FUNDAMENTALS OF ROBOTICS & APPLICATIONS		Semester	III
Course Code	**BRI301**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

COURSE OVERVIEW:

Robotics is an interdisciplinary branch of electronic engineering and mechanical engineering. Robotics involves design, construction, operation, and use of robots. The goal of robotics is to design machines that can help and assist humans. Robotics integrates fields of mechanical engineering, electrical engineering, information engineering, mechatronics, electronics, bioengineering, computer engineering, control engineering, software engineering, mathematics, etc.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand and discuss the fundamental elementary concepts of Robotics.
2. Provide insight into different types of robots.
3. Explain intelligent module for robotic motion control.
4. Educate on applications of robots in various sectors.
5. Illustrate the applications of robots in industries.

Teaching-Learning Process (General Instructions)

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

1. The lecturer's approach (L) does not have to be limited to traditional methods of teaching. It is possible to incorporate alternative and effective teaching methods to achieve the desired outcomes.
2. Utilize videos and animations to illustrate the functioning of different techniques used in the manufacturing of smart materials.
3. Foster collaborative learning exercises within the classroom to encourage group participation and engagement.
4. Pose a minimum of three Higher Order Thinking (HOT) questions during class discussions to stimulate critical thinking among students.
5. Implement Problem-Based Learning (PBL) as an approach that enhances students' analytical skills and nurtures their ability to design, evaluate, generalize, and analyze information, rather than solely relying on rote memorization.

Module-1

INTRODUCTION TO ROBOTICS: 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.

Module-2
ROBOT ANATOMY AND MOTION ANALYSIS: 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, transformations and rotation matrix.
Module-3
ROBOT DRIVES AND END EFFECTORS: Robot drive systems: Hydraulic, Pneumatic and Electric drive systems, classification of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive gripper, gripper force analysis and gripper design, 1 DoF, 2 DoF, multiple degrees of freedom robot hand, tools as end effectors, Robot control types: limited sequence control, point-to-point control, playback with continuous path control, and intelligent control.
Module-4
Application of Robot: aerial robots helicopters, Multi rotor UAV, Flapping wing/Bio inspired UAV, wheeled mobile robots, swarm robots, Legged robots, medical/healthcare robots , Rehabilitation robot, hospital robot, space robots, service robots, Underwater and floating robots, Military Robots.
Module-5
ROBOTICS APPLICATIONS: pick and place, palletizing and depalletizing, machining loading and unloading, welding & assembly, Medical, agricultural and space applications, unmanned vehicles: ground, robotic for computer integrated manufacturing, Industrial robots, Humanoids, Cobots, Autonomous robots

Course Outcomes (COs) (Course Skill Set)

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

1. Understand the significance, social impact and future prospects of robotics and automationin various engineering applications.
2. Identify and describe the components and anatomy of robotic system.
3. Know about various path planning techniques and analyze different motions of roboticssystem
4. Use the suitable drives and end-effectors for a given robotics application.
5. Apply robotics concept to automate the monotonous and hazardous tasks and categorizevarious types of robots based on the design and applications in real world scenarios.

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:

- For the Assignment component of the CIE, there are 25 marks and for the InternalAssessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and thesecond test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-basedthen only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and othermethods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom'staxonomy as per the outcome defined for the course.

Semester-End Examination (SEE):

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

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

Suggested Learning Resources:

TEXT BOOKS:

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education,2009.
2. Mikell P. Groover et. al., "Industrial Robots - Technology, Programming andApplications", McGraw Hill, Special Edition, (2012).
3. Ganesh S Hegde, "A textbook on Industrial Robotics", University science press, 3rdedition, 2017.

REFERENCE BOOKS:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – AnIntegrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. 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.
3. https://www.asme.org/engineering-topics/articles/bioengineering/top-6robotic- applications-in-medicine.

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-and- automation
- https://www.academia.edu/20361073/Web_Based_Control_and_Robotics_Education_pdf
- https://github.com/Developer-Y/cs-video-courses
- https://www.isa.org/

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

- Adaptation of Content from Different Disciplines
- Constructivist Approaches to Learning
- Situated Learning Methodology
- Flipped Classroom
- Gamification
- Online Interactive Tools
- Collaborative and Individual Project-Based Assessment
- Quizzes/Assignment, etc.

Manufacturing Technology for Robots		Semester	III
Course Code	**BRI302**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course overview:

This course explores key manufacturing techniques and technologies essential for building robots. Topics include precision machining, 3D printing, materials selection, and assembly processes. Students will gain hands-on experience in designing and fabricating robot components, fostering a comprehensive understanding of manufacturing in the field of robotics.

Course Learning Objectives (CLOs)

The course will enable the students to:

1. Develop an understanding of the materials used in robotic component fabrication and their properties.
2. Introduce students to different methods of fabrication used in the manufacturing of roboticcomponents.
3. Familiarize students with traditional manufacturing processes commonly employed in the roboticsindustry.
4. Provide an overview of additive manufacturing techniques and their applications in robotics.
5. Introduce students to CNC programming and machining for precise fabrication of robotic components.

Teaching-Learning Process (General Instructions)

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

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

Module-1

Materials for Robotic Components: Material Selection for Robotic Components, Introduction to materials used in robotics (metals, polymers and composites), Material properties and their significance in robotic component design, Factors influencing material selection for specific applications.

Metal Alloys and Composites: Overview of commonly used metal alloys in robotics, Properties and advantages of composite materials, Application areas and considerations for using composites in robotic components, Polymers and Elastomers, Properties and characteristics of polymers and elastomers, Use of polymers and elastomers in robotic component fabrication, Selection criteria and limitations of polymer-based materials.

Module-2

Introduction to Manufacturing Process: Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Casting: Introduction to Casting process &steps involved. Various components produced by casting process, Advantages & Limitations. Patterns: Definition and types. Sand Moulding: Binders and Additives: Definition, Need and Types. Types of base sand, requirements of base sand. Types of Sand Moulding. Cores: Definition, Need and Types. Concept of Gating & Risers: Principle and types. Introduction to Die Casting and injection moulding.

Introduction to metal working: Classification of metal working processes, characteristics of wrought products, advantages and limitations of metal working processes. Forging: Classification, Forging machines & equipment. Die-design parameters. Forging defects, Residual stresses in forging, Applications of forging. Rolling: Classification, Types of rolling mills, Defects in rolled products. Rolling variables, Applications of Rolling. Drawing: Drawing equipment & dies, drawing variables, Tube drawing, classification of tube drawing, Application

Module-3

Extrusion: Types of extrusion processes, extrusion equipment & dies, Extrusion of seamless tubes, lubrication & defects in extrusion, Extrusion variables, Applications. **Sheet & Metal Forming**: Forming methods dies & punches, progressive die, compound die, combination die., piercing, blanking, bending, deep drawing, defects of drawn products, stretch

forming, Roll bending & contouring, Applications. **Advanced Welding processes**: Classification, Advantages & limitations of welding. Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding processes (AHW), Resistance welding, Applications.

Module-4

Additive Manufacturing: Introduction to Additive Manufacturing, Definition and principles of additive manufacturing, Various additive manufacturing technologies (3D printing, selective laser sintering, etc.), Benefits and limitations of additive manufacturing in robotics.

Additive Manufacturing Techniques: Detailed study of different additive manufacturing processes, Materials used in additive manufacturing for robotic components, Design considerations and optimization for additive manufacturing, Applications of Additive Manufacturing in Robotics, Case studies showcasing the use of additive manufacturing in robotics, Rapid prototyping and customization possibilities with additive manufacturing, Future trends and advancements in additive manufacturing for robotics

Module-5

CNC Programming and Machining: Introduction to CNC Programming, Fundamentals of Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM), Basics of CNC programming language (G-code, M-code), Programming techniques and syntax for CNC machining operations, CNC Machining Operations, Detailed study of CNC machining processes (turning, milling, drilling, etc.).

Machining strategies and tool selection for specific operations: Troubleshooting common issues in CNC machining, CNC Machining of Robotic Components, Programming and machining of simple robotic parts using CNC machines, Precision requirements and dimensional tolerances in robotic component fabrication, Inspection and quality control techniques for CNC machined parts

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	**Joining Processes:** Students should practice for joining processes, such as Soldering, Brazing and welding (any two models on each).
2	**Machining Practice:** Students should practice for machining operations (turning, milling, and drilling) on sample work pieces to develop their machining skills.
3	**Sheet Metal Fabrication:** Students should practice for Sheet metal operations for preparing frustum of cone, cylinder and tray. (Optional)
4	**Casting and Molding:** Students should practice to prepare different patterns to pour molten metal by using sand casting.
5	**Additive Manufacturing Workshop:** Organise workshop for students in designing and 3D printing simple robotic components using different materials and printing techniques using Free Open Source Software.
6	**CNC Programming and Machining:** Students should practice for program CNC machines for machining robotic components using CAM software.

Course Outcomes (COs) (Course Skill Set):

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

CO1: Understand various fabrication methods and their applications in the robotics field.

CO2: Understand the material behaviour and analyze its usages for different robotic components based ontheir properties.

CO3: Apply traditional manufacturing processes to fabricate robotic components accurately.

CO4: Adopt additive manufacturing techniques for rapid prototyping and production of roboticcomponents.

CO5: Demonstrate proficiency in CNC programming and machining operations to create precise robotic components.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum 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 havesatisfied the academic requirements and earned the credits allotted to each subject/ course if the student securesa minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theorycomponent of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for thetest to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

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

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

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

Suggested Learning Resources:

Text Books

1. "Manufacturing Engineering and Technology" by Serope Kalpakjian and Steven R. Schmid. Kalpakjian, Serope. 6th edition in SI units Serope Kalpakjian Illinois Institute of Technology Steven R. Schmid The University of Notre Dame SI Conversion by Hamldon Musa Universiti Teknologi Malaysia Prentice Hall Singapore London." (2007).
2. "Materials Science and Engineering: An Introduction" by William D. Callister Jr. and David G. Rethwisch. 10th edition, John Wiley & Sons, 2020.
3. "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing"by Ian Gibson, David W. Rosen, and Brent Stucker. 2nd edition, Springer Publications 2015.
4. "CNC Programming Handbook" by Peter Smid., 2nd edition, Industrial Press Inc. 2003.

