads to failure of integrated system.
c	**Presentation**	• Contents of presentations are appropriate and well delivered. • Proper eye contact with audience and clear voice with good spoken language	• Contents of presentations are appropriate and well delivered. • Clear voice with good spoken language but less eye contact with audience	• Contents of presentations are appropriate but not well delivered . • Eye contact with few people and unclear voice	• Contents of presentations are not appropriate. • Eye contact with few people and unclear voice	• Contents of presentations are not appropriate and not well delivered . • Poor delivery of presentation

Rubric #R4: Project Report Evaluation Maximum Marks: 15

Level of Achievement						
		Excellent(5)	**Good (4)**	**Average(3)**	**Acceptable(2)**	**Unacceptable (1)**
a	**Project Report**	• Project report is according to the specified format. • References and citations are appropriate and well mentioned.	• Project report is according to the specified format. • References and citations are appropriate but not mentioned well.	• Project report is according to the specified format but some mistakes. • In-sufficient references and citations.	• Project report is not fully according to the specified format. • In-sufficient references and citations	• Project report not prepared according to the specified format. • References and citations are not appropriate
b	**Description of Concepts and Technical Details**	• Complete explanation of the key concepts. • Strong description of the technical requirements of the project.	• Complete explanation of the key concepts. • In-sufficient description of the technical requirements of the project.	• Complete explanation of the key concepts but little relevance to literature. • In-sufficient description of the technical requirements of the project.	• All key concepts are not explained and very little relevant to literature. • In-sufficient description of the technical requirements of the Project.	• Inappropriate explanation of the key concepts. • Poor description of the technical requirements of the project.
c	**Conclusion and Discussion**	• Results are presented in very appropriate manner • Project work is well summarized and concluded. • Future extensions in the project are well specified.	• Results are presented in good manner. • Project work summary and conclusion not very appropriate. • Future extensions in the project are specified.	• Results presented are not much Satisfactory. • Project work summary and conclusion not very appropriate. • Future extensions in the project are specified.	• Results presented are not much satisfactory. • Project work summary and conclusion not very appropriate. • Future extensions in the project are not specified.	• Results are not presented properly. • Project work is not summarized and concluded. • Future extensions in the project are not specified.

Rubric #R5: Evaluation by Guide Maximum Marks: 10

Level of Achievement				
		Excellent (5)	**Satisfactory(3)**	**Unsatisfactory(2)**
a	**Self-Motivation, Determination and Regularity**	• Approaches the project with self-motivation and follows it through to completion. • Reports to the guide regularly and consistent in work.	• Completes the project but sometimes lacks self-motivation. • Reports to the guide but lacks consistency	• Lacks self-motivation and determination. • Irregular in attendance and in consistent in work.
b	**Working with in a Team & Technical Knowledge and Awareness related to the Project**	• Collaborates and communicates in a group situation and integrates the views of others. • Extensive knowledge related to the project.	• Exchanges some views but requires guidance to collaborate with others. • Fair knowledge related to the project	• Makes little or no attempt to collaborate in a group situation. • Lack sufficient knowledge.

Semester-VI					
Indian Knowledge Systems **Category: HSMC** **(Common to All)**					
Course Code	:	**B24IKK610**	CIE	:	100 Marks
Teaching Hours L:T:P:S	:	2:0:0:0	SEE	:	-
Total Hours/Semester	:	30	Total	:	100 Marks
Credits	:	PP	SEE Duration	:	-

Course Learning Objective is	
1.	To Understand the knowledge on basics of research and its types.
2.	To Learn the concept of Literature Review, Technical Reading, Attributions and Citations.
3.	To learn Ethics in Engineering Research.
4.	To Discuss the concepts of Intellectual Property Rights in engineering.

