HANDBOOK

of

CURRICULUM STRUCTURE AND SYLLABUS

Master of Technology in Automation and Robotics
(Programme Code: 3210)

Batch: 2021-2023

Institute of Engineering and Technology

Vision

To be one of India's most innovative higher education institutions.

Mission

To realise its vision, the University will:

Practice teaching that inculcates critical thinking and problem solving,

Pursue research that leads to innovation and enhancement of real-life applications,

Offer experience that leads to all round development, and

Develop a culture that is strongly rooted in interdisciplinarity and learning by building, not just doing.

Values

Caring for people.

Integrity including intellectual honesty, openness, fairness, and trust.

Commitment to excellence.

IQAC Documentation

Document Name: Handbook of Curriculum Structure and Syllabus, Master of Technology in Automation and Robotics (Programme Code: 3210) – Batch 2021-2023

Document Creation Date: Jan 24, 2022

Document Description: This document supplements the document titled Curriculum Structure: MTech Programs and is prepared by the Institute of Engineering and Technology (IET), JKLU to serve as an information baseline for further planning and delivery of courses w.r.t. Master of Technology in Automation and Robotics (M.Tech A&R), Batch 2021-23.

It includes Program Education Objectives, Programme Outcomes, Programme Specific Outcomes, Desired minimum level of competence for POs and PSOs, Curriculum Structure, collation of Semester wise Course Description, and Course Articulation Matrix (CAM) of each course (including electives and additional courses, if any, opted by students) prepared by respective faculty members. The document also includes Programme Articulation Matrix (PAM).

This document is in compliance with BoS (upto 13th meeting) and approvals of the Academic Council (upto 20th meeting).

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Program Education Objectives

The B.Tech. and M.Tech. Programs at IET, JKLU are designed to prepare students for continued learning and successful careers. Our alumni are expected to:

PEO1: Apply their technical knowledge, complex problem solving and research skills in professional practice.

PEO2: Continue their intellectual development through critical thinking, self-study, apprenticeship, higher education, professional development courses, as well as participation in research groups and professional networks.

PEO3: Serve as ambassadors for engineering and sustainability by exhibiting high professional standards with a deep sense of civic responsibility.

PEO4: Effectively communicate about technical and related issues.

PEO5: Embrace roles of team members and leaders in their career.

Program Outcomes

"*Competence is a demonstrated ability to apply knowledge, skills and attributes for achieving desirable results."* The graduates of B.Tech. and M.Tech. Programs at IET, JKLU will have following competencies:

PO 1: Life-long learning*:* Demonstrate inquisitiveness, open mindedness, and the ability to engage in independent and life-long learning in the broadest context of technological, organizational, economic, and societal changes.

PO 2: Citizenship, Sustainability, and Professional ethics

PO 2a: Demonstrate knowledge of constitutional values of liberty, equity, justice, and fraternity with understanding of the impact of the engineering solutions in societal and environmental contexts as well as a sense of responsibility for sustainable development.

PO 2b: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, cultural, and environmental issues and the consequent responsibilities relevant to the professional engineering practice.

PO 2c: Demonstrate commitment for professional integrity and excellence and respect for ethics, responsibilities and norms as prescribed for the engineering practice.

PO 3: Engineering knowledge and Modern tool usage

PO 3a: Demonstrate clear conceptual understanding of fundamentals of engineering specialization and cognitive flexibility to appropriately 'transfer' what has been learned in a context, to different situations.

PO 3b: Apply engineering thinking, computational thinking, and the knowledge of mathematics, natural and social sciences, engineering fundamentals, information technology, engineering specialization, and engineering management to the solution of complex engineering problems.

PO 3c: Create, select, modify, and apply appropriate techniques, best practices, standards, resources, and modern engineering and IT tools including prediction and modelling to engineering and social activities with an understanding of the limitations.

PO 4: Complex problem solving, Design and Research

PO 4a: Identify, formulate, review research literature, and analyze complex engineering problems to arrive at substantiated conclusions using critical thinking along with principles of mathematics, computing, engineering as well as natural and social sciences.

PO 4b: Use systems thinking and reflection to identify and consider underlying structures, patterns, volatility, uncertainties, complexities, ambiguities, complications, and risks to design and develop engineering solutions for complex problems to meet the specified and anticipated needs with appropriate concern for constraints, performance, sustainability, and professional ethics.

PO 4c: Use research-based knowledge and research methods including design of experiments, simulation, analysis and interpretation of data, and synthesis of the information to evaluate and improve the engineering solutions and practice.

PO 5: Individual & team work and Engineering management

PO 5a: Ability to work effectively as an individual and as a team member or leader in diverse and distributed teams, and in multidisciplinary settings.

PO 5b: Ability to apply engineering management principles to one's own and team's work to manage engineering projects and operations and in multidisciplinary environment.

PO 6: Communication: Ability to communicate effectively on complex engineering and technology activities, situations, problems, and solutions using verbal, textual, and pictorial elements with the colleagues, engineering community, users, clients, policy makers, and society at large with intellectual honesty, clarity, empathy, and compassion.

PO 7: Innovation and entrepreneurship:

PO 7a: Demonstrate enthusiasm and understanding to identify opportunities and translate research in engineering and other disciplines to conceive and design innovative engineering solutions for business, industry, and societal problems.

PO 7b: Demonstrate enthusiasm and understanding to conceive and plan technology based new ventures either as independent start-up businesses or within existing corporate structures.

Program Specific Outcomes

The graduates of Automation and Robotics at JKLU will be able to:

ARPSO1: Conceive, design, implement, and manage automation systems by using principles of physical computing, control and automation, mechatronics and robotics, robotic process automation, artificial intelligence, and state of the art components and tools.

ARPSO2: Serve in fields of industrial automation, robotics, systems engineering, IT and engineering services, education, research, etc.

Program specific desired minimum level of competence for POs and PSOs

PO/PSO	Competence Level
PO 1	Competent
PO 2a	Novice
PO 2b	Advanced Beginner
PO 2c	Novice
PO 3a	Competent
PO 3b	Advanced Beginner
PO 3c	Advanced Beginner
PO 4a	Advanced Beginner
PO 4b	Advanced Beginner
PO 4c	Advanced Beginner
PO 5a	Competent
PO 5b	Advanced Beginner
PO 6	Advanced Beginner
PO 7a	Advanced Beginner
PO 7b	Novice
ARPSO 1	Competent
ARPSO 2	Competent

Following process has been adopted to create Course Articulation Matrix (CAM) and Program Articulation Matrix (PAM).

- Course Outcome of each Course is mapped to Program Outcome (PO) / Program Specific Outcome (PSO) using three Levels viz., Low Correlation (1), Moderate Correlation (2) and Substantial Correlation (3).

- Average of these Levels of each Course Outcome w.r.t each specific PO/PSO is calculated and it indicates expectations laid in a course to attain different PO/PSO. In order to avoid over committement of a course w.r.t its contribution to POs/PSOs, the following validation check is applied on the sum of PO/PSO wise averages in each course.

  $$\sum (\text{Average}) <= \text{Min}(\text{Credits} * \text{Year}, 20)$$

  In above equation, Credits are the credits assigned to the course, Year (5 for 1st Year and 6 for 2nd Year) indicates the level of the students from 1st and 2nd year. In case this sum exceeds the upper limit, CO-PO mappings are revised. This check ensures that early or low credit courses are not over burdened with very high expectations.

- For creation of Program Articulation Matrix, sum of these averages of different courses w.r.t each PO/PSO is calculated and interpreted as per following Table.

Competence Level *	M.Tech
Novice	<5
Advanced Beginner	5 - 10
Competent	>=10

Novice* (N): Knows objective facts, features, and rules for determining actions wrt this PO/PSO without being context-sensitive. The student has studied the basic concepts.

Advanced beginner* (AB): Recognizes common situations wrt this PO/PSO that help in recalling which rules should be exercised, starts to recognize and handle situations not covered by given facts, features and rules. The student has problem-solving and repeated practice experience for common situations wrt this PO/PSO.

Competent* (C): Performs most standard actions wrt PO/PSO without conscious application of rules after considering the whole situation. Handles new situations through the appropriate application of rules, can design systems, and may lead. Has demonstrated this PO/PSO through repeated engagements in advanced problem-solving, projects, extensive practice in common and exception situations, and participated in professional networks.