Reference Books/Journal

1. Introduction to Robotics: Mechanics and Control Authors: John J. Craig.
2. Renfrew, Alasdair. "Introduction to robotics: Mechanics and control." International Journal of Electrical Engineering & Education 41.4 (2004): 388.

Industrial Robotics: Technology, Programming, and Applications, Groover, Mikell P., Mitchell Weiss, andRoger N. Nagel. Industrial robotics: technology, programming and application. McGraw-Hill Higher Education, 1986.

Web links and Video Lectures (e-Resources):

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

Description: This video lecture series covers various topics in robotics, including fabrication methods, materials, and manufacturing processes.

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

Fabrication Method Demonstration: Conduct hands-on demonstrations of different fabrication methods, such as welding, milling, 3D printing, and laser cutting, to help students understand the practical aspects.

Material Selection Exercise: Assign students a project where they have to analyze the requirements of a robotic component and select the most suitable material based on its properties.

Traditional Manufacturing Case Study: Present a case study of a real-world robotic component manufacturing process and discuss the challenges faced and the solutions employed in the industry.

Additive Manufacturing Workshop: Organize a workshop where students can experiment with additive manufacturing techniques like fused deposition modeling (FDM) or stereo lithography (SLA) to create robotic component prototypes.

CNC Programming and Machining Lab: Provide students with hands-on experience in CNC programming and machining by allowing them to design and manufacture simple robotic components using CNC machines.

Analog and Digital Electronic Circuits		Semester	III
Course Code	**BRI303**	CIE Marks	50
Teaching Hours/Week(L:T:P:S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40hours Theory+12Labslots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature(SEE)	Theory		

Courseobjectives:

Thiscoursewillenablestudents:

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

Teaching-Learning Process(General Instructions)

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

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

Module-1

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

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

Module-2

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

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

Module-3

Analysis and design of combinational logic: Decoders, Encoders, Digital multiplexers, Adders and subtractors, Look ahead carry, Binary comparators.(Text 3 - Chapter 4).

Programmable Logic Devices, Complex PLD, FPGA. (Text 5 - Chapter 9, 9.6 to 9.8)

Module-4

Counters: Counters: Asynchronous Counters, Decoding Gates, Synchronous Counters Decade Counters, Pre settable Counters, Counter Design as a Synthesis problem, A Digital Clock,. D/A Conversion and A/D Conversion: Variable, Resistor Networks, Binary Ladders, D/A Converters, D/A Accuracy and Resolution, A/D Converter-Simultaneous. Text book 6:- Ch 10.1,10.2, 10.3 Ch 10: 10.5 to 10.8. Ch 12: 12.1 to 12.5.

Module-5

Flip-Flops and its Applications: Basic Bitable elements, Latches, The master-slave flip flops (pulse-triggered flip-flops): SR flip-flops, JK flip-flops, Characteristic equations, Registers, binary ripple counters, and synchronous binary counters.(Text4-Chapter6)

Course outcome (Course Skill Set)

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

1. CO1: Understand analyse clippers, clampers, amplifier and D/A and A/D converter circuits.
2. CO2: Explain opamp basics and Analyze OPAMP applications.
3. CO3: Explain the concept of combinational and sequential logic circuits.
4. CO4: Design the combinational logic circuits.
5. CO5:Design the sequential circuit susing SR, JK,D, T flip-flops

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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.

The IPCC means the practical portion integrated with the theory of the course. CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.

CIE for the theory component of the IPCC

- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-

voce and marks shall be awarded on the same day.

- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

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

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

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

- The minimum marks to be secured in CIE to appear for SEE shall be 10 (40% of maximum marks-25) in the theory component and 10 (40% of maximum marks -25) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 sub-questions are to be set from the practical component of IPCC, the total marks of all questions should not be more than 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify for the SEE. Marks secured will be scaled down to 50.
- The student is declared as a pass in the course if he/she 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.

Suggested Learning Resources:

Books

1. Analog Electronic Circuits: A simplified approach by U.B. Mahadevaswamy, Pearson Education India, 2010
2. OPAMPS and Linear IC's by Ramakant Gayakwad, Fourth Edition,PearsonEducation,20015.
3. John M Yarbrough,-Digital Logic Applications and Design,Thomson Learning,2001.
4. DonaldD. Givone,—DigitalPrinciplesandDesign,McGrawHill,2002.
5. Charles H RothJr. ,LarryL.Kinney—Fundamentals of Logic Design, Cengage Learning, 7th Edition, 2013.

Web links and Video Lectures(e-Resources):

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

PRACTICALCOMPONENTOFIPCC*(Maycoverall/majormodules)*

1. To construct and observe clipping for different configurations.
2. To construct and find band width of RC coupled amplifier.
3. To construct and check oscillation frequency for RC phase shift oscillator.
4. To construct and obtain OPAMP astable multi-vibrator.
5. Design and implement (i) Half Adder &Full Adderusing i)basicgates. ii)NAND gates (ii)Half Sub-tractor & Full Sub-tractor using i)basic gates ii)NAND gates.
6. Design and implement 4-bitParallel Adder/Sub-tractor using IC7483.
7. Design and Implementation of 1-bit Comparator.
8. Realize 4-variable function using IC74151(8:1MUX).
9. Realize the following flip-flops using NAND Gates. JK,DFlip-Flop.
10. Realize 4bit SISO, SIPO, PIPO using D Flip flop.
11. Realize 3bita synchronous counter using JK flip flop.
12. Realize 3bit synchronous counter using D flip flop

DATA STRUCTURES AND ALGORITHMS		Semester	III
Course Code	**BRI304**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

COURSE OVERVIEW:

Robotics is an interdisciplinary branch of electronic engineering and mechanical engineering. Robotics involves design, construction, operation, and use of robots. The goal of robotics is to design machines that can help and assist humans. Robotics integrates fields of mechanical engineering, electrical engineering, information engineering, mechatronics, electronics, bioengineering, computer engineering, control engineering, software engineering, mathematics, etc.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Develop proficiency in designing and implementing fundamental data structures.
2. Learn various sorting and searching algorithms and analyze their time complexity.
3. Understand algorithmic problem-solving techniques, including recursion and dynamic programming.
4. Explore advanced data structures like trees, graphs, and hash tables.
5. Apply data structures and algorithms knowledge to solve real-world programming challenges efficiently.

Teaching-Learning Process (General Instructions)

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

1. The lecturer's approach (L) does not have to be limited to traditional methods of teaching. It is possible to incorporate alternative and effective teaching methods to achieve the desired outcomes.
2. Utilize videos and animations to illustrate the functioning of different techniques used in the manufacturing of smart materials.
3. Foster collaborative learning exercises within the classroom to encourage group participation and engagement.
4. Pose a minimum of three Higher Order Thinking (HOT) questions during class discussions to stimulate critical thinking among students.
5. Implement Problem-Based Learning (PBL) as an approach that enhances students' analytical skills and nurtures their ability to design, evaluate, generalize, and analyze information, rather than solely relying on rote memorization.

Module-1

Introduction: Data Structure, Classification (Primitive and non-operations. Pointers: Definition and Concepts, Array of pointers, Structure and pointers

Linear Data Structures –Stacks: Introduction and Definition, Representation of stack: Array and structure representation of stacks, Operations on stacks.

Stack Applications: Conversion of Expressions, Evaluation of expressions.

Module-2
Linear Data Structures - Singly Linked lists: Definition and concepts singly linked List: Representation of link list in memory, Operations on singly Linked List. Linked List representation of stack and queues. Linear Data Structures –Queues: Introduction and Definition Representation of Queue: Array representation of queues. Linear Data Structures- Doubly Linked lists: Operations
Module-3
Nonlinear Data Structures -Basic Terminologies, Binary Trees: Properties, Representation of Binary Tree: Linear representation, Linked representation, Operations on Binary Tree: Insertion, Simple Deletion, Traversals, Binary search trees. graphs using adjacency matrix and linked list. Understanding and representing graphs using adjacency matrix AND LINKED LIST
Module-4
Introduction to Algorithms: Fundamentals of Algorithmic Problem Solving, Fundamentals of the Algorithms Efficiency: Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-Recursive Algorithms and Recursive Algorithms. Sorting And Searching Algorithms: Linear Search and Binary Search.
Module-5
Decrease & Conquer: Concept of Decrease and Conquer, Graph traversal algorithms Depth First Search, Breadth First Search. Dynamic Programming: Concept of Dynamic Programming, Computing a Binomial Coefficient. Greedy Method: Concept of Greedy technique, Prim's algorithm.
Course Outcomes (COs) (Course Skill Set) At the end of the course, the student will be able to: 1. Master the implementation and application of key data structures in programming. 2. Demonstrate the ability to analyze algorithm efficiency and optimize code. 3. Solve complex problems by applying algorithmic strategies and techniques. 4. Design and implement algorithms for tasks involving searching, sorting, and graph traversal. 5. Utilize data structures and algorithms to enhance software performance and scalability

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:

- For the Assignment component of the CIE, there are 25 marks and for the InternalAssessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-basedthen only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination (SEE):

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

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

Suggested Learning Resources:

TEXT BOOKS:

1. Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures in C, 2nd Ed, Universities Press, 2014.
2. Introduction to the Design and Analysis of Algorithms, Anany Levitin: 2nd Edition, 2009. Pearson.
3. Seymour Lipschutz, Data Structures Schaum's Outlines, Revised 1st Ed, McGraw Hill, 2014.