Module– 1	**No. of Hours**
Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Problem. Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.	6
Module– 2	**No. of Hours**
Literature Review and Technical Reading: New and Existing Knowledge, Analysis and Synthesis of Prior Art Bibliographic Databases, Web of Science, Google and Google Scholar, Effective Search: The Way Forward Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet. **Attributions and Citations:** Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.	6
Module– 3	**No. of Hours**
Introduction To Intellectual Property: Role of IP in the Economic and Cultural Development of the Society, IP Governance, IP as a Global Indicator of Innovation, Origin of IP History of IP in India. Major Amendments in IP Laws and Acts in India. **Patents:** Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention. Rights Associated with Patents. Enforcement of Patent Rights. Inventions Eligible for Patenting. Non-Patentable Matters. Patent Infringements. Avoid Public Disclosure of an Invention before Patenting. Process of Patenting. **Process of Patenting:** Prior Art Search. Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Publication. Pre-grant Opposition. Examination. Grant of a Patent. Validity of Patent Protection. Post-grant Opposition. Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be Obtained? Do I Need First to File a Patent in India? Patent Related Forms. Fee Structure. Types of Patent Applications. Commonly Used Terms in Patenting. National Bodies Dealing with Patent Affairs. Utility Models.	6
Module– 4	**No. of Hours**
Copyrights and Related Rights: Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements. Copyright Infringement is a Criminal Offence. Copyright Infringement is a Cognizable Offence. Fair Use Doctrine. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights. Fee Structure. Copyright Symbol. Validity of Copyright. Copyright Profile of India. Copyright and the word 'Publish'. Transfer of Copyrights to a Publisher. Copyrights and the Word 'Adaptation'. Copyrights and the Word 'Indian Work'. Joint Authorship. Copyright Society. Copyright Board. Copyright Enforcement Advisory Council (CEAC). International Copyright Agreements, Conventions and Treaties. Interesting Copyrights Cases. **Trademarks:** Eligibility Criteria. Who Can Apply for a Strademark? Acts and Laws.	6

Designation of Trademark Symbols. Classification of Trademarks. Registration of a Trademark is Not Compulsory. Validity of Trademark. Types of Trademark Registered in India. Trademark Registry. Process for Trademarks Registration. Prior Art Search. Famous Case Law: Coca-Cola Company v/s. Bisleri International Pvt. Ltd.	
Module– 5	**No. of Hours**
Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India. Protection Term. Procedure for Registration of Industrial Designs. Prior Art Search. Application for Registration. Duration of the Registration of a Design. Importance of Design Registration. Cancellation of the Registered Design. Application Forms. Classification of Industrial Designs. Designs Registration Trend in India. International Treaties. Famous Case Law: Apple Inc. vs. Samsung Electronics Co. **Geographical Indications:** Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India. Identification of Registered GI. Classes of GI. Non-Registerable GI. Protection of GI. Collective or Certification Marks. Enforcement of GI Rights. Procedure for GI Registration Documents Required for GI Registration. GI Ecosystem in India. **Case Studies on Patents.** Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, Case study of Basmati patent. **IP Organizations In India. Schemes and Programmes**	6

Course Outcomes: At the end of the course, the students will be able to	
CO1	To know the meaning of engineering research.
CO2	To know the procedure of the literature Review and Technical Reading.
CO3	To understand the fundamentals of the patent laws and drafting procedure.
CO4	Understanding the copyright laws and subject matters of copyrights and designs.
CO5	Understanding the basic principles of design rights.

Text Books	
1.	Dr. Santosh M Nejakar, Dr. Harish Bendigeri "Research Methodology and Intellectual Property Rights", ISBN 978-93-5987-928-4, Edition: 2023-24.
Reference Text Books	
1.	David V. Thiel "Research Methods for Engineers" Cambridge University Press, 978-1-107-03488-4
2.	Intellectual Property Rights by N.K.Acharya Asia Law House 6th Edition. ISBN: 978-93-81849-30-9

ASSESSMENT DETAILS (CIE only)
The weightage of Continuous Internal Evaluation (CIE) is 100%. The minimum passing mark for the CIE is 40% of the maximum marks (40 marks out of 50).

CONTINUOUS INTERNAL EVALUATION (MCQs)

CIE	Type of Assessment	Max. Marks	Max. Marks Scaling Down to	Total Marks
Theory	**Internal Assessment-1**	**50**	**30 (Average of Best two Assessments)**	**50**
	Internal Assessment-2	**50**		
	Internal Assessment-3	**50**		
AAT	**Two Assessments as per regulations**	**20**	**20**	
SEE	**Semester End Examination**	**50**	**50**	**50**
Total Marks				**100**

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	0	0	0	0	3	2	0	0	0	0
CO2	0	0	0	0	0	1	1	0	0	0	1
CO3	0	0	0	0	0	2	2	0	0	0	2

Level 3 - High, Level 2 - Moderate, Level 1 - Low

SEMESTER-V & VI					
NATIONAL SERVICE SCHEME (NSS) **Category: NCMC**					
Course Code	:	B24NCK591/691	CIE	:	100 Marks
Teaching Hours L : T : P	:	1:0:0	SEE	:	---
Total Hours	:	50	Total	:	100 Marks
Credits	:	--	SEE Duration	:	--

Course Objectives	
1.	Understand the community in which they work
2.	Identify the needs and problems of the community and involve the min problem-solving
3.	Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems
4.	Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes
5.	Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony

CONTENT	**No. of Hours**
1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing. 2. Waste management–Public, Private and Govt. organization. 3. Setting of the information imparting club for women leading to contribution in social and economic issues. 4. Water conservation techniques–Role of different take holders–Implementation. 5. Preparing an actionable business proposal for enhancing the village income and approach for implementation. 6. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education. 7. Developing Sustainable Water management system for rural areas and implementation approaches. 8. Contribution to any national level initiative of Government of India.Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc. 9. Spreading public awareness under rural outreach programs.(minimum 5 programs). 10. Social connect and responsibilities. 11. Plantation and adoption of plants. Know your plants. 12. Organize National integration and social harmony events/ workshops / seminars. (Minimum 02 programs). 13. Govt. school Rejuvenation and helping them to achieve good infrastructure. **NOTE:** Students have to take up any one activity on the above said topics and have to prepare content for awareness and technical contents for implementation of the projects and have to present strategies for implementation of the same. Compulsorily students have to attend one camp. CIE will be evaluated based on their presentation, approach and implementation strategies.	50

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the importance of his/her responsibilities towards society.
CO2	Analyze the environmental and societal problems/issues and will be able to design solutions for the same.
CO3	Evaluate the existing system and to propose practical solutions for the same for sustainable development.
CO4	Implement government or self-driven projects effectively in the field.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO12
CO1	3	2	-	-	3	-	-	-	-	-	-
CO2	3	2	-	-	3	-	-	-	-	-	-
CO3	3	2	-	-	3	-	-	-	-	-	-
CO4	3	2	-	-	3	-	-	-	-	-	-

Level 3- Highly Mapped, Level 2-Moderately Mapped, Level 1-Low Mapped, Level 0- Not Mapped

SEMESTER-V & VI NATIONAL CADET CORPS (NCC) Category: NCMC					
Course Code	:	B24NCK592/692	CIE	:	100 Marks
Teaching Hours L : T : P	:	1:0:0	SEE	:	--
Total Hours	:	50	Total	:	100 Marks
Credits	:	--	SEE Duration	:	--

Course Objectives	
1.	To develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit, and ideals of selfless service amongst cadets by working in teams, honing qualities such as self-discipline, self-confidence, self-reliance, and dignity of labour in the cadets.
2.	To create a pool of organized, trained, and motivated youth with leadership qualities from all walks of life, who will serve the Nation regardless of which career they choose
3.	To provide a conducive environment to motivate young Indians to choose the Armed Forces as a career

Content	No. of Hours
Unit 1. Personality Development: Group Discussions - Change your Mindset, Public Speaking. **Unit 2.LeadershipDevelopment:** Case Studies– APJ Abdul Kalam, DeepaMalik, Maharana Pratap, N Narayan Murthy etc. **Unit 3. Disaster management:** Disaster Management Capsule, Organization, Types of Disasters, Essential Services, Assistance, Civil Defense Organization. **Unit 4.Adventure:**AdventureActivities **Unit 5. Border & Coastal Areas:** History, Geography &Topography of Border/ Coastal Areas. **Unit 6. Drill:** Arm Drill, Rifle ke saath Savdhan, Vishram aur Aram se, Rifle ke saath Parade Paraur Saj, Riflekesaath Visarjan, LineTod, Bhumi Shastra aur Uthao Shastra, BagalShastra aur Baju Shastra. **Unit 7.WeaponTraining**: Short Range firing. **Unit 8.MapReading:**SettingofMap,FindingsNorthandOwnPosition **Unit 9.Field Craft & Battle Craft:** Observation, Camouflage, Concealment. **Unit 10. Obstacle Training:** Obstacle training - Introduction, Safety-measures, Benefits. Obstacle Course- Straight balance, Clear Jump, Gate Vault, Zig- Zag Balance, High Wall	50

SEMESTER-V & VI					
PHYSICAL EDUCATION(PE) **Category: NCMC**					
Course Code	:	B24NCK593/693	CIE	:	100 Marks
Teaching Hours L : T : P	:	1:0:0	SEE	:	--
Total Hours	:	--	Total	:	100 Marks
Credits	:	--	SEE Duration	:	--

Semester	Course
III	Fitness Components Kabaddi / KhoKho
IV	Athletics Volleyball Throw ball
V	Athletics Football / Hockey
V	Athletics Cricket / Base ball
VI	Athletics Netball / Basketball
VI	Individual Games Handball / Badminton

Notes:

- One Hour of Lecture is equal to 1 Credit
- One Hour of Tutorial is equal to1 Credit (Except Languages)
- Two Hours of Practical is equal to 1 Credit
- SEE: Semester End Examination
- CIE: Continuous Internal Examination
- L+T+P: Lecture + Tutorial + Practical