JK Lakshmipat University, Jaipur
Institute of Engineering and Technology
Curriculum Structure
Master of Technology in Automation and Robotics (Batch 2021-2023)

Courses							**Credits**
Semester I							
Optimisation and Control EE2104 (3 1 0) 4	Instrumentation and Embedded Systems Laboratory EE2102 (0 0 4) 2	Industrial Automation and IoT-I EE2101 (3 0 2) 4	Robotic Process Automation and Applications CS2103 (3 0 4) 5	Project-I PR2101/ Research Methodology-I IL2107 (2 0 0) 2	Critical Thinking for Developing Perspectives CC2171 (2 0 0) 2	Elective-I (3 0 0) 4	**22**
Semester II							
Intelligent Control Systems EE2106 (3 0 4) 5	Industrial Automation and IoT-II EE2105 (3 0 2) 4	Mechatronics ME1207 (3 0 4) 5	Project-II PR2102/ Research Methodology-II IL2108 (2 0 0) 2	Critical Thinking for Problem Solving and Decisions CC2121 (2 0 0) 2	Elective-II (3 0 0) 4		**22**
PS2101 Internship (6-8 weeks)							**4**
Exit Option with PG Diploma							
Semester III							
Dissertation-I/ Industrial Project-I/ Entrepreneurial Project-I PR2103/ PR2104/ PR2105 10			Elective – III (3 0 0) 4		Elective – IV (3 0 0) 4		**18**
Semester IV							
Dissertation-II/ Industrial Project-II/ Entrepreneurial Project-II PR2106/ PR2107/ PR2108 16							**16**
Total Credits							**82**

Elective I
Statistical Data Analysis-I AS2106
Advanced Algorithms- CS2202
Elective II
Electric Vehicle Technology – EE1220
Statistical Data Analysis-II- AS2104
Elective III, Elective IV (Tentative)
Computational Game Theory and Applications-EE2202
Large Scale Graph Analytics- CS2201
Industrial Robotics- IL2203

NOTE:

1. Students have the option to exit the program with a PG Diploma after completing one year and internship.
2. For every credit, in each course, every student is expected to put in a total work of 35-36 hours including the class time. The specified teaching scheme is applicable if the course is taught as full semester course. However, sometimes, a few courses may actually be completed in a shorter duration by increasing the weekly contact hours.
3. Learning outcomes focus on higher order thinking and practical skills. Rote learning is completely de-emphasized and assessment scheme includes several components like assignments, labs, projects, reports etc. The exams are designed to assess problem solving ability through questions focusing on analysis, synthesis, and evaluation.
4. Relevant engineering standards and sustainability issues are incorporated in all engineering courses.
5. A student may sometimes be allowed to take a few additional courses for earning extra credits, fulfilling credit deficiency or completion of academically equivalent core course requirements in special cases.

Course Title and Code	Optimisation and Control (EE2104)
Hours per Week	L-T-P: 3-1-0
Credits	4
Students who can take	MTech Automation & Robotics – 1st semester

Course Objective- This course aims at equipping students with the conceptual tools necessary to solve estimation and control problems, maximizing performance and minimizing cost.

Course Outcomes:

On successful completion of this course, the students should be able to:

EE2104.1 analyze the requirements of a given estimation and control problem
EE2104.2 design and implement a solution for a given estimation and control problem
EE2104.3 efficiently use Computer Aided Control Systems Design (CACSD) tools
EE2104.4 assess, troubleshoot, improve and document a given estimation and control system
EE2104.5 apply relevant engineering standards to meet technical, safety, regulatory, societal and market needs

Prerequisites		
Sr. No	**Specifications**	**Marks**
01	Attendance	Nil
02	Assignment (4)	40
03	Class Participation	Nil
04	Quiz	Nil
05	Theory Exam-I	Nil
06	Theory Exam-II	Nil
07	Theory Exam-III	30
08	Report-I	30
09	Report-II	Nil
10	Report-III	Nil
11	Project-I	Nil
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	Nil
15	Lab Evaluation-II	Nil
16	Course Portfolio	Nil
	Total (100)	**100**

Retest

1	Theory Exam	30

Syllabus (Theory):

1) Mathematics refresher: linear algebra, linear programming, nonlinear programming, dynamic systems, modelling identification and simulation, both in continuous time and discrete time.
2) Control system project planning and documentation.
3) Discrete-event control systems. Typical models, counters, and timers. State machines, Petri nets, Sequential Flow Charts.
4) Continuous control systems: Stability, time domain, frequency domain, design specifications, compensation. State variable modelling of linear continuous systems, controllability, and observability.
5) Introduction to optimal control. Performance assessment.

Reference Books:

- R. F. Stengel (1994). Optimal control and estimation. Dover Publications.
- C.-T. Chen, Linear System Theory and Design, 3rd ed. USA: Oxford University Press, Inc., 1998.
- B. Hrúz and M. Zhoum (2007). Modeling and control of discrete-event dynamical systems: with Petri nets and other tools. London: Springer.
- D. H. Hanssen, Programmable Logic Controllers A Practical Approach TO IEC 61131-3 Using CoDeSys. Wiley, 2015.

IT Resources

https://nptel.ac.in/courses/107/106/107106081/
https://nptel.ac.in/courses/108/105/108105019/
https://nptel.ac.in/courses/112/107/112107220/
https://www.controldraw.co.uk/
https://www.codesys.com/
https://web.math.princeton.edu/~cwrowley/python-control/index.html

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
EE2104.1							3										
EE2104.2							3										
EE2104.3							3										
EE2104.4																3	3
EE2104.5																3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code	Instrumentation and Embedded Systems Laboratory (EE2102)
Hours per Week	L T P: 0 0 4
Credits	2
Students who can take	M. Tech Semester-I

Course Objective-.

To study the instrumentation and embedded system design using a building block approach, which allows one to visualize the requirement of an instrumentation and embedded system and then to design it efficiently. The course will teach embedded system design using a microcontroller, namely Texas Instruments MSP430 low power microcontroller. The course will introduce various interfacing techniques for popular input devices including sensors, output devices and communication protocols.

Course Outcome:

On successful completion of this course, the students should be able to:

EE2102.1 Explain the concept, classification, characteristics, quality attributes and applications of Instrumentation and Embedded Systems.

EE2102.2 Describe the architecture of MSP430 and use the peripherals for various applications.

EE2102.3 Interface different sensors and displays for different applications.

EE2102.4 Develop programs for various application using embedded C.

Prerequisites		Basic Programming and Circuits
Sr. No	**Specifications**	**Marks**
1	Attendance	Nil
2	Assignment	10
3	Class Participation	5
4	Quiz	10
5	Theory Exam-I	Nil
6	Theory Exam-II	Nil
7	Theory Exam-III	Nil
8	Report-I	Nil
9	Report-II	Nil
10	Report-III	Nil
11	Project-I	15
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I (Continuous)	30
15	Lab Evaluation-II	30
16	Course Portfolio (MOOC certificate)	Nil
	Total (100)	**100**

Retest

1	Theory Exam-III	Nil
2	Lab Evaluation-II	30
	Total (30)	**30**

Syllabus (Theory):

Introduction to Instrumentation. Sensors, display devices and Microcontrollers for automation: Working principle of sensors and display devices. Architecture of ATMega328/MSP430 Lunchbox (concepts on ALU, memory, ports). Applications of sensors, display devices interfacing with microcontroller.

Syllabus (Lab):

Write an Embedded C Program to

- blink Internal / External LED and generate different LED patterns.
- control Internal/External LED using Internal/External switch.
- Implement switch Debouncing.
- operate the 7 Segment display CC/CA.
- print data on Serial Monitor.
- operate the LCD to display the message.
- interface POT and show its value on LCD. (Analog to Digital Convertor ADC)
- interface inbuilt temperature sensor and show its value on LCD.
- interface External Sensor (LM35, LDR, NTC, IR etc) and show its value on LCD.

Reference Books:

- Designing Embedded Hardware, John Catsoulis. 2nd edition. Shroff Publishers and Distributors. ISBN-10: 9788184042597
- Embedded System Design: A Unified Hardware / Software Introduction. Tony Givargis and Frank Vahid. Wiley. ISBN-10: 812650837X
- MSP430 Microcontroller Basics. John H. Davies. Elsevier. ISBN-10: 9789380501857. Programming Embedded Systems in C and C++. Micheal Barr. Shroff Publishers and Distributors. ISBN-10: 817366076X

Video lectures:

1. Introduction to Embedded System Design By By Prof. Dhananjay V. Gadre, Prof. Badri Subudhi. https://onlinecourses.nptel.ac.in/noc21_ee58/course

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
EE2102.1					1	1	1	1								2	2
EE2102.2					1	1	1	1								2	2
EE2102.3					1	1	1		1							2	2
EE2102.4					1	1	1	1	1	1						2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code	Industrial Automation and IoT-I (EE2101)
Hours per Week	L-T-P: 3-0-2
Credits	4
Students who can take	M.Tech Semester-I

Course Objectives

The course focuses on the application of technologies to control and monitor the industrial processes. Course aims to introduce industrial automation, IoT technologies and standards. Its emphasis is on theoretical principles and applications for problem solving.

Course Outcomes

On successful completion of this course, the students should be able to:

EE2101.1 Analyze the link between Information Technology and Operational Technology.

EE2101.2 Specify the key components to design an Industrial automation & IoT system.

EE2101.3 Choose technologies for communication and real time data collection.

EE2101.4 Design, deploy and test a basic Industrial automation & IoT system.

EE2101.5 Apply recommended engineering practices to meet desired requirements for applications, considering sustainability, security and safety as design constraints.

Sr. No	Specifications	Marks
1	Attendance	NIL
2	Assignment	15
3	Class Participation	05
4	Quiz	10
5	Theory Exam-I	NIL
6	Theory Exam-II	10
7	Theory Exam-III	20
8	Report-I	NIL
9	Report-II	NIL
10	Report-III	NIL
11	Project-I	15
12	Project-II	NIL
13	Project-III	NIL
14	Lab Evaluation-I (Continuous)	15
15	Lab Evaluation-II (Exam)	10
16	Course Portfolio (MOOC Course)	NIL
Total (100)		**100**

Evaluation Scheme for Retest:

S. No.	Specifications	Marks
1	Theory Exam-III (End Term)	20
2	Lab Evaluation-II (Exam)	10
	Total	**30**

Syllabus

Theory

UNIT1: Introduction: Classical hierarchical industrial automation model. Essential functions of each level. Elements of industrial control (sensors, actuators, transmitters, controllers, etc.). ISA 95 / ISA S88 – Enterprise integration. Emergent architectures.

UNIT2: Instrumentation: Characteristics of instruments: accuracy, precision, sensitivity, etc. Units and standards. Voltage, current and electrical power measurements. Measurement of temperature, position, speed, force, pressure, light, level, humidity and other variables. Signal conditioning and transmission. Indicators, recorders. Actuators. Valves and motors. Instrumentation symbols. Functional identification. Standards: ISA 5.1 – Instrument symbols and identification. IEC 61511 Safety Instrumented Systems.