REFERENCEBOOKS:

1. Reema Thareja, Data Structures using C, 3rd Ed, Oxford press, 2012.
2. Gilberg and Forouzan, Data Structures: A Pseudo-code approach with C, 2ndEd, CengageLearning,2014.
3. Jean-Paul Tremblay & Paul G. Sorenson, An Introduction to Data Structures withApplications,2nd Ed, McGraw Hill, 2013.
4. Computer Algorithms/C++, Ellis Horowitz, SatrajSahni and Rajasekaran, 2nd Edition, 2014, Universities Press.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/106/102/106102064/
- https://archive.nptel.ac.in/courses/106/106/106106127/
- https://nptel.ac.in/courses/106102064
- http://elearning.vtu.ac.in/econtent/courses/video/CSE/06CS35.html
- https://nptel.ac.in/courses/106/105/106105171/
- http://www.nptelvideos.in/2012/11/data-structures-and-algorithms.html
- http://elearning.vtu.ac.in/econtent/courses/video/CSE/06CS43.html
- https://nptel.ac.in/courses/106/101/106101060/

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

Real world problem solving using group discussion.

- Back/Forward stacks on browsers.
- Undo/Redo stacks in Excel or Word.
- Linked list representation of real-world queues -Music player, image viewer
- Real world problem solving and puzzles using group discussion. E.g., Fake coin identification, Peasant, wolf, goat, cabbage puzzle, Konigsberg bridge puzzle etc.,
- Demonstration of solution to a problem through programming.

Introduction to Modelling and Design		Semester	III
Course Code	**BRIL305**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**0:0:2*:0**	SEE Marks	50
Total Hours of Pedagogy	**14 Sessions**	Total Marks	100
Credits	**01**	Exam Hours	3
Examination nature (SEE)	**Practical**		

***One hour per week can be taken additionally**

Teaching-Learning Process (General Instructions)

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

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

Module-1

Introduction to Computer Aided Sketching Review of graphic interface of the software. Review of 2D Sketching, Parametric Solid Modeling, Assembly creation and product rendering.

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry. ***(Above topics to be studied as a review)*** **01 Session**

Sectional View: Sectioning, sectional view, Projection of sectional view, Representation of section plane, Hatching, Inclination of Hatching lines, Spacing between Hatching lines, Hatching of large areas, Hatching of Adjacent parts, Hatching of Adjacent parallel cut surfaces, Dimensioning on Hatched areas, Full Section, Half Section, Different types of sections, Partial or Local sections **03 Sessions**

Module-2 — 02 Sessions

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

Create a basic sketch - Profile Tools, Curve Tools, Editing Tools, Operation Tools, Constraints, construction geometries and adding dimensions. Part- Solid from sketches, Solid from surfaces, modify Tools, Operation Tools.

Exploring design tools for production:

Create draft during a feature - Create draft as a feature - Add ribs and plastic supports - Analyze draft on a design - Create holes and threads - Use a coil feature - Mirrors and patterns - Surface creation for complex geometry - Use surfaces to replace faces - Use surfaces to split bodies andfaces - Practice exercise.

Module-3 — 03 Sessions

The Basics of Assemblies

The different ways to create components - Use scripts to create gears - Component color swatch and color cycling - Use McMaster-Carr parts in a design - Copy, paste, and paste new - Distributed designs - Create as-built joints - Create joints - Joint origins and midplane joints -

Drive joints and motion studies - Interference detection and contact sets - Isolation and opacity control - Create groups and organize a timeline - Practice exercise

Module-4 **06 Sessions**

Assembly Drawings: (Part drawings shall be given)

Drawing Basics-Detailing Drawings. Explode a 3D model for a drawing, Create a drawing sheet and views, Add geometry and dimensions to a drawing, Add GD & T text, BOM, tables and symbols, Place an exploded view, Edit a title block, Export to different file formats.

1. **Reciprocating saw mechanical assembly,**
2. **Innovated bottle design for sustainability**
3. **Engine Piston**
4. **Cylinder Flange**
5. **Engine Case**
6. **Design for Injection Molding**

Course outcome (Course Skill Set)

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

Demonstrate their visualization skills.
Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies.
Make component drawings.
Produce the assembly drawings using part drawings.
Engage in lifelong learning using sketching and drawing as communication tool.

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 (CIE):

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

Module	**Max. Marks weightage**	**Evaluation Weightage in marks**	
		Computer display & printout	**Preparatory sketching**
Module-1	15	10	05
Module-2	15	10	05
Module-3	20	15	05
Module-4	50	40	10
Total	**100**	**80**	**20**

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

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

Module	Max. Marks Weightage	Evaluation Weightage in marks	
		Computer display & printout	Preparatory sketching
Module-1 OR Module-2	20	15	05
Module-3	20	15	05
Module-4	60	50	10
Total	**100**	**80**	**20**

Suggested Learning Resources:

Books

Text Books:

1. 'A Primer on Computer Aided Machine Drawing-2007', Published by VTU, Belgaum.
2. 'Machine Drawing', N.D.Bhat & V.M.Panchal, Published by Charotar Publishing House, 1999.
3. 'Machine Drawing', K.R. Gopala Krishna, Subhash publication.

Reference Book:

1. "A Text Book of Computer Aided Machine Drawing", S. Trymbakaa Murthy, CBS Publishers, New Delhi, 2007.
2. 'Machine Drawing', N.Siddeshwar, P.Kannaih, V.V.S. Sastri, published by Tata Mc.Grawhill, 2006.
3. K L Narayana, P Kannaiah, K Venkata Reddy, "Machine Drawing", New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5, 2006
4. Ajeet Singh, "MACHINE DRAWING", Tata McGraw-Hill Education, , ISBN: 9781259084607, 2012

Web links and Video Lectures (e-Resources):

- https://www.autodesk.com/certification/learn/course/learn-fusion-360-in-90-minutes
- Introduction to Modelling and Design for Manufacturing
- https://www.autodesk.com/certification/learn/course/fusion360-intro-modeling-design-professional

Material Science		Semester	III
Course Code	**BRI306A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand Material Properties: Develop a comprehensive understanding of the fundamental properties of materials, including mechanical, thermal, electrical, and optical characteristics.
2. Analyze Material Structures: Learn to analyze the atomic and molecular structures of materials, including crystallography and defects, to explain material behavior.
3. Explore Material Processing: Investigate various methods for processing and shaping materials, such as casting, forming, and heat treatment, to achieve desired properties.
4. Study Material Performance: Evaluate the performance of materials in different environments and applications, considering factors like corrosion, fatigue, and wear resistance.
5. Apply Material Knowledge: Apply material science principles to make informed decisions in engineering and manufacturing, including material selection, design optimization, and sustainability considerations.

Teaching-Learning Process (General Instructions)

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

1. The lecturer's approach (L) does not have to be limited to traditional methods of teaching. It is possible to incorporate alternative and effective teaching methods to achieve the desired outcomes.
2. Utilize videos and animations to illustrate the functioning of different techniques used in the manufacturing of smart materials.
3. Foster collaborative learning exercises within the classroom to encourage group participation and engagement.
4. Pose a minimum of three Higher Order Thinking (HOT) questions during class discussions to stimulate critical thinking among students.
5. Implement Problem-Based Learning (PBL) as an approach that enhances students' analytical skills and nurtures their ability to design, evaluate, generalize, and analyze information, rather than solely relying on rote memorization.

Module-1

Introduction to Crystal Structure: Coordination number, atomic packing factor, Simple Cubic, BCC,FCC and HCP Structures, Crystal imperfections–point, line, surface and volume imperfections. Atomic Diffusion: Phenomena, Fick's laws of diffusion (First and Second Law);Factors affecting diffusion.

Mechanical Behaviour: Stress-strain diagrams showing ductile and brittle behaviour of materials, Engineering stress and true strains, Linear and non- linear elastic behaviour and properties, Mechanical properties in plastic range: Stiffness, Yield strength, Offset Yield strength, Ductility, Ultimate Tensile strength, Toughness. Plastic deformation of single crystal by slip and twinning, Mechanisms of strengthening in metals.

Module-2

Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, S-N diagram, fatigue testing.Creep: Description of the phenomenon with examples, three stages of creep, creep properties, Stress relaxation. Concept of fracture toughness.

Binary phase diagrams:

Eutectic, and Eutectoid systems, Lever rule, Intermediate phases,(The same type of process will study in Iron Carbon Phase Diagrams) Gibbs phase rule, Effect of non-equilibrium cooling,

Coring and Homogenization Iron-Carbon (Cementite) diagram:description of phases, Effect of common alloying elements in steel, Common alloy steels, Stainless steel, Tool steel, Specifications of steels.

Module-3

Heat Treatment, Ferrous and Non-Ferrous Alloys:

Heat treating of metals: Time-Temperature Transformation (TTT) curves, Continuous Cooling Transformation (CCT) curves, Annealing: Recovery, Re crystallization and Grain growth, Types of annealing, Normalizing, Hardening, Tempering, Mar tempering, Austempering, Concept of harden ability, Factors affecting harden ability. Surface hardening methods: carburizing, cyaniding, nit riding, flame hardening and induction hardening, Age hardening of aluminium-copper alloys and PH steels. Ferrous materials: Properties, Compositions and uses of Grey cast iron and steel.

Module-4

Composite Materials :

Composite materials - Definition, classification, types of matrix materials & reinforcements, Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber- reinforced composites, Fundamentals of production of composites, characterization of composites, constitutive relations of composites, determination of composite properties from component properties, hybrid composites. Applications of composite materials. Numerical on determining properties of composites.

Module-5

Ceramics: Structure type sand properties and applications of ceramics. Mechanical/ Electrical behaviour and processing of Ceramics. Plastics: Various types of polymers/plastics and their applications. Mechanical behaviour and processing of plastics, Failure of plastics.