Guideline for Athletic and Sports

Semester & Course Code	Course Title	Content	No. of Hours
3rd Semester B24NCK393	**Fitness Components** Speed Strength Endurance Agility Flexibility	Meaning and Importance, Fit India Movement, Definition of fitness, Components of fitness, Benefits of fitness, Types of fitness and Fitness tips. ***Practical Components: Speed, Strength, Endurance, Flexibility, and Agility*** **KABADDI** **A. Fundamental skills** ➢ Skills in Raiding: Touching with hands, Use of leg-toe touch, squat leg thrust, side kick, mule kick, arrow fly kick, crossing of baulk line. Crossing of Bonus line. ➢ Skills of holding the raider: Various formations, catching from particular position, different catches, catching formation and techniques. ➢ Additional skills in raiding: Escaping from various holds, techniques of escaping from chain formation, offense and defense. ➢ Game practice with application of Rules and Regulations. **B. Rules and their interpretations and duties of the officials.**	Total-32 hours 2 hours / week
	Kho kho	**A. Fundamental skills** ➢ Skills in Chasing: Sit on the box (Parallel & Bullet toe method), Get up from the box (Proximal & Distal foot method), Give Kho (Simple, Early, Late & Judgment), Pole Turn, Pole Dive, Tapping, Hammering, Rectification of foul. ➢ Skills in running: Chain Play, Ring play and Chain & Ring mixed play. ➢ Game practice with application of Rules and Regulations. **B. Rules and their interpretations and duties of the officials.**	
	Kabaddi	**A. Fundamental skills** 1. Skills in Raiding: Touching with hands, Use of leg-toe touch, squat leg thrust, side kick, mule kick, arrow fly kick, crossing of baulk line. Crossing of Bonus line. 2. Skills of holding the raider: Various formations, catching from particular position, different catches, catching formation and techniques. 3. Additional skills in raiding: Escaping from various holds, techniques of escaping from chain formation, offense and defense. 4. Game practice with application of Rules and Regulations. **B. Rules and their interpretations and duties of the officials**	

4th Semester **B24NCK493**	**Athletics** **Track-**Sprints **Jumps-**Long Jump **Throws-**Shot Put	**Track Events** ➢ Starting Techniques: Standing start and Crouch start (its variations) use of Starting Block. ➢ Acceleration with proper running techniques. ➢ Finishing technique: Run Through, Forward Lunging and Shoulder Shrug. **Long Jump**: Approach Run, Take-off, Flight in the air (Hang Style / Hitch Kick) and Landing **Shot put:** Holding the Shot, Placement, Initial Stance, Glide, Delivery Stance and Recovery (Perry O'Brien Technique)	Total-32 hours 2 hours / week
	Volleyball	**A. Fundamental skills** Service: Under arm service, Side arm service, Tennis service, Floating service. Pass: Under arm pass, Over head pass. Spiking and Blocking. Game practice with application of Rules and Regulations **B. Rules and their interpretation and duties of officials.**	
	Throw ball	**A. Fundamental skills** Overhand service, Side arm service, two hand catching, one hand overhead return, side arm return. **B. Rules and their interpretations and duties of officials**	

5th Semester **B24NCK593**	**<u>Athletics</u>** **Track-11**0&400 Meters Hurdles **Jumps-**High Jump **Throws-**Discuss Throw	**110 Meters and 400 Meters:** Hurdling Technique: Lead leg Technique, Trail leg Technique, Side Hurdling, Over the Hurdles Crouch start (its variations) use of Starting Block. Approach to First Hurdles, In Between Hurdles, Last Hurdles to Finishing. **High jump**: Approach Run, Take-off, Bar Clearance (Straddle) and Landing. **Discus Throw**: Holding the Discus, Initial Stance Primary Swing, Turn, Release and Recovery (Rotation in the circle).	