UNIT 3: IoT fundamentals, Architecture and protocols,

UNIT 4: Industrial IoT fundamentals. Convergence of IT and OT. Industrial communication: principles, protocols and technologies. Design methodology. Design of IoT systems for industrial safety processes.

UNIT5: CASE STUDIES

Design and test a basic IIoT system involving prototyping, programming and data analysis. Application to sustainability problems: health, energy, water, smart cities, etc.

Practical

1. Characteristics of sensors. Calibration. Temperature, moisture, displacement, voltage, current, etc. Signal conditioning and processing.
2. Interfacing LEDs. Serial port. DC-motor.
3. IoT communication. Standards: MODBUS, OPC, MQTT etc.
4. PLC programming.
5. Mini-project

Text Book(s)

- Krishna Kant. "*Computer-based Industrial Control*". PHI Learning Private Limited, 2010.
- Hanes, Salgueiro, Grossetete, Barton and Henry (2017). "*IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things*". Cisco Press.
- Curtis Johnson. "*Process Control Instrumentation Technology*". PHI Learning Private Limited, 2013.

Reference Book(s)

- Gilchrist (2016). "*Industry 4.0: The Industrial Internet of Things*" Apress.
- John P. Bentley. Principles of Measurement Systems. 4th Edition, Addison Wesley Longman Ltd.,UK, 2004

Web Resources

https://nptel.ac.in/courses/108/105/108105062/
https://nptel.ac.in/courses/106/105/106105195/

Online Courses:

Developing Industrial Internet of Things
https://www.coursera.org/programs/j-k-lakshmipat-university-on-coursera-kzogk/browse?index=prod_enterprise_products&productId=84QbLYtsEeicuBLWaYsl_g&productType=s12n&query=industrial+iot&showMiniModal=true
Design of Internet of Things
https://nptel.ac.in/courses/108/108/108108098/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
EE2101.1	2				2	1	1				1	1	1	1			
EE2101.2		1			1	1	1	1									
EE2101.3					1	2	1	1	1		1						
EE2101.4	1	1	1		1	1	1	1	1		1		1				

EE2101.5	1		1	1	1	1	1	1	1		1	1					

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code	Robotic Process Automation and Applications (CS2103)
Hours per Week	L-T-P: 3 0 4
Credits	5
Students who can take	M.Tech (Automation and Robotics + Data Science)

Course Objective:
The course aims to develop an understanding of Robotic Process Automation for automating business processes using software robots with cost-efficient digital delivery.

Course Outcomes: On successful completion of this course, the students should be able to:

CS2103.1. Use and understand the various functionalities and features of UiPath Studio and Orchestrator.
CS2103.2. Design, implement and use RPA activities.
CS2103.3. Develop basic robots using UiPath Community Edition.
CS2103.4. Explore various data extraction techniques.
CS2103.5. Deploy, monitor, and control robots with UiPath Orchestrator.
CS2103.6. Identify processes which can be automated.
CS2103.7. Apply best practices in RPA projects.

Prerequisites: To understand and complete the course successfully the student must have basic programming skills.

Sr. No	Specifications	Marks
01	Attendance	Nil
02	Assignments	Nil
03	Class Participation	10
04	Quiz	20
05	Theory Exam-1	Nil
06	Theory Exam-2	Nil
07	Theory Exam-3	Nil
08	Report-1	Nil
09	Report-2	Nil
10	Report-3	Nil
11	Project-1	30
12	Project-2	Nil
13	Project-3	Nil
14	Lab Evaluation-1 (Test)	20
15	Lab Evaluation-2	Nil
16	Course portfolio	20
	Total (100)	**100**

Retest

1	Quiz	20
2	Lab Evaluation-1	20
	Total	40

Syllabus (Theory):

Unit I: Programming Basic & Recap: Programming concept basic; **Introduction to RPA:** scopes and techniques of automation, RPA components and various RPA platforms, Introduction to UiPath as RPA

platform, Applications and Benefits of RPA, Introduction to UiPath Studio, UiPath robot, types of robots, and UiPath Orchestrator. Brief on Studio interface and components.

Unit II: **RPA Projects:** Types of Projects in RPA: Sequence, Flowcharts, and State machines; Variables, Arguments, Data Types and Control flow: flow chart activities and sequences activities. **Data Manipulation:** Text and Data Manipulation**,** Data tables, clipboard management, file operation, importing from and exporting to CSV/Excel file and data table.

Unit III: **Control of Controls:** Attach window activity, Finding the control, Waiting for a control, Act on Control- mouse and keyboard activity. Handling event driven controls as working with UiExplorer handling events. Introduction to Recorder, OCR, types of OCR and Screen Scrapping Using OCR. **Selectors:** Selectors, Defining and Assessing Selectors, Customization, Debugging, Dynamic Selectors, Partial Selectors, RPA Challenge.

Unit IV: **Application with Plugins and Extensions:** Java plugins, Citrix automation, Mail plugins, PDF plugins, Web integration, excel and word plugins. Extensions- Java, chrome, firefox, and Silverlight. **UiPath Advanced Automation concepts and techniques:** Image, Text and introduction of Citrix Automation; **Excel Data Tables & PDF:** Data Tables in RPA, Excel and Data Table basics, Data Manipulation in excel, Extracting Data from PDF, Extracting a single piece of data, Anchors. **Email Automation:** Incoming Email automation, Sending Email automation.

Unit V: **Debugging and Exception Handling:** Common exceptions and ways to tackle them, Strategies for solving issues, Catching errors. **Introduction to Orchestrator:** Tenants, Authentication, Robots, Environments, Asset. **Capstone Project.**

Syllabus (Practical):

1. Setup, configuration, and introduction of components of UiPath Studio.
2. Execution of prebuilt examples of sequence, flow chart and state machines projects.

Create a sequence/Flow chart activity defining various types of variable as:

3. Generic Value Variables, Text Variables, Boolean Variables, Number Variables,
4. Array Variables, Date and Time Variables, Data Table Variables

Managing Arguments:

5. Create two activities, one activity defined with arguments and second activity which manages the argument to receive value from first activity.
6. Create an activity to manage importing active namespaces.

Create a project to Manage the control Flow:

7. The Assign Activity, The Delay Activity, The Do While Activity, The If Activity
8. The Switch Activity, The While Activity, The For-Each Activity, The Break Activity.

The Recording toolbar Activity:

9. Exercises using basic, web, and Desktop recoding.

10. Automate manual recording projects on Left-click on buttons, check boxes, drop-down lists, GUI elements, and Text typing

Data Scrapping:

11. Bot to extract structured data from your browser, application or document to a database, .csv file or even Excel spreadsheet.
12. Image and Text Automation
13. Excel Data Tables & PDF
14. Email Automation
15. Deployment of plugins and extensions.
16. Deploying and maintaining the BOT.

Text Books:

T1 Tripathi, Alok Mani. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool–UiPath. Packt Publishing Ltd, 2018.

T2. Murdoch, Richard. "Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant." Middletown, DE. Omakustanne (2018).

Reference Books:

R1. Abhinav Sabharwal, “Introduction To RPA”, Independently Published Kindle Edition on Amazon Asia-Pacific Holdings Private Limited, 201 8

R2. Gerardus Blokdyk, “Rpa Robotic Process Automation”, 5Starcook, Second Edition, 2018

R3. Kelly Wibbenmeyer, “The Simple Implementation Guide to Robotic Process Automation (Rpa): How to Best Implement Rpa in an Organization” Paperback, iUniverse, 2018

R4. Willcocks, Leslie P., Mary Lacity, and Andrew Craig. "The IT function and robotic process automation." (2015).

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
CS2103.1	1				1												2
CS2103.2		1				1		2			1		1	1		2	3
CS2103.3	1				1					1	1			2		3	3
CS2103.4					1					1			1			3	
CS2103.5							1			1				1			3
CS2103.6	1		1		1								1	1		3	3
CS2103.7		1	1				1									3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code	**Project-I (PR2101)**
Hours per Week	L-T-P: 2-0-0
Credits	02
Students who can take	M.Tech., Semester I

Course Objective- The course aims to equip the students with knowledge and skills for working on an engineering project.

Course Outcome:

On successful completion of this course, the students should be able to:

PR2101.1. Identify project goals, constraints, deliverables, performance criteria, control needs, and resource requirements.

PR2101.2. Use appropriate tools and techniques for problem solving.

PR2101.3. Utilize technology tools for communication, collaboration, information management, and decision support.

PR2101.4. Design appropriate solution/system for given problem.

PR2101.5. Test the system with varied test cases.

Prerequisites		
Sr. No	**Specifications**	**Marks**
01	Attendance	NIL
02	Assignment	NIL
03	Class Participation	NIL
04	Quiz	NIL
05	Theory Exam	NIL
06	Theory Exam	NIL
07	Theory Exam (Final)	NIL
08	Report-1 (Synopsis)	10
09	Report-2 (Final report)	20
10	Report-3	NIL
11	Project -1 (Day to Day work)	30
12	Project -2	40
13	Project -3	NIL
14	Lab Evaluation – I	NIL
15	Lab Evaluation – II	NIL
16	Course portfolio	NIL
	Total (100)	**100**
Retest		
01	Project-I	40

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
PR2101.1	1				1			1			1						
PR2101.2					1			1		1		1					
PR2101.3						1		1	1	1		1					
PR2101.4			1			1	1		1	1	1			1			
PR2101.5	1					1	1		1	1	1	1			1		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code	Critical Thinking for Developing Perspectives (CC2171)
Hours per Week	L-T-P: 2-0-0
Credits	2
Students who can take	M.Tech Semester-I

Course Objective:

The ability to clearly reason through problems and to present arguments in a logical, and compelling way, have become a key skill for survival in today's world. In this course, students will learn to dissect and evaluate the components of argument. Students will learn to raise vital questions, think from multiple perspectives, become aware of their biases, gather and assess information and come to a well-reasoned position.