Brief description of other materials such as optical and thermal materials Smart materials – fiber optic materials, piezo-electrics, Shape Memory Alloys – Nitinol, superelasticity, Biological applications of smart materials - materials used as implants in human Body, Selection of Materials, Performance of materials in service Residual life assessment – use of non-destructive testing, Economics, Environment and Sustainability

Course Outcomes (COs)(Course Skill Set)

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

1. Understand the mechanical properties of metals and their alloys.
2. Analyze the various modes of failure and understand the microstructures of ferrous and nonferrous materials.
3. Describe the processes of heat treatment of various alloys.
4. Acquire the Knowledge of composite materials and their production process as well as applications.
5. Understand the properties and potentialities of various materials available and material selection procedures..

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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination (SEE):

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

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

Suggested Learning Resources:

TEXT BOOKS:

Textbook/s

1 Foundations of Materials Science and Engineering Smith McGrawHill 4thEdition, 2009.
2 Material science and Engineering and Introduction WilliamD.Callister Wiley 2006
3 Materials Science Shackle ford., & M. K. Muralidhara Pearson Publication 2007

Reference Books

1 Materials Science and Engineering V.Raghavan PHI 2002
2 The Science and Engineering of Materials Donald R. Askland and Pradeep.P. Phule Cengage Learning 4lhEd., 2003
3 Mechanical Metallurgy GeorgeEllwoodDieter McGrawHill.
4 ASM Handbooks American Society of Metals
5 Elements of Materials Science and Engineering H. VanVlack, AddisonWesley Edn 1998
6 An introduction to Metallurgy Alan Cottrell University Press India Oriental 1974.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/113/102/113102080/
- https://archive.nptel.ac.in/courses/112/108/112108150/

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

- Collaborative and Individual Project-Based Assessment

Linear Integrated Circuits		Semester	III
Course Code	**BRI306B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

The objectives of this course are to:

1. Understand the basic concepts of OP-AMP circuits
2. Analyze the applications of operational amplifiers
3. Understand special function ICs and waveform Generators using operational amplifiers circuits
4. Compare design issues, advantages, disadvantages and limitations of communication systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the variouscourse outcomes.

1. Lecturer method (L) does not mean only the traditional lecture method, but a differenttype of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various communicationsystems
3. Encourage collaborative (Group) Learning in the class

Module-1

IC FABRICATION

IC classification, fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of impurities. Realisation of monolithic ICs and packaging. Fabrication ofdiodes, capacitance, resistance, FETs and PV Cell.

Module-2

CHARACTERISTICS OF OPAMP

Ideal OP-AMP characteristics, DC characteristics, AC characteristics, differential amplifier; frequency response of OP-AMP; Basic applications of op-amp — Inverting and Non-inverting Amplifiers, summer, differentiator and integrator-V/I & I/V converters.

Module-3

APPLICATIONS OF OPAMP

Instrumentation amplifier and its applications for transducer Bridge, Log and Antilog Amplifiers- Analog multiplier & Divider, first and second order active filters, comparators, multivibrators, waveform generators, clippers, clampers, peak detector, S/H circuit, D/A converter (R- 2R ladder and weighted resistor types), A/D converters using opamps.

Module-4

SPECIAL ICs

Functional block, characteristics of 555 Timer and its PWM application — IC-566 voltage controlled oscillator IC; 565-phase locked loop IC, AD633 Analog multiplier ICs.

Module-5

APPLICATION ICs

AD623 Instrumentation Amplifier and its application as load cell weight measurement — IC voltage regulators – LM78XX, LM79XX; Fixed voltage regulators its application as Linear power supply — LM317, 723 Variability voltage regulators, switching regulator- SMPS — ICL 8038 function generator IC.

Course outcome (Course Skill Set)

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

1. Design linear and nonlinear applications of OP – AMPS
2. Design ADC and DAC using OP – AMPS
3. Generate waveforms using OP – AMP Circuits
4. Analyze special function ICs

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). The minimum passing mark for the SEE is 35% of the 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 subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination (SEE):

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

The question paper shall be set for 100 marks. The medium of the question paper shall be English. The duration of SEE is 03 hours.

The question paper will have 10 questions. Two questions per module. Each question is set for 20marks. The students have to answer 5 full questions, selecting one full question from each module. The student has to answer for 100 marks and marks scored out of 100 shall be proportionally reduced to 50 marks.

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

Suggested Learning Resources:

Books

1. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age InternationalPvt. Ltd.,Fifth edition 2018.
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits",Forth Edition,Tata Mc Graw-Hill, 2014.

Reference :

1. Ramakant A. Gayakwad, "OP-AMP and Linear ICs", 4 th Edition, Prentice Hall / PearsonEducation,2001.
2. Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear IntegratedCircuits",Sixth Edition, PHI, 2001

Web links and Video Lectures (e-Resources):

- https://www.digimat.in/nptel/courses/video/108108111/L01.html
- https://www.digimat.in/nptel/courses/video/108108114/L01.html

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

- Design of a differential amplifier.
- Design and Verification of Applications of Op-amp (Adder, Subtractor, Integrator,Differentiator).
- Design of Full wave rectifier using 741 IC
- Design of Instrumentation Amplifier using Op-Amp.
- Design of Triangular waveform generators using 741 IC

Unmanned Aerial Vehicles (UAV)		Semester	III
Course Code	**BRI306C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

COURSE OBJECTIVES:

The objectives of this course are to:

1. Acquire the knowledge of basic concepts needed in modelling and analysing an unmanned system.
2. To expose students to the development of UAV
3. To expose students to the type of payloads used in UAV
4. To study path planning.
5. To understand the avionics hardware used in the UAV.

Teaching-Learning Process (General Instructions)

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

1. The lecturer's approach (L) does not have to be limited to traditional methods of teaching. It is possible to incorporate alternative and effective teaching methods to achieve the desired outcomes.
2. Utilize videos and animations to illustrate the functioning of different techniques used in the manufacturing of smart materials.
3. Foster collaborative learning exercises within the classroom to encourage group participation and engagement.
4. Pose a minimum of three Higher Order Thinking (HOT) questions during class discussions to stimulate critical thinking among students.
5. Implement Problem-Based Learning (PBL) as an approach that enhances students' analytical skills and nurtures their ability to design, evaluate, generalize, and analyze information, rather than solely relying on rote memorization.

Module-1

Introduction to UAV: Introduction Aviation History and Overview of UAV systems, Classes and Missions of UAVs, Definitions and Terminology, UAV fundamentals, Examples of UAV systems-very small, small, Medium and Large UAV

Module-2

The Air Vehicle Basic Aerodynamics: Basic Aerodynamics equations, Aircraft polar, the real wing and Airplane, Induced drag, the boundary layer, Flapping wings, Total Air-Vehicle Drag. Performance: Overview, climbing flight, Range and Endurance – for propeller-driven aircraft, range- a jet-driven aircraft, Guiding Flight.

Module-3

Avionics Hardware: Overview, Stability, longitudinal, lateral, dynamic stability, Aerodynamics control, pitch control, lateral control, Autopilots, sensor, controller, actuator, airframe control, inner and outer loops, Flight-Control Classification, Overall Modes of Operation, Sensors Supporting the Autopilot.

Module-4

Operating Systems: Propulsion Overview, Thrust Generation, Powered Lift, Sources of Power, The Two-Cycle Engine, The Rotary Engine, The Gas Turbine, Electric Motors, and Sources of Electrical Power. Loads and Structures Loads, Dynamic Loads, Materials, Sandwich Construction, Skin or Reinforcing Materials, Resin Materials, Core Materials, Construction Techniques.

Module-5

Communication Payloads and Controls: Air Vehicle and Payload Control, Reconnaissance/Surveillance Payloads, Weapon Payloads, Other Payloads, Data-Link Functions and Attributes, Data-Link Margin, Data-Rate Reduction, Launch Systems, Recovery Systems, Launch and Recovery Trade-offs

Course Outcomes (COs)(Course Skill Set)

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

CO1: Apply the basic concepts of UAV systems.

CO2: Explain the basic aerodynamics, performance, stability and control required for UAV.

CO3: Identify different hardware components for UAV

CO4: Apply the knowledge of UAV and select suitable propulsion system and materials for construction of micro aerial vehicle.

CO5: Perform system testing for unmanned aerial vehicles.

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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination (SEE):

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

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

Suggested Learning Resources:

TEXT BOOKS:

1. DGCA RPAS Guidance Manual, Revision 3, 2020
2. Introduction to UAV Systems-Paul Gerin Fahlstrom, Thomas James Gleason Unmanned Aerial Vehicle-Landen Rosen
3. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998..
4. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.

REFERENCE BOOKS:

1. Unmanned Aerial Vehicles: DOD's Acquisition Efforts
2. Unmanned Aerial Vehicles-Valavanis, Kimon P Handbook of Unmanned Aerial Vehicles-Valavanis, K.,Vachtsevanos, George J
3. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics

Company, 200.
4. Kimon P. Valavanis, “Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy”, Springer, 2007.
5. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

Web links and Video Lectures (e-Resources):

- https://roboticscasual.com/ros-tutorial-pick-and-place-task-with-the-moveit-c-interface/
- https://www.mdpi.com/2072-4292/11/12/1443
- https://www.britannica.com/technology/unmanned-aerial-vehicle
- https://www.rand.org/topics/unmanned-aerial-vehicles.html
- https://youtu.be/S-XiFIRVkgQ
- https://www.youtube.com/watch?v=VCZK2iexDso

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

- Adaptation of Content from Different Disciplines
- Constructivist Approaches to Learning
- Situated Learning Methodology
- Flipped Classroom
- Online Interactive Tools
- Collaborative and Individual Project-Based Assessment

Data Structures and Algorithms LAB			
Course Code	**BRI358A**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	15 Sessions	Total	100
Credits	01	Exam Hours	03

Additional One hour may be considered for instructions if required

Course objectives:

- Apply theoretical knowledge of data structures and algorithms to practical programming tasks.
- Gain hands-on experience in implementing and debugging data structures and algorithms through coding exercises and projects.