5th Semester **B24NCK593**	Football	**A. Fundamental Skills** ➢ Kicking: Kicking the ball with inside of the foot, Kicking the ball with Full Instep of the foot, Kicking the ball with Inner Instep of the foot, Kicking the ball with Outer Instep of the foot and Lofted Kick. ➢ Trapping: Trapping-the Rolling ball, and the Bouncing ball with sole of the foot. ➢ Dribbling: Dribbling the ball with Instep of the foot, Dribbling the ball with Inner and Outer Instep of the foot. ➢ Heading: In standing, running and jumping condition. ➢ Throw-in: Standing throw-in and Running throw-in. ➢ Feinting: With the lower limb and upper part of the body. ➢ Tackling: Simple Tackling, Slide Tackling. ➢ Goal Keeping: Collection of Ball, Ballclearance-kicking, throwing and deflecting. ➢ Game practice with application of Rules and Regulations. **B. Rules and their interpretation and duties of officials.**	Total-32 hours 2 hours / week
	Hockey	**A. Fundamental Skills** ➢ Passing: Short pass, Long pass, push pass, hit ➢ Trapping. ➢ Dribbling and Dozing. ➢ Penalty stroke practice. ➢ Penalty corner practice. ➢ Tackling: Simple Tackling, Slide Tackling. ➢ Goal Keeping, Ball clearance-kicking, and deflecting. ➢ Game practice with application of Rules and Regulations. **B. Rules and their interpretation and duties of officials.**	
	Athletics **Track**-Relays **Jumps**-Triple Jump **Throws**-Javelin Throw	**Relay Race**: Starting, Baton Holding / Carrying, Baton Exchange in between zone, and Finishing. **Triple Jump**: Approach Run, Take-off, Flight in the Hop, Step, Jump and Landing. **Javelin Throw**: Grip, Carry, and Recovery (3/5 Impulse stride). Release.	Total-32 hours 2 hours / week
	CRICKET	**A. Fundamental Skills** ➢ Batting-Forward Defense Stroke, Backward Defense Stroke, Off Drive, On Drive, Straight Drive, Cover Drive, Square Cut. ➢ Bowling-Out-swing, In-swing, Off Break, Leg Break and Googly. ➢ Fielding: Catching - The High Catch, The Skim Catch, The Close Catch and throwing at the stumps from different angles. Long Barrier and Throw, Short Throw, Long Throw, Throwing on the Turn. ➢ Wicket Keeping **B. Rules and their interpretation and duties of officials.**	

	BASEBALL	**A. Fundamental Skills** Player Stances–walking, extending walking, L stance, cat stance. Grip – standard grip, choke grip. Batting – swing and bunt. Pitching. Baseball: Slider, fast pitch, curve ball, drop ball, rise ball, change up, knuckle ball, screw ball. **B. Rules and their interpretation and duties of officials.**	

6th Semester **B24NCK693**	**Athletics** Combined Events-Heptathlon & Decathlon **Jumps**- Pole Vault **Throws**-Hammer Throw	Combined Events: Heptathlon all the7 events Decathlon: All10Events **Pole Vault**: Approach Run, Planting the Pole, Take-off, Bar Clearance and Landing. **Hammer Throw**: Holding the Hammer, Initial Stance Primary Swing, Turn, Release and Recovery (Rotation in the circle).	Total-32 hours 2 hours / week
	Basketball	**A. Fundamental Skills** ➢ Passing: Two hands Chest Pass, Two hands Bounce Pass, One hand Base ball Pass, Side arm Pass, Overhead Pass, Hook Pass. ➢ Receiving: Two hand receiving, one hand receiving, Receiving in stationary position, receiving while jumping and Receiving while Running. ➢ Dribbling: How to start dribble, drop dribble, High Dribble, Low Dribble, Reverse Dribble, Rolling Dribble. ➢ Shooting: Lay-up shot and its variations, one hand set shot, two hands jump shot, Hook shot, Free Throw. ➢ Rebounding: Defensive rebound and Offensive rebound. ➢ Individual Defence: Guarding the player with the ball and without the ball, pivoting. ➢ Game practice with application of Rules and Regulations. **B. Rules and their interpretation and duties of officials.**	
	Netball	**A. Fundamental skills** ➢ Catching: one handed, two handed, with feet grounded and in flight. ➢ Throwing (Different passes and their uses): One hand passes (shoulder, high shoulder, underarm, bounce, lob), two hand passes (Push, overhead and bounce). ➢ Footwork: Landing on one foot, landing on two feet, Pivot, Running pass. ➢ Shooting: One hand, forward step shot, and back ward step shot.	

		➢ Techniques of free dodge and sprint, sudden sprint, sprint and stop, sprinting with change at speed. ➢ Defending: Marking the player, marking the ball, blocking, inside the circle, outside the circle. Defending the circle edge against the passing. ➢ Intercepting: Pass and shot. ➢ Game practice with application of Rules and Regulations. **B. Rules and their interpretation and duties of officials.**	
	Individual games Shuttle Badminton	**A. Fundamental skills** ➢ Basic Knowledge: Various parts of the Racket and Grip. ➢ Service: Short service, Long service, Long-high service. ➢ Shots: Over head shot, Defensive clear shot, Attacking clear shot, Drop shot, Net shot, Smash. ➢ Game practice with application of Rules and Regulations. **B. Rules and their interpretation and duties of officials.**	Total-32 hours 2 hours / week
	Table Tennis	**A. Fundamental skills** ➢ Basic Knowledge: Various parts of the Racket and Grip (Shake Hand & Pen Hold Grip). ➢ Stance: Alternate & Parallel. ➢ Push and Service: Backhand & Forehand. ➢ Chop: Backhand & Forehand. ➢ Receive: Push and Chop with both Backhand & Forehand. ➢ Game practice with application of Rules and Regulations. **B. Rules and their interpretation and duties of officials.**	
	Hand ball	**A. Fundamental skills** ➢ Catching, Throwing and Ball control, ➢ Goal Throws: Jump shot, Center shot, Dive shot, Reverse shot. ➢ Dribbling: High and low. ➢ Attack and counter attack, simple counter attack, counter attack from two wings and center. ➢ Blocking, Goal Keeping and Defensive skills. ➢ Game practice with application of Rules and Regulations. **B. Rules and their interpretation and duties of officials.**	
	Ball Badminton	**A. Fundamental skills** ➢ Basic Knowledge: Various parts of the Racket and Grip. ➢ Service: Short service, Long service, Long-high service. ➢ Shots: Over head shot, Defensive clear shot, Attacking clear shot, Drop shot, Net shot, Smash. ➢ Game practice with application of Rules and Regulations. **B. Rules and their interpretation and duties of officials.**	