After course completion, the student will be able to:

CC2171.1 Explain the relevance of critical thinking
CC2171.2 Formulate significant questions for inquiry.
CC2171.3 Evaluate information and evidence for correctness, consistency, and relevance.
CC2171.4 Compose well-structured and well-reasoned arguments.
CC2171.5 Recognize their own beliefs, biases, claims and assumptions by viewing the issues from multiple perspectives

	Prerequisites	
Sr. No	Specifications	Marks
1	Attendance	Nil
2	Assignment	Nil
3	Class Participation	20
4	Quiz	20
5	Theory Exam-I	Nil
6	Theory Exam-II	Nil
7	Theory Exam-III	20
8	Report-I	Nil
9	Report-II	Nil
10	Report-III	Nil
11	Project-I	40
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	Nil
15	Lab Evaluation-II	Nil
16	Course Portfolio	Nil
	Total (100)	100

Evaluation Scheme for Retest:

S. No.	Specifications	Marks
1	Theory Exam-III	**20**
3	**Total**	**40**

SYLLABUS:

Pedagogy: This course will be an amalgamation of lectures and activity-based learning i.e. films, group discussions, debates, and case studies. The objective behind utilizing activity-based learning is for the learners to have a more hands on experience.

Topics to be covered

I. Introduction to the concept of critical thinking:

- Evolution of the concept: Philosophy and Cognitive psychology as origins of critical thinking
- Revisit Paul-Elder Critical Thinking Framework

II. Questioning for Critical Thinking

- Importance of questioning
- Models of Questioning: Questioning Circles Model, Christenbury and Kelly (1983), Webb's Depth of Knowledge (1997). Elder & Paul (2007). Socratic Questioning Taxonomy.

III. Understanding Arguments

The sessions under this topic will make use of the context of current media, social and political debates to comprehend the topics.

- Meaning and Elements of Reasoning
- Formation of Arguments: Premise and Conclusion
- Inductive –Deductive reasoning: Difference between valid and invalid arguments/ between sound and unsound arguments.
- Evaluating Arguments: Examining data and information critically
- Cognitive Biases and Fallacies: Distinguishing between fact and opinion

Reference Books:

R1. Moore, B. N., & Parker, R. (2009). Critical thinking. Boston, MA: McGraw-Hill. eBook

R2. Sinnott-Armstrong, W., & Fogelin, R. J. (2014). Cengage Advantage Books: Understanding Arguments: An Introduction to Informal Logic. Cengage Learning eBook

Readings/Video(s)

1. The Evolution of Critical Thinking (Research project by Barba Albers, Washington, State University, 2004

2. Bowker, M. H., & Fazioli, K. P. (2016). Rethinking Critical Thinking: A Relational and Contextual Approach. Pedagogy and the Human Sciences, 6(1), 1-26.

3. Bauer, N. J. (1991). Dewey and Schon: An Analysis of Reflective Thinking.

4. Nappi, J. S. (2017). The importance of questioning in developing critical thinking skills. Delta Kappa Gamma Bulletin, 84(1), 30.

5. https://cpb-us e1.wpmucdn.com/cobblearning.net/dist/6/3101/files/2018/05/The-Importance-of-Questioning-2aqkc5j.pdfBloom, B. S. (1956). Taxonomy of educational objectives. Vol. 1: Cognitive domain. New York: McKay, 20-24.

6. Paul, R., & Binker, A. J. A. (1990). Socratic questioning. Critical thinking. Center for Critical Thinking and Moral Critique. http://www.criticalthinking.org/files/SocraticQuestioning2006.pdf

7. The Art of Asking Questions | Dan Moulthrop | TEDxSHHS
https://www.youtube.com/watch?v=hZSY0PssqH0

8. Analysing the argument - Part 1 of 2 (Video)

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

	Correlation with POs and PSOs

COs	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
CC2171.1	2						1	2									
CC2171.2	2		1					2							1		
CC2171.3	2		2	1			1	1		1							
CC2171.4	2								1				1				
CC2171.5	2										2						

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code	Statistical Data Analysis-I (AS2106)
Hours per Week	L-T-P: 3-0-4
Credits	5
Students who can take	MTech Semester-I

Course Objective:
This course aims to introduce basic concepts in descriptive and inferential statistics, as well as data exploration methods. Topics covered include probability distributions, hypothesis testing, frequency analysis, correlation, regression and design of experiments.

Course Outcomes: After course completion, the student will be able to:

AS2106.1: Frame real world analysis problems using statistical concepts and solve them using standard techniques.
AS2106.2: Use professional level tools to support the study of statistics.
AS2106.3: Communicate quantitative ideas to a range of audiences.
AS2106.4: Apply recommended practices for data analysis.

Prerequisites		
Sr. No	**Specifications**	**Marks**
1	Attendance	Nil
2	Assignment	Nil
3	Class Participation	10
4	Quiz	15
5	Theory Exam-I	Nil
6	Theory Exam-II	Nil
7	Theory Exam-III	30
8	Report-I	Nil
9	Report-II	Nil
10	Report-III	Nil
11	Project-I	25
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	20
15	Lab Evaluation-II	Nil
16	Course Portfolio	Nil
	Total (100)	100

SYLLABUS

Principles of Statistical Data Analysis: Data Elements, Variables, and Data categorization, Levels of Measurement: Nominal, Ordinal, Interval, or Ratio, Data management and indexing, Tabular data, Measures of dispersions, Skewness – Karl Pearson and Bowley, Skewness – Kelly coefficient of Skewness and Kurtosis

Probability Theory, Mathematical expectation, moments, probability and moment generating function, Chebyshev's inequality, Mean and Variance of a Random Variable, product moments, independence of random variables, Joint, marginal and conditional distributions, Discrete and continuous distribution function, Introduction to statistical learning using R-Programming/Python

Basic Statistical Techniques: Sampling Theory and Distributions for Normal and Non-normal Populations, Central Limit Theorem, Point and Interval Estimates, Estimator and Estimates, Sample size calculations Sample Size for Estimating Means and Proportions, Maximum likelihood test, The Central Limit Theorem, p-values and power, Parametric and Non-Parametric test of Hypothesis, Goodness of fit, Analysis of contingency tables, Non-parametric tests of location and dispersion, Statistical inference using R/Python

Analysis of Continuous and Categorical Data: Estimation Using the Regression Line, Method of Least Squares, Standard Error of Estimate, Prediction Intervals, Multi Variate regression, generalized linear models, Logistic regression, Ordinal logistic regression, Proportional odds models, Multinomial logistic regression, Poisson regression, negative binomial regression, zero-inflated models, Log linear models for (paired) tables. Procedures for stepwise building of a regression model, Introduction to random intercept models, penalized linear regression methods, Graphical and formal diagnostic methods for the inspection of residuals, Correlation Analysis, autocorrelation and cross correlation, Regression and Correlation analysis using R/Python

Design of experiments: Basic principles of experimental designs, Analysis of variance: one-way, Two-way classifications, Latin square design, Two Factorial Design.

Text Book(s)

1. Prem S Mann. Introductory statistics. Wiley. Edition: 7th ed. 2010.
2. Ronald E Walpole, Raymond H Myers, Sharon L Myers and Keying Ye. Probability and statistics for engineers and scientists. 8th ed - New Delhi. Pearson. 2007.

Web Resources

1. Statistics full Course for Beginners. https://www.youtube.com/watch?v=74oUwKezFho
2. Introduction to R and R Studio. https://www.youtube.com/watch?v=lL0s1coNtRk

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs															
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
AS2106.1	2				2												
AS2106.2							2										
AS2106.3													2				
AS2106.4														2			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course code	Course Title	Teaching Scheme				
		L	T	P	S	Credits
EE2106	Intelligent Control Systems	3	0	4		05

Course Objectives:

This course aims at introducing the fundamentals of control system analysis and design, based on fuzzy logic and artificial neural networks.

Course Outcomes:

On successful completion of this course, the students should be able to:

EE2106.1 Design, simulate and implement a controller based on fuzzy logic and/or artificial neural networks for specified requirements.

EE2106.2 Assess the advantages and disadvantages of intelligent control systems, relative to other methods

EE2106.3 Assess, troubleshoot, improve, and fully document intelligent control systems.

Assessment Scheme:

Prerequisites		
Teaching Scheme (Hours per Week)		In Class-L T P (3 0 2) 0ut Class (2)
Credits		5
Sr. No.	**Evaluation Component**	**Marks**
01	Attendance	Nil
02	Assignment	20
03	Class Participation	Nil
04	Quiz	Nil
05	Theory Exam-I	20
06	Theory Exam-II	Nil
07	Theory Exam-III	30
08	Report-I	Nil
09	Report-II	Nil
10	Report-III	Nil
11	Project-I	20
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	10
15	Lab Evaluation-II	Nil
16	Course Portfolio	Nil
17	Presentation	Nil
18	Viva	Nil
	Total (100)	**100**
Evaluation Scheme for Retest		
1	**Theory Exam-3**	**30**

Course Syllabi (Theory):

Linear control systems – Review. Classical control theory. Discrete time control systems. State space analysis. Basic concepts. Full-state feedback. Observer design. Kalman filter. Integrated full-state feedback and observer. Introduction to system identification.