Sl..NO	Experiments
1	Pointer implementation using arrays
2	Stack implementation using arrays
3	Queue implementation using arrays
4	Singly Linked list implementation
5	Doubly Linked list implementation
6	Binary Tree Construction and Tree traversal operations.
7	Implementation of Insertion sort
8	Implement Linear search and Binary Search algorithms to search an element in a given array. (with calculation of time)
9	Implementation of DFS and BFS traversals of a graph
10	Implementation of Prims algorithm.

Course outcomes (Course Skill Set):

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

- Develop proficiency in coding and debugging complex algorithms and data structures.
- Acquire practical problem-solving skills by applying data structures and algorithms to real-world programming challenges.

Assessment Details(both CIE and SEE)

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

Continuous Internal Evaluation(CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will beevaluatedfor10marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-upon time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and these test shall be conducted after the 14^{th}week of the semester.
- In each test, write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40%of the maximum marks).

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

Semester End Evaluation(SEE):

SEE marks for the practical course is 50Marks.

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

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

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

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners. General rubrics suggested for SEE are mentioned here, write up-20%, Conduction procedure and result -60%, Viva-voce 20% of maximum marks. SEEf or practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. The duration of SEE is 03hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- Textbooks:
- Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures in C, 2nd Ed, Universities Press, 2014.
- Introduction to the Design and Analysis of Algorithms, Anany Levitin: 2nd Edition, 2009.Pearson.

- Online Courses:
  - Coursera: "Algorithms" by Princeton University (taught by Robert Sedgewick and Kevin Wayne).
  - edX: "Algorithmic Design and Techniques" (offered by UC San Diego and Higher School of Economics).
- Websites and Online Resources:
  - Geeks for Geeks: Offers a wide range of tutorials, practice problems, and coding challenges related to data structures and algorithms.
  - Leet Code: Provides coding challenges that are frequently asked in technical interviews and cover a

variety of algorithmic concepts.
    - Hacker Rank: Offers coding challenges and competitions with a focus on algorithms and data structures.
    - Top Coder: Provides algorithmic challenges and competitions for practicing and improving problem-solving skills.
- YouTube Channels:
    - My code school: Offers video tutorials on various data structures and algorithms topics.
    - The Coding Train: Provides interactive coding tutorials on algorithms and data structures.
- Coding Platforms:
    - Code forces: Offers competitive programming challenges to improve algorithmic problem-solving skills.

  Hackerearth: Provides coding competitions and challenges along with tutorials and practice problems.

Applications of MAT LAB		Semester	III
Course Code	**BRI358B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15 sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination nature (SEE)	Lab/Practical		

Course objectives:

The objectives of this course are to:

- To provide the requisite and relevant background necessary to understand the other importantengineering mathematics courses offered for Engineers and Scientists.
- To introduce important topics of applied mathematics, namely Single and MultivariableCalculus and Vector Calculus etc.
- To impart the knowledge of Laplace transform, an important transform technique forEngineers this requires knowledge of integration.

EXPERIMENTS

1. Introduction to MATLAB through matrices, and general Syntax
2. Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations usingMATLAB
3. Evaluating Extremum of a single variable function
4. Understanding integration as Area under the curve
5. Evaluation of Volume by Integrals (Solids of Revolution)
6. Evaluating maxima and minima of functions of several variables
7. Applying Lagrange multiplier optimization method.
8. Evaluating Volume under surfaces.
9. Evaluating triple integrals.
10. Evaluating gradient, curl and divergence.
11. Evaluating line integrals in vectors.
12. Applying Green's theorem to real world problems

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write- up. Rubrics for

the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.

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

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

SEE marks for the practical course is 50 Marks.

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

All laboratory experiments are to be included for practical examination.

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

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

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

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Official MATLAB Documentation: Start with MathWorks' official MATLAB documentation and guides. It offers

comprehensive information, examples, and tutorials.

2. MATLAB Online Courses: Platforms like Coursera, edX, and Udemy offer MATLAB courses with video lectures and practical exercises.

3. MATLAB Books: Books like "MATLAB for Dummies" and "MATLAB: A Practical Introduction to Programming and Problem Solving" provide in-depth knowledge.

4. YouTube Tutorials: Many YouTube channels offer free MATLAB tutorials for various skill levels.

Fundamentals of Virtual Reality and App Development		Semester	III
Course Code	**BRI358C**	CIE Marks	50
Teaching Hours/Week(L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	01
Examination nature (SEE)	Theory		

Course objectives:
The objectives of this course are:

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

Teaching-Learning Process(General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. The lecturer's approach (L) does not have to be limited to traditional methods of teaching. It is possible to incorporate alternative and effective teaching methods to achieve the desired outcomes.
2. Utilize videos and animations to illustrate the functioning of different techniques used in the manufacturing of smart materials.
3. Foster collaborative learning exercises within the classroom to encourage group participation and engagement.
4. Pose a minimum of three Higher Order Thinking (HOT) questions during class discussions to stimulate critical thinking among students.
5. Implement Problem-Based Learning (PBL) as an approach that enhances students' analytical skills and nurtures their ability to design, evaluate, generalize and analyze information, rather than solely relying on rote memorization.
6. Adopt different types of teaching methods to develop the outcomes through Power Point presentations and Video demonstrations or Simulations.
7. Adopt flipped classroom teaching method and collaborative (Group Learning) learning in the class.
8. Adopt Problem Based Learning (PBL) which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.

Module-1

Introduction to Virtual Reality : Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to theVirtualWorld-Input&output-Visual,Aural&HapticDisplays,ApplicationsofVirtual Reality.

Module-2

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

Module-3

The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Models, Changing Position and

Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.
Module-4
Visual Perception & Rendering: Visual Perception - Perception of Depth, Perception of Motion, Perception of Colour, Combining SourcesofInformation.VisualRendering-RayTracingandShadingModels,Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates
Module-5
Motion & Tracking: Motion in Real and Virtual Worlds-Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies
Course outcome (Course Skill Set) At the end of the course the student will be able to: CO1: Describe how VR systems work and list the applications of VR. CO2: Understand the design and implementation of the hardware that enables VR systems to be built. CO3: Understand the system of human vision and its implication on perception and rendering. CO4: Explain the concepts of motion and tracking in VR systems. CO5: Describe the importance of interaction and audio in VR systems.

Assessment Details (both CIE and SEE)

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 Examination (CIE)

• For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.

• The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered

• Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.

• For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

• SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions).

• The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

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

Reference Books:

1. Gerard Joungh yun Kim, “Designing Virtual Systems:The Structured Approach”,2005.

2. Doug A Bowman, Ernest Kuijff, Joseph JLa Viola, Jr and Ivan Poupyrev, “3D User Interfaces, Theory and Practice”, Addison Wesley, USA, 2005.

3. Oliver Bimber and Ramesh Raskar, “Spatial Augmented Reality: imaging Real and Virtual Worlds”, 2005.

4. Burdea, Grigore Cand Philippe Coiffet, “Virtual Reality Technology”,Wiley Inter science, India, 2003.

Web links and Video Lectures(e-Resources):

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

ActivityBasedLearning(SuggestedActivitiesinClass)/PracticalBasedlearning

- Mini Project
- Course seminars
- You Tube video learning approach

Introduction to C++ Programming		Semester	III
Course Code:	**BRI358D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	01
Examination nature (SEE)	Theory		

Course objectives

The objectives of this course are to:

- Understanding about object oriented programming and Gain knowledge about thecapability to store information together in an object.
- Understand the capability of a class to rely upon another class and functions.
- Understand about constructors which are special type of functions.
- Create and process data in files using file I/O functions
- Use the generic programming features of C++ including Exception handling

Teaching-Learning Process

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching –Learning more effective

1. Chalk and talk
2. Online demonstration
3. Hands on problem solving

Module-1

Introduction to Object Oriented Programming: Computer programming background- C++ overview. First C++ Program -Basic C++ syntax, Object Oriented Programming: What is an object, Classes, methods and messages, abstraction and encapsulation, inheritance, abstract classes, polymorphism.

Module-2

Functions in C++: Tokens – Keywords – Identifiers and constants – Operators in C++ – Scope resolution operator – Expressions and their types – Special assignment expressions – Function prototyping – Call by reference – Return by reference – Inline functions -Default arguments – Function overloading.

Module-3

Inheritance & Polymorphism: Derived class Constructors, destructors-Types of Inheritance-Defining Derived classes, Single Inheritance, Multiple, Hierarchical Inheritance, Hybrid
Inheritance.

Module-4

I/O Streams: C++ Class Hierarchy- File Stream-Text File Handling- Binary File Handling duringfileoperations.

Module-5

Exception Handling: Introduction to Exception - Benefits of Exception handling- Try and catchblockThrow statement- Pre-defined exceptions in C++

Textbook 2: Chapter 13 (13.2 to13.6)

Course outcome (Course Skill Set)

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

CO1: Able to understand and design the solution to a problem using object-orientedprogramming concepts.

CO2: Able to reuse the code with extensible Class types, User-defined operators and function Overloading.

CO3: Achieve code reusability and extensibility by means of Inheritance andPolymorphism

CO4: Implement the features of C++ including templates, exceptions and file handling forprovidingprogrammed solutions to complex problems

Assessment Details (both CIE and SEE)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than

35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together Continuous internal Examination (CIE)

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

Continuous Internal Examination (CIE)

• For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.

• The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered

• Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.

• For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple

choice questions). The time allotted for SEE is 01 hour. The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Textbooks:

1. Bhushan Trivedi, "Programming with ANSI C++", Oxford Press, Second Edition, 2012.
2. Balagurusamy E, Object Oriented Programming with C++, Tata McGraw Hill Education Pvt. Ltd, Fourth Edition 2010.