REFERENCES

1. Saha, A. K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
2. Bandopadhyay, K. Sarir Siksha Parichay, Classic Publishers, Kolkata.
3. Petipus, et al. Athlete's Guide to Career Planning, Human Kinetics.
4. Dharma, P. N. Fundamentals of Track and Field, Khel Sahitya Kendra, New Delhi.
5. Jain, R. Play and Learn Cricket, Khel Sahitya Kendra, New Delhi.
6. Vivek Thani, Coaching Cricket, Khel Sahitya Kendra, New Delhi.
7. Saha, A. K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
8. Bandopadhyay, K. Sarir Siksha Parichay, Classic Publishers, Kolkata
9. Naveen Jain, Play and Learn Basketball, Khel Sahitya Kendra, New Delhi.
10. Dubey, H. C. Basketball, Discovery Publishing House, New Delhi.
11. Rachana Jain, Teach Yourself Basketball, Sports Publication.
12. Jack Nagle, Power Pattern Of fences for winning basketball, Parker Publishing Co., New York. 13 Renu Jain, Play and Learn Basketball, Khel Sahitya Kendra, New Delhi.
13. Sally Kus, Coaching Volleyball Successfully, Human Kinetics.
14. Saha, A. K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
15. Bandopadhyay, K. Sarir Siksha Parichay, Classic Publishers, Kolkata

SEMESTER-V & VI					
YOGA Category: NCMC					
Course Code	:	B24NCK594/694	CIE	:	100 Marks
Teaching Hours L : T : P	:	1:0:0	SEE	:	--
Total Hours	:	--	Total	:	100 Marks
Credits	:	--	SEE Duration	:	--

Semester	Course
III Semester	1) Introduction of Yoga, Aim and Objectives of yoga, Prayer 2) Brief introduction of yogic practices for common man 3) Rules and regulations 4) Misconceptions of yoga 5) Suryanamaskara 6) Different types of Asanas a. Sitting b. Standing c. Prone line d. Supine line
IV Semester	1) Patanjali's Ashtanga Yoga 2) Suryanamaskara 3) Different types of Asanas a. Sitting b. Standing c. Prone line d. Supine line 4) Kapalbhati 5) Pranayama
V Semester	1) Patanjali's Ashtanga Yoga 2) Surya namaskara 3) Different types of Asanas a. Sitting b. Standing c. Proneline d. Supineline 4) Kapalbhati 5) Pranayama

	1) Patanjali's Ashtanga Yoga 2) Suryanamaskara 3) Different types of Asanas a. Sitting b. Standing c. Prone line d. Supine line 4) Kapalbhati 5) Pranayama
VI Semester	1) Patanjali's Ashtanga Yoga 2) Suryanamaskara 3) Different types of Asanas a. Sitting b. Standing c. Prone line d. Supine line 4) Kapalbhati 5) Pranayama
	1) Patanjali's AshtangaYoga 2) Suryanamaskara 3) Different types of Asanas a. Sitting b. Standing c. Prone line d. Supine line 4) Kapalbhati 5) Pranayama 6) Shat Kriyas

Notes:

- One Hour of Lectureisequalto1Credit
- One Hour of Tutorial is equal to 1Credit (Except Languages)
- Two Hours of Practical is equal to 1Credit
- SEE: Semester End Examination
- CIE: Continuous Internal Examination
- L+T+P: Lecture + Tutorial + Practical