Introduction to intelligent control. Foundation of fuzzy logic. Fuzzy inference systems. Fuzzy PI control. PI controller tuning with fuzzy logic. Fuzzy Takagi-Sugeno modeling and control.

Learning process. Neural Networks (NN). Perceptron model. Multi-layer perceptron. Back propagation. Dynamically driven recurrent NN. Back propagation through time.

Introduction to control system performance assessment and fault detection, based on fuzzy logic and/or artificial neural networks.

Text Book(s)/ Reference Book(s)

1. S. R. Jang, C-T. Sun, and E. Mizutani, Neuro-Fuzzy and Soft Computing, Prentice Hall, 1997
2. Kevin M. Passino and Stephen Yurkovich. Fuzzy Control. Addison-Wesley, 1997
3. Haykin, Simon (2008). "Neural Networks and Learning Machines". Third Edition. McMaster University. Hamilton, Ontario, Canada. Pearson.

IT Resources

- https://nptel.ac.in/courses/108/104/108104049/

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
EE2106.1			1	1			1								2	1	1
EE2106.2			1	2			2									2	2
EE2106.3			1	2			2		2		1	2		2	2	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course code	Course Title	Teaching Scheme				
		L	T	P	S	Credits
EE2105	Industrial Automation and IoT - II	3	0	2	-	04

Course Objectives:

This course aims at creating the fundamentals skills required to design, implement, and maintain industrial IoT systems.

Course Outcomes:

EE2105.1 Explain the key components that make up an Industrial IoT system.
EE2105.2 Discuss protocols and standards employed at each layer of the IIoT stack.
EE2105.3 Design, deploy and test a basic Industrial IoT system, including data analysis functionalities.
EE2105.4 Apply best practices to meet desired requirements for IIoT applications.
EE2105.5 Analyze the environmental effects and incorporate robustness in design of IIoT system.
EE2105.6 Choose technology for constrained nodes and network while maintaining real time data collection.
EE2105.7 Explain the importance of cybersecurity for IIoT networks.

Assessment Scheme:

Sr. No.	Evaluation Component	Marks
01	Attendance	Nil
02	Assignment	15
03	Class Participation	Nil
04	Quiz	15
05	Theory Exam-I	Nil
06	Theory Exam-II	20
07	Theory Exam-III	30
08	Report-I	Nil
09	Report-II	Nil
10	Report-III	Nil
11	Project-I	20
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	Nil
15	Lab Evaluation-II	Nil
16	Course Portfolio	Nil
17	Presentation	Nil
18	Viva	Nil
	Total (100)	**100**
Evaluation Scheme for Retest		
1	**Theory Exam-3**	**30**

Course Syllabus:

Unit 1 IIoT Fundamentals

Industrial communication: principles, protocols and technologies. IIoT definition, architectures and use cases. Convergence of IT and OT. Design methodology.

Unit 2 Interfacing sensors and actuators-

Interfacing proximity sensor, vibration sensor, color sensors. Controlling AC motor .

Unit 3 Programming with Node Red- Injecting nodes, debugging**,** managing palettes, designing dashboard.

Unit 4 Cloud services

Basic concepts. Applications: predictive maintenance, quality monitoring, personalized dashboards.

Practical work: Design and test a basic IIoT system involving prototyping, programming, and data analysis.

Textbooks:

Bahga and Madisetti (2014). "*Internet of Things: a hands-on approach*". CreateSpace Independent Publishing Platform, 1st edition. ISBN: 978-0996025515.

Hanes, Salgueiro, Grossetete, Barton and Henry (2017). "*IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things*". Cisco Press

Reference book:

Gilchrist (2016). "*Industry 4.0: The Industrial Internet of Things*". Apress.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
EE2105.1							2										
EE2105.2							2										
EE2105.3																	2
EE2105.4						2											
EE2105.5						2											
EE2105.6							2										
EE2105.7							2										

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Code and Title	Mechatronics (ME1207)
Scheme	L T P: 3 0 4
Credits	5
Students who can take	M. Tech: Semester II, Automation & Robotics B. Tech: Semester VI (open elective)

Course Objective:

To develop an understanding of basic and advanced topics of Mechatronics such as sensors and signal conditioning, actuators, microprocessor and microcontroller systems, system models, and industrial applications.

Course Outcomes:

On successful completion of this course, the students will be able to:

ME1207.1. acquire a mix of skills in mechanical engineering, electronics and computing which is necessary to comprehend and design mechatronics systems.

ME1207.2. operate and communicate across the range of engineering disciplines necessary in mechatronics.

ME1207.3. design mechatronic systems.

Prerequisites	Mathematics concepts, basic mechanical and electrical concepts.
Teaching Scheme (Hours per Week)	3 0 4
Credits	5

Sr. No.	Specifications	Marks
1	Attendance	NIL
2	Assignment	10
3	Class Participation	5
4	Quiz	10
5	Theory Exam-I	NIL
6	Theory Exam-II	10
7	Theory Exam-III	30
8	Report-I	NIL
9	Report-II	NIL
10	Report-III	NIL
11	Project-I	15
12	Project-II	NIL
13	Project-III	NIL
14	Lab Evaluation-I (Continuous)	10
15	Lab Evaluation-II (Examination)	10
16	Course Portfolio	NIL
17	Presentation	NIL
18	Viva	NIL
	Total	**100**

Retest Scheme:

1	Theory Exam-III	30
2	Lab Evaluation-II (Examination)	10
	Total	**40**

COURSE SYLLABUS (Theory)

UNIT I: Introduction

Introduction to Mechatronics system, key elements, Mechatronics Design process, Design Parameters, Traditional and Mechatronics designs, Advanced approaches in Mechatronics, Industrial design ergonomics and safety.

UNIT II: Sensors and Actuators

Sensor and transducers, digital logic, signal processing devices, relays, contactors and timers. Actuation systems, pneumatic and hydraulic system, control valves, cylinders, rotary actuators, mechanical systems, drives, bearings, electrical systems, electrical and mechanical switches, solenoids, motors, signal conditioning, filtering, power transfer, digital signals, A-D and D-A converters.

Unit III: Microprocessor

Microprocessor, microcontroller, programming, application examples, interfacing and applications, PLC, ladder programming, timers and counters, PLC system.

Unit IV: System Models and Micro Mechatronic System

System Models
Mathematical models, building blocks for mechanical systems, electrical systems, fluid systems, thermal systems, description of PID controllers.

Micro Mechatronic System
Introduction, System principle, Component design, System design, Scaling laws, Micro actuation, Micro robot, Micro pump, Applications of micro mechatronic components.

Unit V: Case Studies

Introduction, Fuzzy based washing machine, Motion control using DC Motor & Solenoids, Engine management systems, controlling temperature of a hot/cold reservoir using PID, Control of pick and place robot.

COURSE SYLLABUS (Laboratory)

1. Responses of First and Second Order Mechanical Systems
2. Basics of Frequency Domain Signal Analysis
3. Frequency Response of Mechanical Systems
4. Time-Frequency Analysis of Mechanical Systems
5. Gearbox Fault Detection
6. Pump Impeller Fault Detection
7. Vibration Monitoring of Machineries by Wireless Technique
8. Electrical Motor Fault Detection by MCSA

Exp. No. 1 to 8: http://vlabs.iitkgp.ernet.in/mssp/#

9. Identification and familiarisation of the following components: resistors, inductors, capacitors, diodes, transistors, LED's.
10. Familiarization with the following components: CRO, transformer, function generator, multimeter, power supply.
11. Familiarization with the following electrical machines: Induction motors, DC motors, synchronous motors, single phase motors.
12. Familiarization with the following mechanical components: gears, gear train, bearings, couplings, tachometer.
13. Implementation Logic Gates
14. Implementation of PID Controller

Exp. 13 and 14: http://plc-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering

15. Case study: modeling and control of combustion engines.
16. A case study: automotive transmission as a "gear reducer".

BOOKS

1. David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw-Hill Education.
2. William Bolton, "Mechatronics electronic control systems in mechanical and electrical engineering", Pearson Education Limited.
3. Paul P. L. Regtien, "Sensors for Mechatronics", Elsevier.
4. Dean C. Karnopp, Donald L. Margolis, Ronald C. Rosenberg, "System Dynamics: Modeling, Simulation, and Control of Mechatronic Systems", John Wiley & Sons, Inc.

ONLINE COURSES

1. https://onlinecourses.nptel.ac.in/noc21_me27/preview
2. https://www.edx.org/course/mechatronics
3. https://www.coursera.org/specializations/embedding-sensors-motors

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
ME1207.1	1				1			1			1					1	
ME1207.2		1	2		1			1		1		1					2
ME1207.3						1		1	2	1		1					

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code	Project-II (PR2102)
Hours per Week	L-T-P: 2-0-0
Credits	2
Students who can take	M.Tech Semester-II

Course Objective:

This course is aimed at introducing the primary important concepts of project related to Health Safety and environment in realistic manner. Students will also get familiar with the different activities involved in Project work. Further, they will also come to know how to successfully plan and implement the project activity, and to complete a specific project in time with the available resources.

After course completion, the student will be able to:

PR2102.1 Apply relevant tools and be able to find data to estimate parameters.
PR2102.2 Identify and describe the key phases of project work.
PR2102.3 Carry out an independent limited research and development projects.
PR2102.4 Analyze the estimated parameters and assess the validity of the results.
PR2102.5 Communicate about technical issues, analysis and conclusions in the field.