Web links and Video Lectures (e-Resources):

1. **Basics of C++ - https://www.youtube.com/watch?v=BClS40yzssA**
2. **Functions of C++ - https://www.youtube.com/watch?v=p8ehAjZWjPw**

Tutorial Link:

1. **https://www.w3schools.com/cpp/cpp_intro.asp**

https://www.edx.org/course/introduction-to-c-3

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

- **Assign small tasks to Develop and demonstrate using C++**

Course Seminars

Robot Kinematics, Dynamics & Control		Semester	IV
Course Code	**BRI401**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

COURSE OBJECTIVES:

The objectives of this course are to:

1. Comprehend Kinematic Principles: Understand the fundamental principles of robot kinematics, including the relationships between joint angles and end-effector positions.
2. Analyze Robot Dynamics: Learn to analyze the dynamic behavior of robotic systems, considering factors like inertia, friction, and external forces.
3. Design Control Algorithms: Develop the ability to design and implement control algorithms for robots, enabling precise motion and manipulation.
4. Solve Complex Robot Motion Problems: Acquire problem-solving skills for addressing challenging robot motion problems, including trajectory planning and obstacle avoidance.
5. Apply Theory to Practical Robotics: Apply theoretical knowledge to real-world robotic systems, including programming and controlling robots to perform specific tasks and applications.

Teaching-Learning Process (General Instructions)

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

1. The lecturer's approach (L) does not have to be limited to traditional methods of teaching. It is possible to incorporate alternative and effective teaching methods to achieve the desired outcomes.
2. Utilize videos and animations to illustrate the functioning of different techniques used in the manufacturing of smart materials.
3. Foster collaborative learning exercises within the classroom to encourage group participation and engagement.
4. Pose a minimum of three Higher Order Thinking (HOT) questions during class discussions to stimulate critical thinking among students.
5. Implement Problem-Based Learning (PBL) as an approach that enhances students' analytical skills and nurtures their ability to design, evaluate, generalize, and analyze information, rather than solely relying on rote memorization

Module-1

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

Inverse Kinematics- General properties of solutions, Homogeneous differential transformations, Inverse kinematics for 2 DOF and 3 DOF planar manipulators (Simple derivation and numerical exercises), Jacobian Transformation for

Robotic arm manipulation, Joint and end effector velocities relation.

Module-2

Lagrange-Euler dynamic formulation of Robotic Manipulators: Basic Definitions, Generalized robotic coordinates, Dynamic Constraints, Velocity & Acceleration of Moving Frames, Robotic mass distribution and inertia tensors, Expression for Kinetic Energy and Potential Energy of arms, velocity of links, Manipulator Jacobian, Jacobian computation, The prismatic joint Jacobian, The rotary joint Jacobian, Jacobian inverse, Jacobian singularity, Computation of singularities, Wrist singularities, Arm singularities and singularities configurations**.**

Module-3

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

Module-4

Path Planning- Joint space planning, use of cubic polynomial, Cartesian space planning, Straight line and circular paths, position and orientation planning. Trajectory Planning- Joint space trajectory planning, cartesian and operational space trajectory planning techniques, velocity and positional control.

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

Module-5

Introduction to Robot control, concepts of point to point and continuous path control, Basics of feedback devices, Encoders, Resolver and LVDT, Open and closed loop control techniques. Fundamentals of PD and PID controllers. Linear control schemes, PD and PID control of a single link manipulator, Adaptive control scheme, Force and torque control of robotic manipulators, Hybrid control, compliance and impedance control.

Course Outcomes (COs) (Course Skill Set)

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

1. Understand Robot Kinematics: Gain a deep understanding of robot kinematics, including forward and inverse kinematics, to analyze and describe the motion of robotic manipulators accurately.
2. Master Robot Dynamics: Develop proficiency in robot dynamics, enabling the analysis of forces and torques involved in robot motion and manipulation tasks.
3. Implement Robot Control Algorithms: Learn to design and implement control algorithms for robots, including PID controllers, trajectory planning, and feedback control techniques.
4. Solve Complex Robot Motion Problems: Acquire problem-solving skills to tackle complex challenges in robot motion planning, including collision avoidance, path optimization, and real-time control.
5. Apply Knowledge to Practical Robotics: Apply theoretical concepts to practical robotics scenarios, enabling the ability to program, simulate, and control real robotic systems effectively.

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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and thesecond test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination (SEE):

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

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

Suggested Learning Resources:

TEXT BOOKS:

1. Robotics and Control, R K Mithal and I J Nagrath , McGraw Hill
2. Fu, K., Gonzalez, R. and Lee, C. S. G., Robotics: Control, Sensing, Vision and
3. Intelligence, McGraw- Hill, 2008
4. Introduction to Robotic Analysis
5. Education, 2008.

REFERENCE BOOKS:

1. Introduction to Robotics: Mechanics and Control
2. Welsey, 2nd Edition1989.
3. Fundamentals of Robotics, Analysis and Control

E Books / MOOCs/ NPTEL

1. https://onlinecourses.nptel.ac.in/noc20_me53/preview2.

   https://www.classcentral.com/course/swayammanipulators-43637
2. http://vlabs.iitkgp.ac.in/mr/#

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112/106/112106270/

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

- Visit mechanical labs to access different links and joints employed for various purposes.

Mechanics and Measurement Systems for Robots		Semester	IV
Course Code	**BRI402**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course objectives:

- Understand Simple stress and strain.
- Analyze compound stresses.
- Evaluate torsion of circular shafts and Elastic Stability of Columns.
- Explore Measurement Technologies: Explore a range of measurement technologies, including encoders, accelerometers, and vision systems, for precise robotic control and feedback.
- Design Measurement Systems: Acquire the skills to design and implement measurement systems tailored to specific robotic applications, including sensor selection and calibration.

Teaching-Learning Process (General Instructions)

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

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

MODULE-1

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

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

MODULE-2

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

MODULE-3

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

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

MODULE-4
Introduction to Metrology: Definition, objectives of metrology, Material Standards, Wavelength Standards, Classification of standards, Line and End standards, Calibration of End bars. Numerical examples. **System of Limits, Fits, Tolerance and Gauging:** Definitions, Tolerance, Tolerance analysis (addition & subtraction of tolerances) Interchangeability & Selective assembly. Class &grade of tolerance, Fits, Types of fits, Numerical on limits, fit and tolerance. Hole base system & shaft base system. Taylor's principle, Types of limit gauges, Numerical on limit gauge design.
MODULE-5
Measurement system and basic concepts of measurement methods: Definition, Significance of measurement, generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors. **Transducers:** Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical, Electronic transducers, Relative comparison of each type of transducers. **Intermediate Modifying and Terminating Devices:** Mechanical systems, Inherent problems, Electrical intermediate modifying devices, Input circuitry, Ballast circuit, electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	Tensile, shear and compression tests of steel, aluminium and cast iron specimens using Universal Testing Machine
2	Torsion Test on steel bar and Izod and Charpy Tests on Mild steel and C.I Specimen.
3	Study of Autocollimator-Applications for measuring straightness and squareness.
4	Study of different Comparators and calibration of Dial indicator, Electrical comparators, LVDT, Pneumatic comparators
5	To Study various Temperature Measuring Instruments and to Estimate their Response times. (a) Mercury – in glass thermometer (b) Thermocouple
6	(c) Electrical resistance thermometer (d) Bi-metallic strip
7	Study of the following transducer (i) PT-100 transducer (ii) K –type transducer (iii) Pressure transducer
8	To measure torque of a rotating shaft using torsion meter/strain gauge torque transducer
9	**Can be Demo experiments for CIE** To measure static/dynamic pressure of fluid in pipe/tube using pressure transducer/pressure cell.
10	**Can be Demo experiments for CIE** Study of distortion factor meter and determination of the % distortion of the given oscillator.
11	**Can be Demo experiments for CIE** Study of Autocollimator-Applications for measuring straightness and squareness.
12	**Can be Demo experiments for CIE** Preparation of specimen for Metallographic examination of different engineering materials. To reportmicrostructures of plain carbon steel, tool steel, grey C.I, SG iron, Brass, Bronze & composites.

Course outcomes (Course Skill Set):

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

- Demonstrate a comprehensive understanding of stress and strain concepts, including their applications in analyzing materials and structures.
- Apply knowledge to analyze complex compound stresses in materials and structures, providing solutions for real-world engineering problems.
- Perform in-depth evaluations of circular shaft torsion and the elastic stability of columns, demonstrating the ability to assess and optimize structural integrity.
- Explore a wide range of measurement technologies, such as encoders, accelerometers, and vision systems, to accurately acquire data for robotic control and feedback.
- Develop the skills to design and implement measurement systems customized for specific robotic applications, including the selection of appropriate sensors and calibration techniques to ensure precise and reliable data collection.

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). The student is declared as a pass in the course if he/she 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.

The IPCC means the practical portion integrated with the theory of the course. CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.

CIE for the theory component of the IPCC

- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

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

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

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

- The minimum marks to be secured in CIE to appear for SEE shall be 10 (40% of maximum marks-25) in the theory component and 10 (40% of maximum marks -25) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 sub-questions are to be set from the practical component of IPCC, the total marks of all questions should not be more than 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify for the SEE. Marks secured will be scaled down to 50.
- The student is declared as a pass in the course if he/she 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.

Suggested Learning Resources:

Books

1. Mechanics of Materials", by R.C.Hibbeler, Prentice Hall. Pearson Edu., 2011.
2. "Mechanics of materials", James.M.Gere, Thomson, Eighth edition2013.
3. "Mechanics of materials", in SI Units, Ferdinand Beer & Russell Johston, 5th Ed., TATA McGraw Hill- 2003.

Reference Books:

1. "Strength of Materials", S.S. Rattan, Tata McGraw Hill, 2009.
2. "Strength of Materials", S.S.Bhavikatti, Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.
3. "Engineering Mechanics of Solids", Egor.P. Popov, Pearson Edu. India, 2nd, Edition, 1998.
4. "Strength of Materials", W.A. Nash, 5th Ed., Schaum's Outline Series, Fourth Edition-2007.