Guidelines for Yoga Syllabus

Semester & Course Code	Course Title	Content	No. of Hours
3rd Semester B24NCK394	Introduction of Yoga, Aim and Objectives of yoga, Prayer	Yoga, its origin, history and development. Yoga, its meaning, definitions. Different schools of yoga, importance of prayer	Total-32 hours 2 hours / week
	Brief introduction of yogic practices for common man	Yogic practices for common man to promote positive health	
	Rules and regulations	Rules to be followed during yogic practices by practitioner	
	Misconceptions of yoga	Yoga its misconceptions, Difference between yogic and non yogic practices.	
	Suryanamaskara	Suryanamaskar prayer and its meaning, Need, importance and benefits of Suryanamaskar12 count, 2 rounds	
	Different types of Asanas Sitting ➢ Padmasana ➢ Vajrasana Standing ➢ Vrikshana ➢ Trikonasana Prone line ➢ Bhujangasana ➢ Shalabhasana Supine line ➢ Utthitadvipadasana ➢ Ardhahalasana	Asana, Need, importance of Asana. Different types of asana. Asana its meaning by name, technique, precautionary measures and benefits of each asana.	

4th Semester **B24NCK494**	Patanjali's Ashtanga Yoga ➢ Yama ➢ Niyama	Patanjali's Ashtanga Yoga its need and importance. Yama: Ahimsa, satya, asteya, brahmacarya, aparigraha. Niyama: shoucha, santosh, tapa, svaadhyaya, Eshvara pranidhan	Total-32 hours 2 hours / week
	Suryanamaskara	Suryanamaskar 12 count, 4 rounds	
	Different types of Asanas Sitting ➢ Sukhasana ➢ Paschimottanasana Standing ➢ Ardhakati Chakrasana ➢ Parshva Chakrasana Prone line ➢ Dhanurasana Supine line ➢ Halasana ➢ Karna Peedasana	Asana, Need, importance of Asana. Different types of asana. Asana its meaning by name, technique, precautionary measures and benefits of each asana.	
	Kapalabhati	Meaning, importance and benefits of Kapalabhati. 40 strokes/min, 3 rounds	
	Pranayama ➢ Suryanuloma–Viloma ➢ Chandranuloma-Viloma ➢ Suryabhedana ➢ ChandraBhedana ➢ Nadishodhana	Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama	

5th Semester **B24NCK594**	Ashtanga Yoga ➢ Asana ➢ Pranayama	Patanjali's Ashtanga Yoga its need and importance.	Total-32 hours 2 hours / week
	Suryanamaskara	Suryanamaskar 12 count, 6 rounds	
	Different types of Asanas Sitting ➢ Ardha Ushtrasana ➢ Vakrasana Standing ➢ Urdhva Hastothanasana ➢ Hastapadasana Prone line ➢ Padangushtha Dhanurasana Supine line ➢ Sarvangasana ➢ Chakraasana	Asana, Need, importance of Asana. Different types. Asana its meaning by name, technique, precautionary measures and benefits of each asana.	
	Kapalabhati	Revision of practice 50 strokes/min, 3 rounds	
	Pranayama ➢ Surya Bhedana ➢ Ujjayi	Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, Precautionary measures and benefits of each Pranayama.	
	Ashtanga Yoga ➢ Pratyahara ➢ Dharana	Patanjali's Ashtanga Yoga its need and importance.	Total-32 hours 2 hours / week
	Suryanamaskara	Revisionofpractice12count, 8 rounds	
	Different types of Asanas Sitting ➢ AakarnaDhanurasana ➢ YogamudrainPadmasana Standing ➢ ParivrittaTrikonasana ➢ Utkatasana Prone line ➢ PoornaBhujangasana/	Asana, Need, importance of Asana. Different types, Asana by name, technique, precautionary measures and benefits of each asana.	

	Rajakapotasana Supine line ➢ Navasana/Noukasana ➢ Pavanamuktasana		
	Kapalabhati	Revision of practice 60 strokes/min, 3 rounds	
	Pranayama ➢ Sheetali ➢ Sheektari	Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama	

6th Semester **B24NCK694**	Ashtanga Yoga ➢ Dhyana (Meditation) ➢ Samadhi	Patanjali's Ashtanga Yoga its need and importance.	Total-32 hours 2 hours / week
	Suryanamaskara	Revision of practice 12count, 10rounds.	
	Different types of Asanas Sitting ➢ Vibhakta Paschimottanasana ➢ Yogamudra inVajrasana Standing ➢ Parshvakonasana ➢ Ekapadbaddhapadmottanasana Prone line balancing ➢ Mayurasana Supine line ➢ Sarvangasana ➢ Setubandhasana ➢ Shavasanaa (Relaxation poisture)	Asana, Need, Importance of Asana. Different types, Asana by name, technique, precautionary measures and benefits of each asana.	
	Kapalabhati	Revision of practice 80 strokes/min, 3 rounds	