S. No	Specifications	Marks
01	Attendance	NIL
02	Assignment	NIL
03	Class Participation	NIL
04	Quiz	NIL
05	Theory Exam	NIL
06	Theory Exam	NIL
07	Theory Exam(Final)	NIL
08	Report-1 (Synopsis)	10
09	Report-2 (Final report)	20
10	Report-3	NIL
11	Project -1 (Day to Day work)	30
12	Project -2	40
13	Project -3	NIL
14	Lab Evaluation – I	NIL
15	Lab Evaluation – II	NIL
16	Course portfolio	NIL
	Total (100)	**100**
Retest		
01	Project-I	40

Syllabus:

Course content will vary depending upon the actual project chosen by the supervisor. All graduate research topics do include a literature search and writing of a scientific report. The course offers a detailed project description that includes the problem, specified academic training and milestones and a list of background literature. Some but not all students will perform independent practical research and/or theoretical calculations in the chosen topic.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
PR2102.1						1					1						1

PR2102.2								1							1		
PR2102.3																	
PR2102.4																1	
PR2102.5									1			1					

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code	Critical Thinking for Problem Solving and Decisions (CC2121)
Hours per Week	L T P: 2 0 0
Credits	2
Students who can take	M. Tech Sem 2

Course Objective

In today's world, the idea of right and wrong is being challenged by businesses, use of technology, economic conditions, and norms of societies. The relevance of a well-reasoned decision is crucial. This course intends to make students take better decisions keeping in mind purpose, context, and ethics.

Course Outcomes

On successful completion of this course, the students should be able to:

CC2121.1 Describe how to think critically and solve problems.

CC2121.2 Apply advocacy and enquiry to analyze organizational problems.

CC2121.3 Improve critical thinking and questioning skills.

CC2121.4 Analyze the context and information to identify a problem.

CC2121.5 Make use of problem-solving methods and tools.

Evaluation Scheme

Sr. No	Specifications	Marks
1	Attendance	NIL
2	Assignment	40
3	Class Participation	20
4	Quiz	NIL
5	Theory Exam-I	NIL
6	Theory Exam-II	NIL
7	Theory Exam-III	20
8	Report-I	NIL
9	Report-II	NIL
10	Report-III	NIL
11	Project-I	NIL
12	Project-II	NIL
13	Project-III	NIL
14	Lab Evaluation-I	NIL
15	Lab Evaluation-II	NIL
16	Course Portfolio	NIL
17	Presentation	NIL
18	Viva	20
Total (100)		**100**

Evaluation scheme for Re-test

Sr. No	Specifications	Marks
1	Theory Exam (Re-test)	30
Total (30)		**30**

COURSE SYLLABUS:

-Definition and Type of Decision Making

-Decision-Making Processes

-Ethical approaches and Decisions

-The significance of purpose and context

-Techniques for problem analysis

-Techniques for Decision Implementation

-Obstacles to Sound Reasoning

-Examining alternate solutions

Readings/Video(s)

1. Lehrer, J. (2010). How we decide. Houghton Mifflin Harcourt.

2. Heath, C., & Heath, D. (2013). Decisive: How to make better choices in life and work. Random House.

3. Hammond, J. S., Keeney, R. L., & Raiffa, H. (2015). Smart choices: A practical guide to making better decisions. Harvard Business Review Press.

4. Cases and scenario will be shared in the class

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
CC2121.1	1										2		2				
CC2121.2	2					1		2					1				
CC2121.3									1		1	2	1				
CC2121.4							1	2				2					

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course code	Course Title	Teaching Scheme				
		L	T	P	S	Credits
EE1220	**Electric Vehicle Technology** Open Elective (BTech VI Sem. and MTech II Sem.)	3	1	0	0	04

Course Objectives:

This course will prepare students to provide a comprehensive knowledge of technology behind electric cars. This course will also enable students to battery pack construction and battery technology, EV charging, and about future trends in the development of electric cars.

Course Outcomes:

On successful completion of this course, the students should be able to:

EE1220.1 Identify and describe the history and evolvement of electric & hybrid electric vehicles to emphasize on the need, and importance of EV/HEV for sustainable future.

EE1220.2 Analyze the drive train configurations of electric drive vehicles.

EE1220.3 Apply the design methodologies and control strategy on hybrid electric vehicles

EE1220.4 Calculate the required motor rating, and battery pack for different type of E-Vehicles to operate in different conditions.

EE1220.5 Realize battery charger topologies for electric vehicles

Assessment Scheme:

Prerequisites		
Teaching Scheme (Hours per Week)		In Class-L T P (3 1 0)
Credits		4
Sr. No.	**Evaluation Component**	**Marks**
01	Attendance	Nil
02	Assignment	15
03	Class Participation	10
04	Quiz	15
05	Theory Exam-I	Nil
06	Theory Exam-II	15
07	Theory Exam-III	30
08	Report-I	10
09	Report-II	Nil
10	Report-III	Nil
11	Project-I	Nil
12	Project-II	Nil
13	Project-III	Nil
14	Lab Evaluation-I	Nil
15	Lab Evaluation-II	Nil
16	Course Portfolio	Nil
17	Presentation	05
18	Viva	Nil

	Total (100)	**100**
Evaluation Scheme for Retest		
1	**Theory Exam-3**	**30**

Syllabus (Theory):

UNIT-I Introduction: Basics of vehicles mechanisms, history of electric vehicles (EV) and hybrid electric vehicles (HEV), need and importance of EV and HEV, Power/Energy supplies requirements for EV/HEV applications, vehicle power source characterization, and transmission characteristics

UNIT II: Electric Vehicle Modelling – Consideration of Rolling Resistance, Transmission Efficiency, Consideration of Vehicle Mass, Tractive Effort, Modelling Vehicle Acceleration, Modelling Electric Vehicle Range, EV Motor Sizing, Energy Consumption. General Issues in Design.

UNIT-III Battery Technology for EVs: Types of Battery and Classification, Commercially available lithium ion cells, Li ion cell Parameters: : Capacity, C-rate, impedance, DOD, SOC, SOH, Life cycles, Mechanical characteristics, Form factor, Battery Management System, Safety, Battery modules and complete battery pack system.

UNIT-IV Charging Infrastructure : Introduction to EV Charging technology , Onboard charging and Off-board charging, AC charging vs DC charging , AC charging – Type-1/2/3, DC charging - Chademo, Tesla, CCS, Electric Vehicle Supply Equipment.

UNIT-V Future Electric Mobility: Energy Management Strategies: V2G, G2V, V2B, V2H, Future Trends in Electric Cars, Wireless Charging of EVs, Battery Swap Technology, Charging EVs From Renewables, Govt. Policies and Regulations.

Activity:

- Design a battery pack using Lithium-Ion batteries
- Design Electric Motor and Lithium Battery Capacity of Electrical Bike.

Text Books/ Reference Books:

- Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003.
- Husain, I. "Electric and Hybrid Vehicles" Boca Raton, CRC Press, 2010.
- Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012.
- Tariq Muneer and Irene Illescas García, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, 2017.
- Electric Vehicle Battery Systems – Sandeep Dhameja – Newnes – New Delhi – 2002.

Online Resources:

- E-materials available at the website of NPTEL- http://nptel.ac.in/
- MATLAB (Trial version): Software is useful for simulation and analysis of electrical systems

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
EE1220.1	1	2						1		1				1		1	1

EE1220.2					1	2						1			2	2
EE1220.3		1			1	1	2					1			2	2
EE1220.4					1		2	1				2		1	2	2
EE1220.5	1	2						2	2			2			2	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code	**Internship (PS2101)**
Total Duration	6-8 Weeks
Credits	04
Students who can take	M.Tech Semester-III

Course Objective:
The purpose of the internship is to give students the opportunity to develop an understanding of their profession in a professional context.

After course completion, the student will be able to:

PS2101.1 Identify skills and capabilities that intersect effectively with the needs of industry.
PS2101.2 Apply and practice good communication skills in the workplace setting.
PS2101.3 Reflect and evaluate on experiences that might lead to future employment.

Evaluation Scheme:

Supervisor Evaluation	**Evaluation Component**	**Marks**
External Supervisor	Day to Day task Record, External supervisor feedback form	50
Faculty Supervisor	Reporting Activity Fortnightly, Presentation &Viva	30
	Report	20
	Total	**100**

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
PS2102.1	2		2		3	3	1	3			3			1		2	2
PS2102.2		2			2						2		3			2	2
PS2103.3	2		2	2	2	2	2				3	3			1		2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code	Industrial Project-I (PR2104)	
Hours per Week	Minimum 20 hrs. Per week for full semester.	
Credits	10	
Students who can take	M.Tech Semester-III	

Course Objective:

The purpose of the Industrial Project-I is to give students the opportunity to develop an understanding of their profession in a professional context. They will prepare a research, development, or other type of engineering project with the guidance of an industrial and academic supervisors.

Course outcome

After course completion, the student will be able to:

PR2104.1 Identify skills and capabilities that intersect effectively with the needs of industry.
PR2104.2 Apply and practice good communication skills in the workplace setting.
PR2104.3 Reflect and evaluate on experiences that might lead to future employment.
PR2104.4 Report research findings in written and verbal forms.
PR2104.5 Demonstrate and apply industry observation/research skills to complete a project.

Evaluation Scheme: Weightages of different evaluation components

Mid-Term

Expert Evaluation	Evaluation Component	Marks
Panel of Examiner	Synopsis	15
Panel of Examiner	Report Content & Presentation	15
Internal Mentor	Reporting Activity Fortnightly	10
Industry Expert	Industry Expert Feedback	15
M.Tech Coordinator	M.Tech Coordinator Feedback	5
	Total	**60**

Final Term

Industry Expert	Industry Feedback	50
Internal Mentor	Reporting Activity Fortnightly	20
Panel of Examiner	Presentation, Report, Viva	60
M.Tech Coordinator	M.Tech Coordinator Feedback	10
	Total	**140**
	Total (Mid-term Final Term)	**200**

Syllabus:

Dissertation-I/ Industrial Project-I/ Entrepreneurial Project-I, Research and development projects based on problems of practical and theoretical interest. Students may choose a project based on any subject of Automation & Robotics. The student will submit a synopsis at the beginning of the semester for approval from the departmental committee in a specified format. Evaluation will be based on student seminars, written reports, and evaluation of the developed system and/or theories.