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/105/104/105104160/

MICROCONTROLLER

Course Code	**BRI403**	SEMESTER	IV
		CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40+8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

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

Course Learning Objectives: This course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

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

Module-1

8051 Microcontroller:

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

Teaching-Learning Process	Chalk and Talk Method

Module-2

8051 Instruction Set:

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

Teaching-Learning Process	Chalk and Talk Method

Module-3

8051 Stack, I/O Port Interfacing and Programming: 8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops. Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status.	
Teaching-Learning Process	Chalk and Talk Method
Module-4	
8051 Timers and Serial Port: 8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 anda square wave using Mode- 2 on a port pin. 8051 Serial Communication - Basics of Serial Data Communication, RS- 232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and toreceive data serially.	
Teaching-Learning Process	Chalk and Talk Method
Module-5	
8051 Interrupts and Interfacing Applications: 8051 Interrupts, 8051 Assembly language programming to generate an external interrupt using a switch, 8051 C programming to generate a square waveform on a port pin using a Timer interrupt, Interfacing 8051 to ADC-0804,DAC, LCD and Stepper motor and their 8051 Assembly language interfacing programming.	
Teaching-Learning Process	Chalk and Talk Method

PRACTICAL COMPONENT OF IPCC

Experiments
1. Write an ALP program to transfer a block of data byte from source memory to destination memory using 8051.
2. Write an ALP program to exchange two blocks of data bytes using 8051.
3. Write an ALP to add, subtract, multiply and divide two 16 bit numbers.
4. Write an ALP to find largest and smallest of element in an array using 8051.
5. Write an ALP to arrange the 8 bit number in ascending order
6. Write and ALP to arrange the 8 bit number in descending order
7. Code Conversion :BCD to ASCII ,ASCII-DECIMAL ,DECIMAL -ASCII,HEX-DECIMAL and DECIMAL-HEX
8. Write an ALP program to find square and cube of a number
9. Write a c program to generate {Using keil} I) square wave ii) sine wave iii) sawtooth waveform iv) triangular wave v) staircase waveform
10. Write an ALP To count I) hex up counter II) hex down counter III) decimal up counter iv) decimal down counter

Experiments (Hardware)

1. Write an ALP to interface a stepper to 8051 to 8051 to rotate the motor
2. Write an ALP to interface an LCD display and to display message on it
3. Write a c program or ALP to generate sine wave, square wave, triangular, ramp using DAC interface to 8051
4. Write a program to show the on off control of DC motor
5. Write a program to interface 7 segment display to a 8051 microcontroller

Course outcome (Course Skill Set)

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

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

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

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

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

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

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

Assessment Details (both CIE and SEE)

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

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.

- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for thetest to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

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

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

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

Suggested Learning Resources:

Books:

1. "The 8051 Microcontroller and Embedded Systems – using assembly and C", Muhammad Ali Mazidi, JaniceGillespie Mazidi and Rollin D. McKinlay, PHI, 2006 / Pearson, 2006.

2. "The 8051 Microcontroller", Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.

Reference Books:

1. "The 8051 Microcontroller Based Embedded Systems", Manish K Patel, McGraw Hill, 2014, ISBN: 978-93-329-0125-4.

2. "Microcontrollers: Architecture, Programming, Interfacing and System Design", Raj Kamal, Pearson Education, 2005.

Web links and Video Lectures (e-Resources):

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

Robot Programming and Simulation Laboratory

Course Code	**BRIL404**	Semester	IV
		CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	15 sessions	Total	100
Credits	01	Exam Hours	03

Additional One hour may be considered for instructions if required

Course objectives:

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

Sl.NO	Experiments
1	Determination of maximum and minimum position of links.
2	Verification of transformation (Position and orientation) with respect to gripper and world coordinate system.
3	Estimation of accuracy, repeatability and resolution.
4	Robot programming and simulation for pick and place.
5	Robot programming and simulation for Colour identification.
6	Robot programming and simulation for Shape identification.
7	Robot programming and simulation for machining (cutting, welding).
8	Robot programming and simulation for any industrial process (Packaging, Assembly).
9	Robot programming and simulation for Forward Kinematics using Virtual labs.
10	Robot programming and simulation Inverse Kinematics using Virtual labs.
11	Robot programming and simulation for 3D printing using CURA

LIST OF EQUIPMENTS BATCH OF 30 STUDENTS:

ROS (Robotic Operating System) 30 Systems with server

- ADAMS Software
- WorkspaceLT
- Verification of direct kinematics equations and inverse kinematics equations of 1DOF "R- configuration" robot. https://mr-iitkgp.vlabs.ac.in/exp/forward-kinematics/simulation.html
- Verification of direct kinematics equations and inverse kinematics equations of 2DOF"R-R-configuration"robot. https://mr-iitkgp.vlabs.ac.in/exp/inverse-kinematics/simulation.html

Course outcomes (Course Skill Set):

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

- Use of any robotic simulation software to model the different types of robots and calculate work volume for different robots.

Assessment Details(both CIE and SEE)

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

Continuous Internal Evaluation(CIE):

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

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

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

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

Semester End Evaluation(SEE):

SEE marks for the practical course is 50Marks.

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

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

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

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners. General rubrics suggested for SEE are mentioned here, write up-20%, Conduction procedure and result -60%, Viva-voce 20% of maximum marks. SEEf or practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. The duration of SEE is 03hours. Rubrics suggested in Annexure-II of Regulation book.
Suggested Learning Resources: • https://www.coppeliarobotics.com/ • https://www.youtube.com/watch?v=MX3VXvZFk0U • https://www.fer.unizg.hr/en/course/rpas • https://www.hindawi.com/journals/jr/2018/2312984/ • https://unity.com/solutions/automotive-transportation-manufacturing/robotics

Fuzzy Logic for Robotics		Semester	IV
Course Code	**BRI405A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

- Understand Fuzzy Logic Principles: Develop a solid understanding of fuzzy logic theory and its application in robotics.
- Implement Fuzzy Controllers: Learn to design and implement fuzzy logic controllers for robotic systems to handle imprecise or uncertain information.
- Solve Complex Robotic Decision Problems: Acquire the skills to apply fuzzy logic to address complex decision-making problems in robotics, such as path planning and obstacle avoidance.
- Optimize Robotic Systems: Explore techniques to optimize robotic systems' performance and behavior using fuzzy logic-based control strategies.
- Apply Fuzzy Logic to Real-world Scenarios: Apply fuzzy logic concepts and techniques to practical robotic applications, demonstrating the ability to enhance robot adaptability and autonomy in uncertain environments.

Teaching-Learning Process (General Instructions)

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

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

Module-1

Fuzzy set theory – Fuzzy sets – Operation on fuzzy sets – Scalar cardinality, fuzzy cardinality, union and intersection, complement (Yager and Sugeno), equilibrium points, aggregation, projection, composition, cylindrical extension, fuzzy relation – Fuzzy membership functions

Module-2

Fuzzy Arithmetic, Fuzzy Relations & Possibility Theory, Fuzzy Logic, Uncertainty based Information, Fuzzy Expert System – Overview, Fuzzy Controllers, Applications of Fuzzy Logic in Robotics.

Module-3

Modelling of non-linear systems using fuzzy models – TSK model – Fuzzy logic controller – Fuzzification – Knowledge base – Decision making logic – Defuzzification – Adaptive fuzzy systems – Familiarization with fuzzy logic toolbox. Features of membership function, Standard forms and Boundaries, membership value assignments, Fuzzy to Crisp Conversions, Defuzzification methods.

Module-4

Introduction to Neural Networks (7 hrs) Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, McCulloch - Pitts Neuron, Simple Neural Nets for Pattern Classification, Linear Separability - Hebb Net, Perceptron, Adaline, Madaline - Architecture, algorithm, and Simple Applications.

Module-5

Neural Networks: Case Studies: Inverted Pendulum, CMAC, Robotics, Image compression, and Control systems - Fuzzy Logic: Mobile robot navigation, Autotuning a PID Controller.

Course outcome (Course Skill Set)

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

1. Mastery of Fuzzy Logic Concepts: Achieve a high level of proficiency in understanding and applying fuzzy logic principles in the context of robotics.
2. Fuzzy Controller Design Skills: Develop the ability to design, implement, and fine-tune fuzzy logic controllers for robotic systems to handle uncertain and complex environments.
3. Effective Problem Solving: Demonstrate the capacity to use fuzzy logic to solve intricate robotic decision-making problems, including navigation, localization, and sensor fusion.
4. Improved Robotic Performance: Apply fuzzy logic-based control strategies to enhance robotic systems' performance, adaptability, and robustness in real-world scenarios.
5. Practical Application: Successfully implement fuzzy logic concepts in practical robotic applications, showcasing the capability to create more intelligent and responsive robotic systems in uncertain and dynamic environments.

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:

● For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.

● The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered

● Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two
assignments at the end of the semester if two assignments are planned.

● For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Fuzzy Sets and Fuzzy Logic – Theory and Applications, George J. Klir& Bo Yuan, Prentice Hall of India Private Limited.
2. Fuzzy Sets, Uncertainty and Information, George J. Klir& Tina A. Folger, Prentice Hall of India Private Limited.
3. Jacek M. Zurada, 'Introduction to Artificial Neural Systems', Jaico Publishing home, 2002.
4. Timothy J. Ross, 'Fuzzy Logic with Engineering Applications', Tata McGraw Hill, 2009.

Reference Books:

5. LaureneFausett, Englewood cliffs, N.J., 'Fundamentals of Neural Networks', Pearson Education, 2008.
6. Simon Haykin, 'Neural Networks', Pearson Education, 2003.
7. George.J.Klir, 'Fuzzy Sets and Fuzzy Logic – Theory and Applications', Pearson, 2015.