	Pranayama ➢ Bhastrika ➢ Bhramari	Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, Precautionary measures and benefits of each Pranayama.	
	Suryanamaskara	Revision of practice 12count, 12 rounds.	Total-32 hours 2 hours / week
	Different types of Asanas Sitting ➢ Bakasana ➢ Hanumanasana ➢ Ekapada Rajakapotasana Standing ➢ Vatayanasana ➢ Garudasana ➢ Natarajasana Balancing ➢ Sheershasana Supine line ➢ 1.Setubandha Sarvangasana ➢ Shavasanaa (Relaxation poisture)	Asana, Need, importance of Asana. Different types, Asana by name, technique, precautionary measures and benefits of each asana.	
	Kapalabhati	Revision of practice 100 strokes/min, 3 rounds.	
	Pranayama ➢ Nadishodhana ➢ Ujjai ➢ Bhramari	Revision of practices	
	ShatKriyas ➢ Jalaneti & sutraneti ➢ Nouli (only for men) ➢ Sheetkarma Kapalabhati	Meaning, Need, importance of Shatkriya. Different types. Meaning by name, technique, precautionary measures and benefits of each Kriya	

Book for Reference:

- Swami Kuvulyananda: Asma (Kavalyadhama, Lonavala)
- Tiwari, O P: Asana Why and How

- Ajitkumar: Yoga Pravesha (Kannada)
- Swami Satyananda Saraswati: Asana Pranayama, Mudra, Bandha (Bihar School of yoga, Munger)
- Swami Satyananda Saraswati: Surya Namaskar (BiharSchoolofyoga,Munger)
- Nagendra H R: The art and science of Pranayama
- Tiruka: Shatkriyegalu (Kannada)
- Iyengar B K S: Yoga Pradipika (Kannada)
- Iyengar B K S: Light on Yoga (English)

SEMESTER-V & VI					
MUSIC **Category: NCMC**					
Course Code	:	B24NCK595/695	CIE	:	100 Marks
Teaching Hours L : T : P	:	1:0:0	SEE	:	--
Total Hours	:	--	Total	:	100 Marks
Credits	:	--	SEE Duration	:	--

Course Objectives	
1.	Identify the major traditions of Indian music, both through notations and aurally.
2.	Analyze the compositions with respect to musical and lyrical content
3.	Demonstrate an ability to use music technology appropriately in a variety of setting.

Module – 1	**No. of Hours**
Preamble: Contents of the curriculum intend to promote music as language to develop an analytical, Creative, and intuitive Understanding. For this the student must experience music through study and direct participation in improvisation and composition. Origin of the Indian Music: Evolution of the Indian music system, Understanding of Shruthi, Nada, Swara, Laya, Raga Tala, Mela.	3
Module – 2	**No. of Hours**
Compositions: Introduction to the types of composition in Carnatic Music- Geethe, Jath i, Swara, Swarajathi, Varna, Krithi, and Thillana, Notation System.	3
Module – 3	**No. of Hours**
Composers: Biography and contributions of Purandaradasa, Thyagaraja, Mysoro Vasudevacharya.	3
Module – 4	**No. of Hours**
Music Instruments: Classification and construction of string instruments, wind instrurments, percussion instruments, Idiophones (Ghana Vaadya), Examples of each class of Instrum ents	3
Module – 5	**No. of Hours**
Abhyasa Gana: Singing the swara exercises (Sarale Varase Only), Botation writing for Sarale Varase and Suladi Saptha Tala (Only in Mayamalavagowla Raga), Singing 4 Geethe in M alahari, and one jathi Swara, One Krithi in a Mela raga	14

Course Outcomes: At the end of the course, the students will be able to	
CO1	Discuss the Indian system of music and relate it to other genres (Cognitive DOmain)
CO2	Experience the emotions of composer and develop empathy (Affective Domain)
CO3	Respond to queries on various patterns in a composition (Psycho Motor Domain)

Text Books	
1.	Vidushi Vasantha Madhavi, "Theory of Music", Prism Publication, 2007.
2.	T Sachidevi and T Sharadha (Thirumalai Sisters), Karnataka Sangeetha Dharpana- Vol. 1 (English), Shreenivaas Prakaashana, 2018.

Reference Text Books	
1.	Lakshminarayana Subramaniam, Viji Subramanaim, "Classical Music of India: A Practical Guige", Tranqueber 2018.
2.	R. Rangaramanuja Ayyangar, "History of South Indian (Carnatic) Music", Vipanci Charitable Trust; Third edition, 2019.
3.	Ethel Rosenthal, "The Story of Indian Music and Its Istruments: A Study of the Present and a Record of the Past", Pilgrims Publishing, 2007.
4.	Carnatic Music, National Institute of Open Schooling, 2019.