Operation Procedure

- Student has to devote full semester for Dissertation-I/ Industrial Project-I/ Entrepreneurial Project-I.
- Student has to report to the Supervisor regularly.
- Seminars evaluation has to be carried out in the presence of a two-member Committee comprising.
- Experts in the relevant area constituted by the Supervisor.
- Final Dissertation-I/ Industrial Project-I/ Entrepreneurial Project-I Report to be submitted has to be in formal hard bound cover bearing of the Institute emblem.

Reference Books and Tools:

Based on literature survey to be done with peer reviewed journals and magazines and relevant tools required to build the project.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs															
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
PR2104.1	2		2		3	3	1	3			3			1		2	
PR2104.2		2		2	2						2		3				
PR2104.3	2		2	3	2	2	2				3	3				2	
PR2104.4		3		3	3		1				2		2	3	2		2
PR2104.5	2				3	2					3			3	3		2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Course Code	**Computational Game Theory and Applications (EE2202)**
Hours per Week	L T P: 3 0 0
Credits	4
Students who can take	M. Tech Semester-III A&R

Course Objective

The course focuses on areas of game theory that are relevant for engineering applications. The emphasis is both on theoretical principles and on the application of the theory to problem formulation and problem solving. The course covers a wide range of topics, from different models of non-cooperative games and related equilibrium concepts, to cooperative games.

Course Outcomes

On successful completion of this course, the students will be able to:

EE2202.1 Explain the key concepts of preferences, utility, and decision-making under certainty and uncertainty.

EE2202.2 Apply the key models and solution concepts of non-cooperative game theory, including both strategic form and extensive form games.

EE2202.3 Evaluate the importance of competitive and cooperative factors in a variety of decision problems.

EE2202.4 Analyse the key models and solution concepts of cooperative game theory, including TU and NTU games.

EE2202.5 Analyze games with imperfect and incomplete information.

Sr. No	Specifications	Marks
1	Attendance	NIL
2	Assignment	15
3	Class Participation	05
4	Quiz	10
5	Theory Exam-I	NIL
6	Theory Exam-II	15
7	Theory Exam-III	30
8	Report-I (case study)	NIL
9	Report-II	NIL
10	Report-III	NIL
11	Project-I	15
12	Project-II	NIL
13	Project-III	NIL
14	Lab Evaluation-I (Continuous)	NIL
15	Lab Evaluation-II (Exam)	NIL
16	Course Portfolio	10
Total (100)		**100**

Evaluation Scheme for Retest:

S. No.	Specifications	Marks
1	Theory Exam-III (End Term)	30
3	**Total**	**30**

Syllabus:

Unit-1: Introduction

Introduction to game theory, routing games and mechanism design; Strategies, costs, and payoffs; Prisoner's dilemma, Nash Equilibrium, Strategic games; Best response; Dominant strategies; Pure strategy v/s Mixed strategy.

Unit-2: Preferences, Utility, and Goals

Preference relations and their interpretation, utility as a numeric model of preference, Decision-making under uncertainty: preferences over lotteries; Von Neumann and Morgenstern utility functions; expected utility and expected utility maximisation, Paradoxes of expected utility maximisation; framing effects and prospect theory.

Unit-3: Bayesian Games

Definition of a Bayesian Game and Bayesian Nash Equilibrium, Games with incomplete information, Bayesian-Nash equilibrium, Perfect Bayesian equilibrium, Refinements of PBE, Applications to spence job-market signaling game, oligopoly games with asymmetric information etc.

Unit-4: Cooperative and Non-Cooperative Games

Noncooperative Game Theory: Strategic form games, existence of Nash equilibrium, computation of Nash equilibrium, matrix games, minimax theorem, extensive form games.

Cooperative Game Theory: Correlated equilibrium, two person bargaining problem, coalitional games, core, shapley value and its implications, Transferable utility (TU) and nontransferable utility (NTU) games.

Unit-5: Engineering Applications

Game theory based control approach for smart grid operation, power control schemes, reactive power management, demand side management, electric vehicle charging, storage management, electricity pricing etc.

MOOC Course Link:

https://www.coursera.org/learn/game-theory-1?action=enroll&courseSlug=game-theory-1&showOnboardingModal=check

https://online.stanford.edu/courses/soe-ycs0002-game-theory

Reference Books:

1. Dutta, Prajit K., "Strategies and Games : Theory and Practice" MIT Press.
2. Vladimir Mazalov, "Mathematical Game Theory and Applications" John Wiley & Sons, Ltd.
3. Ken Binmore, "Playing for Real: A Text on Game Theory" Oxford University Press.
4. Erich Prisner, "Game Theory Through Examples" The Mathematical Association of America.
5. Steven Tadelis, "Game Theory: An Introduction" Princeton University Press.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
EE2202.1	2		1		2	1	1				1	1	1	1			
EE2202.2		1		1	1	1	1	1								1	
EE2202.3	1	1			2	2	1	1	1		1						1
EE2202.4					1		1	1	2		2		1				
EE2202.5	1		1	1	1	1	1		1		1	1					1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Course Code	**Industrial Robotics (IL2203)**
Hours per Week	L T P: 3 0 2
Credits	4
Students who can take	B. Tech (VII Sem) and M. Tech (III Sem.)

Course Objective:

To provide understanding of robots and manipulators in different fields of application, also to synthesis planar and spatial manipulator and its control strategy. The course builds upon the foundations of Design and Prototyping, Fundamentals of Automation Engineering and Calculus and Applied Mechanics.

Learning Outcomes:

On successful completion of this course, the students will be able to:

IL2203.1 identify the use of robots and its application in industry and everyday life and analyze kinematic parameters of different robots.

IL2203.2 analyze dynamic parameters of robots and method to improve its performance including energy requirements.

IL2203.3 develop open and close loop control system for a manipulator.

IL2203.4 perform trajectory planning for a manipulator.

Sr. No	Specifications	Marks
1	Attendance	NIL
2	Assignment	10
3	Class Participation	NIL
4	Quiz	20
5	Theory Exam-I	10
6	Theory Exam-II	NIL
7	Theory Exam-III	20
8	Report-I	NIL
9	Report-II	NIL
10	Report-III	NIL
11	Project-I	20
12	Project-II	NIL
13	Project-III	NIL
14	Lab Evaluation-I (Continuous)	10
15	Lab Evaluation-II (Exam)	10
16	Course Portfolio	NIL
Total (100)		**100**

Evaluation Scheme for Re-Test	
Lab Evaluation-II (Exam)	10
Theory Exam-III	20
Total (30)	30

COURSE SYLLABUS (Theory):

UNIT - I
Introduction:
Robotics trends and the future. Introduction: serial robot, parallel robot, exoskeleton, mobile robot, under water robot, flexible & space robot. Robot anatomy: links, joints and joint notation scheme, Degrees of Freedom (DOF), required DOF in a manipulator, arm configuration, wrist configuration; end-effector, human arm characteristics, design & control issues, manipulation & Control, robotics sensors, robot specification, different robot programming platform.

UNIT - II
Robot Motion Analysis:
Introduction to co-ordinate frames mapping, mapping between rotated frames, mapping between translated frames, description of objects in space, transformation of vectors - rotation & translation of vectors, composite transformations, inverting a homogeneous transform, fundamental rotation matrices – principle axes rotation fixed, Euler and equivalent angle axis representations.
Kinematics Manipulators:
The kinematic modeling of manipulator, direct kinematics, Denavit – Hartenberg notation, kinematic relationship between links, manipulator transformation matrix, the inverse kinematics manipulator: workspace, solvability of inverse kinematic model, singularities of manipulators.

UNIT – III
Differential Motion, Statics:
Linear and angular velocity of a rigid body, relationship between transformation matrix and angular velocity, mapping velocity vectors, velocity propagation along links. manipulator Jacobian, Jacobian inverse, Jacobian singularities, static analysis. Jacobian in statics.

UNIT – IV
Dynamics:
Introduction, Lagrangian mechanics, Lagrange – Euler formulation, velocity of a point on the manipulator, the inertia tensor, the kinetic energy, the potential energy. equations of motions, the Lagrangian-Euler (LE) dynamic model algorithm. Introduction to robot control, Open loop, close loop system, and differential equation, control of movements of mechanical joints.

UNIT – V
Trajectory Planning
Definition and planning tasks, joint space techniques, Cartesian space techniques, joint space versus Cartesian space tp. Introduction to machine vision.

COURSE SYLLABUS (Practical):

1. To determine the forward kinematic of a 1-DOF robot using virtual platform
2. To determine the forward kinematic of a 3-DOF robot using virtual platform
3. To determine the forward kinematic of a 6-DOF robot using virtual platform
4. To determine the inverse kinematic of a 1-DOF robot using virtual platform
5. To determine the inverse kinematic of a 3-DOF robot using virtual platform
6. To determine the forward dynamic of a 3-DOF robot using virtual platform
7. To determine the inverse dynamics of a 3-DOF robot using virtual platform

8. To determine the trajectory control of a 3-DOF robot using virtual platform
9. To determine the trajectory control of a 6-DOF robot using virtual platform
10. To write a MATLAB program to interface camera for data acquisition.
11. To write a MATLAB program to determine pattern in an image.

Lab software Link:

1. http://www.roboanalyzer.com/
2. https://cyberbotics.com/doc/guide/puma
3. https://www.autodesk.com/education/edu-software/overview?sorting=featured&page=1

Virtual Lab link

1. Mechanisms and Robotics Lab: http://vlabs.iitkgp.ac.in/mr/

Text Books:

1. Saha, Subir Kumar. Introduction to robotics. Tata McGraw-Hill Education, 2014.
2. Mittal, R. K., and I. J. Nagrath. Robotics and control. Tata McGraw-Hill, 2003.
3. Fu, King Sun, Ralph Gonzalez, and CS George Lee. Robotics: Control Sensing. Vis. Tata McGraw- Hill Education, 1987.
4. Craig, John J. Introduction to robotics: mechanics and control, 3/E. Pearson Education India, 2009.
5. Waldron, Kenneth J., Gary L. Kinzel, and Sunil K. Agrawal. Kinematics, dynamics, and design of machinery. John Wiley & Sons, 2016.
6. Groover, Mikell P., Mitchell Weiss, and Roger N. Nagel. Industrial robotics: technology, programming and application. McGraw-Hill Higher Education, 1986.
7. Schilling, Robert J. Fundamentals of robotics: analysis and control. Vol. 629. New Jersey: Prentice Hall, 1990.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs																
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
IL2203.1	2				2			2						1	1	1	1
IL2203.2	2				1											1	1
IL2203.3	3				2		2	2						1	1	1	1
IL2203.4	2				1											1	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Title and Code	**Industrial Project-II (PR2107)**
Hours per Week	Minimum 20 hrs. Per week for full semester.
Credits	16
Students who can take	M.Tech Semester-IV

Course Objective:
The purpose of the Industrial Project-II is to give students the opportunity to develop an understanding of their profession in a professional context. They will prepare a research, development, or other type of engineering project with the guidance of an industrial and academic supervisors.

Course outcome
After course completion, the student will be able to:
PR2107.1 Identify skills and capabilities that intersect effectively with the needs of industry.
PR2107.2 Apply and practice good communication skills in the workplace setting.
PR2107.3 Reflect and evaluate on experiences that might lead to future employment.
PR2107.4 Report research findings in written and verbal forms.
PR2107.5 Demonstrate and apply industry observation/research skills to complete a project.

Evaluation Scheme: Weightages of different evaluation components

Mid-Term		
Expert Evaluation	**Evaluation Component**	**Marks**
Panel of Examiner	Synopsis	15
Panel of Examiner	Report Content & Presentation	15
Internal Mentor	Reporting Activity Fortnightly	10
Industry Expert	Industry Expert Feedback	15
M.Tech Coordinator	M.Tech Coordinator Feedback	5
	Total	**60**
Final Term		
Industry Expert	Industry Feedback	50
Internal Mentor	Reporting Activity Fortnightly	20
Panel of Examiner	Presentation, Report, Viva	60
M.Tech Coordinator	M.Tech Coordinator Feedback	10
	Total	**140**
	Total (Mid-term Final Term)	**200**

Course Syllabi:

Dissertation-II/Industrial Project-II/Entrepreneurial Project-II - The students who work on a project are expected to work towards the goals and milestones set in Dissertation-II / Industrial Project-II/ Entrepreneurial Project-II. The problem can be extension of Dissertation-I/ Industrial Project-I /Entrepreneurial Project-I or a new problem. The student will submit a synopsis at the beginning of the semester for approval from the departmental committee in a specified format. At the end there would be a demonstration of the solution and possible future work on the same problem. The student will have to present the progress of the work through seminars and progress reports.

Operation Procedure

- Student has to devote full semester for Dissertation/Industrial Project/Entrepreneurial Project.
- Student has to report to the Supervisor regularly.
- Dissertation-II/ Industrial Project-II/Entrepreneurial Project-II evaluation has to be carried out in the presence of a two member Committee comprising.
- Experts in the relevant area constituted by the Supervisor.
- Final Seminar Report to be submitted has to be in formal hard bound cover bearing of the Institute emblem.

Reference Books and Tools:

Based on literature survey to be done with peer reviewed journals and magazines and relevant tools required to build the project.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

COs	Correlation with POs and PSOs															
	PO 1	PO 2a	PO 2b	PO 2c	PO 3a	PO 3b	PO 3c	PO 4a	PO 4b	PO 4c	PO 5a	PO 5b	PO 6	PO 7a	PO 7b	PSO 1	PSO 2
PR2107.1	2		2		3	3	1	3			3			1		3	
PR2107.2		2			2						2		3				2
PR2107.3	2		2	2	2	2	2				3	3					
PR2107.4		3		3	3		1				2		2	3	2		
PR2107.5	2			3	3	2					3			3	3	2	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Program Articulation Matrix (MTech-A&R) Batch 2021-2023

S. No.	Course Code	Course Title	Credit	Year	Semester	Target Student Groups	PO1	PO2a	PO2b	PO2c	PO3a	PO3b	PO3c	PO4a	PO4b	PO4c	PO5a	PO5b	PO6	PO7a	PO7b	PSO1	PSO2
1	**AS2106**	Statistical Data Analysis	5	5	1	M.Tech A&R	1.25	0.50	0.25	0.00	1.75	0.00	0.75	0.75	0.00	1.50	0.00	0.00	0.75	0.00	0.00	0.00	1.75
2	**EE2101**	Industrial Automation and Internet of Things-I	4	5	1	M.Tech A&R	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.00	0.25	0.25	0.25	0.25	0.00	0.25	0.25
3	**CS2103**	Robotic Process Automation and Applications	5	5	1	M.Tech A&R	0.50	0.33	0.33	0.00	0.67	0.17	0.33	0.33	0.00	0.50	0.33	0.00	0.50	0.83	0.00	2.33	2.83
4	**PR2101**	Project-I	2	5	1	M.Tech A&R	0.40	0.00	0.20	0.00	0.40	0.60	0.40	0.60	0.60	0.80	0.60	0.60	0.00	0.20	0.20	0.00	0.00
5	**CC2171**	Critical Thinking for Developing Perspectives	2	5	1	M.Tech A&R	2.00	0.00	0.60	0.20	0.00	0.00	0.40	1.00	0.20	0.20	0.40	0.00	0.20	0.00	0.20	0.00	0.00
6	**EE2102**	Instrumentation and Embedded System Laboratory	2	5	1	M.Tech A&R	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.75	0.50	0.25	0.00	0.00	0.00	0.00	0.00	2.00	2.00
7	**EE2104**	Optimisation and Control	4	5	1	M.Tech A&R	0.00	0.00	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50
8	**EE2105**	Industrial Automation and Internet of Things-II	4	5	2	M.Tech A&R	0.00	0.00	0.00	0.00	0.00	0.57	1.14	0.00	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29
9	**EE1220**	Electric Vehicle Technology	4	5	2	M.Tech A&R	0.25	0.00	0.00	0.00	0.50	0.00	0.25	0.00	0.50	0.25	0.00	0.25	0.00	0.25	0.25	1.25	1.25
10	**PR2102**	Project-II	2	5	2	M.Tech A&R	1.20	0.20	0.40	0.00	1.20	0.40	0.20	0.00	0.00	0.60	1.00	0.00	0.40	0.20	0.00	0.20	1.00
11	**CC2121**	Critical Thinking for Problem Solving and Decisions	2	5	2	M.Tech A&R	0.75	0.00	0.00	0.00	0.00	0.25	0.25	1.00	0.25	0.00	0.75	1.00	1.00	0.00	0.00	0.00	0.00
12	**EE2106**	Intelligent Control System	5	5	2	M.Tech A&R	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.33	0.33	0.33	0.00	0.00	0.00	0.33
13	**ME1207**	Mechatronics	5	5	2	M.Tech A&R	0.33	0.33	0.67	0.00	0.67	0.33	0.00	1.00	0.67	0.67	0.33	0.67	0.00	0.00	0.00	0.33	0.67
14	**PS2101**	Internship	4	5	3	M.Tech A&R	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
15	**PR2104**	Industrial Project-I	10	6	3	M.Tech A&R	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
16	-	DE	4	6	3	M.Tech A&R	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
17	-	DE	4	6	3	M.Tech A&R	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
18	**PR2107**	Industrial Project-II	16	6	4	M.Tech A&R	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
						Total	**6.9**	**1.6**	**2.7**	**0.5**	**6.4**	**3.6**	**6.5**	**6.0**	**4.1**	**4.8**	**4.0**	**3.1**	**3.4**	**1.7**	**0.7**	**6.9**	**10.9**
						Program Articulation	C	N	AB	AB	C	AB	AB	AB	AB	AB	C	AB	AB	AB	N	C	C
						Expectation	C	N	N/AB	N	C	AB	AB	AB	AB	N	AB	AB	AB	AB	N	C	C

Nomenclature	Description	Sum (PG)
Novice (N)	Knows objective facts, features, and rules for determining actions with respect to this PO/PSO without being context-sensitive. Has studied the basic concepts.	(sum<5)
Advanced beginner (AB)	Recognizes common situations with respect to this PO/PSO that help in recalling which rules should be exercised, starts to recognize and handle situations not covered by given facts, features and rules. Has problem solving and repeated practice experience for common situations with respect to this PO/PSO.	(5<=sum<10)
Competent (C)	Performs most standard actions with respect to this PO/PSO without conscious application of rules after considering the whole situation. Handles new situations through the appropriate application of rules, can design systems. May lead. Has demonstrated this PO/PSO through repeated engagements in advanced problem solving, projects, extensive practice in common and exception situations, and participated in professional networks.	(sum>=10)