8. Rajasekaran, VijayalakshmiPai, “Neural Networks, Fuzzy Systems and Evolutionary Algorithms”, PHI Learning, 2017.
9. 5. Shigeo Abe, “Neural Networks and Fuzzy Systems”, Springer, 2012.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_ge04/preview
- https://onlinecourses.nptel.ac.in/noc23_ee21/preview

Machine Learning Fundamentals		Semester	IV
Course Code	**BRI405B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand Machine Learning Concepts: Develop a solid foundation in machine learning principles, algorithms, and techniques.
2. Implement Machine Learning Algorithms: Learn to implement and apply a range of machine learning algorithms for tasks such as classification, regression, clustering, and recommendation systems.
3. Evaluate Model Performance: Acquire the skills to assess and optimize machine learning model performance through metrics, cross-validation, and hyperparameter tuning.
4. Solve Real-world Problems: Apply machine learning to real-world problems and datasets, gaining experience in data preprocessing, feature engineering, and model deployment.
5. Explore Advanced Topics: Delve into advanced machine learning topics, including deep learning, natural language processing, and reinforcement learning, to understand the breadth of machine learning applications and techniques.

Teaching-Learning Process (General Instructions)

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

1. The lecturer's approach (L) does not have to be limited to traditional methods of teaching. It is possible to incorporate alternative and effective teaching methods to achieve the desired outcomes.
2. Utilize videos and animations to illustrate the functioning of different techniques used in the manufacturing of smart materials.
3. Foster collaborative learning exercises within the classroom to encourage group participation and engagement.
4. Pose a minimum of three Higher Order Thinking (HOT) questions during class discussions to stimulate critical thinking among students.
5. Implement Problem-Based Learning (PBL) as an approach that enhances students' analytical skills and nurtures their ability to design, evaluate, generalize, and analyze information, rather than solely relying on rote memorization.

Module-1

Overview of Artificial Intelligence and Machine Learning, Historical Context and Milestones in Machine Learning, Types of Machine Learning: Supervised, Unsupervised, Reinforcement, Machine Learning Workflow and Process Data Preparation and Preprocessing, Exploratory Data Analysis (EDA), Introduction to Python and Libraries (NumPy, Pandas, Matplotlib)

Module-2

Supervised Learning

Regression vs. Classification, Linear Regression, Logistic Regression, Decision Trees and Random Forests.

Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation, Crystal growth, cast metal structures, Solidification of Steels and Cast irons. Numerical on Lever rule.

Module-3

Support Vector Machines (SVM), K-Nearest Neighbors (KNN), Naive Bayes, Ensemble Methods and Model Evaluation Metrics

Module-4

Unsupervised Learning

Clustering Algorithms (K-Means, Hierarchical Clustering), Principal Component Analysis (PCA), Dimensionality Reduction Techniques, Association Rule Mining, Anomaly Detection, Evaluation of Unsupervised Models

Module-5
Introduction to Reinforcement Learning, Markov Decision Processes (MDPs), Dynamic Programming, Q-Learning and Value Iteration, Policy Gradient Methods, Deep Reinforcement Learning, Applications of Reinforcement Learning

Course Outcomes (COs)(Course Skill Set)

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

1. **Mastery of ML Foundations:** Achieve a strong command of fundamental machine learning concepts, algorithms, and methodologies.
2. **Proficient ML Implementation:** Develop proficiency in implementing a wide range of machine learning algorithms to solve diverse problem types.
3. **Data-Driven Decision Making:** Gain the ability to make data-driven decisions by evaluating and fine-tuning machine learning models for optimal performance.
4. **Real-world Problem Solving:** Apply machine learning techniques to address real-world problems, demonstrating the capability to preprocess data, engineer features, and deploy models effectively.
5. **Exploration of Advanced ML:** Explore advanced machine learning topics and techniques, including deep learning and reinforcement learning, to expand the breadth of machine learning expertise and applications.

Assessment Details (both CIE and SEE)

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

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination (SEE):

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

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

Suggested Learning Resources:

TEXT BOOKS:

Textbook/s

1. "Pattern Recognition and Machine Learning" by Christopher M. Bishop

   This widely used textbook provides a comprehensive introduction to machine learning, covering various topics from pattern recognition to probabilistic graphical models.

2. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy
   This book takes a probabilistic approach to machine learning, offering insights into both classical and modern techniques, along with practical examples and exercises.
3. "Introduction to Machine Learning with Python" by Andreas C. Müller and Sarah Guido
   Geared towards beginners, this book combines an introduction to machine learning with practical examples using the Python programming language and popular libraries like scikit-learn.
4. "Machine Learning: The Art and Science of Algorithms that Make Sense of Data" by Peter Flach
   This book provides a balanced and accessible introduction to machine learning concepts, algorithms, and their applications.

Reference Books:

1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
   A comprehensive reference on deep learning, covering neural networks, optimization, and generative models.
2. "Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili
   This reference book explores machine learning concepts and practical implementations using Python, with a focus on scikit-learn and TensorFlow.
3. "The Hundred-Page Machine Learning Book" by Andriy Burkov
   A concise and practical reference guide to machine learning concepts, algorithms, and best practices.
4. "Pattern Classification" by Richard O. Duda, Peter E. Hart, and David G. Stork
   A classic reference in pattern recognition and machine learning, this book provides a solid foundation in classification and feature selection techniques.
5. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
   This reference book focuses on practical implementations of machine learning using popular Python libraries like scikit-learn, Keras, and TensorFlow.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc23_ee87/preview
- https://onlinecourses.nptel.ac.in/noc23_cs18/preview

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

- Collaborative and Individual Project-Based Assessment

Robot Vision		Semester	IV
Course Code	**BRI405C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

The objectives of this course are to:

1. To learn fundamental image processing and algorithms in vision
2. To learn vision based image Classification, object recognition and object detection
3. To be familiar about the applications regarding vision

Teaching-Learning Process (General Instructions)

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

1. The lecturer's approach (L) does not have to be limited to traditional methods of teaching. It is possible to incorporate alternative and effective teaching methods to achieve the desired outcomes.
2. Utilize videos and animations to illustrate the functioning of different techniques used in the manufacturing of smart materials.
3. Foster collaborative learning exercises within the classroom to encourage group participation and engagement.
4. Pose a minimum of three Higher Order Thinking (HOT) questions during class discussions to stimulate critical thinking among students.
5. Implement Problem-Based Learning (PBL) as an approach that enhances students' analytical skills and nurtures their ability to design, evaluate, generalize, and analyze information, rather than solely relying on rote memorization.

Module-1

Introduction to Robot Vision

Overview of robot vision and its applications.

Image formation and representation. Image acquisition: cameras and sensors

Image pre-processing and enhancement techniquesBasic image filtering and feature extraction

Module-2

Image Processing and Analysis

Image segmentation: thresholding, edge detection, and region-based methods Feature extraction and representation: corners, blobs, texture, and colour featuresImage registration and alignment

Image-based measurements and morphological operations

Module-3

3D Perception and Depth Estimation

Stereoscopic vision and binocular disparity, Depth from motion and optical flow, Depth from focus and defocus Structured light and laser range finders, Time-of-flight, cameras and depth sensors

Module-4
Object Recognition and Tracking Object detection and localization, Feature-based object recognition, Template matching and correlation techniques,Model-based object recognition. Object tracking algorithms: Kalman filters, particle filters, and mean-shift tracking
Module-5
Advanced Topics in Robot Vision Image-based 3D reconstructionVisual servicing and control Scene understanding and semantic segmentation, Deep learning for robot vision Robot vision in real-world applications: industrial automation, autonomous vehicles, and robotics in healthcare
Course outcome (Course Skill Set) At the end of the course the student will be able to: 1. Understand the fundamentals of robotics and its applications. 2. Give an understanding of image processing for computer vision 3. Focus on early processing of images and the determination of structure: edges, lines, shapes 4. Apply computer vision to recognize objects, its trajectory and the basics of visual learningfor the purpose of classification. 5. Learn the applications of vision system in modern manufacturing environment

Assessment Details (both CIE and SEE)

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

- For the Assignment component of the CIE, there are 25 marks and for the InternalAssessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and thesecond test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct twoassignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methodsof assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom'staxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

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

Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. "Computer Vision: Algorithms and Applications" by Richard Szeliski, 2nd Edition, 2022.
2. "Robot Vision" by Berthold Klaus Paul Horn, Vol. 30, Issue 1, 1988. https://doi.org/10.1137/1030032.
3. "Introduction to Autonomous Robots: Kinematics, Perception, Localization, and Planning" by Nikolaus Correll, Bradley Hayes, 2016. ISBN: 0692700870, ISBN13: 9780692700877.
4. "Multiple View Geometry in Computer Vision" by Richard Hartley and Andrew Zisserman, Cambridge University Press, 2004.
5. "Machine Vision" by David Vernon, Prentice Hall International (UK), 1991, ISBN 0-13- 543398-3.

Web links and Video Lectures (e-Resources):

- https://www.baslerweb.com/en/vision-campus/markets-and-applications/robots-with- vision-technology/
- https://new.abb.com/products/robotics/application-equipment-and-accessories/vision- systems
- www.vision-systems.com
- www.invision-news.de
- www.en.vereinigte-fachverlage.info.

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

- Quizzes
- Assignments
- Worksheets
- Vision-Based Learning from Demonstration System for Robot Arms

SPREAD SHEETS FOR ENGINEERS			
Course Code	**BRI456A**	CIE Marks	50
Teaching Hours/Week(L:T:P:S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15 Lab sessions	Total Marks	100
Credits	01	Exam Hours	03

Course objectives:
This course will enable students to:

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

Pedagogy(General Instructions)

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

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

Sl.NO	Experiments
1	Charting: Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart
2	Functions: Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using The CONVERT Function to Convert Units
3	Conditional Functions: Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.
4	Regression Analysis: Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis Tool Pack.

5	Iterative Solutions Using Excel: Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver, Minimization Analysis, Non-Linear Regression Analysis.
6	Matrix Operations Using Excel: Adding Two Matrices, Multiplying a Matrix by a Scalar, Multiplying Two Matrices, Transposing a Matrix, Inverting a Matrix and Solving System of Linear Equations.
7	VBA User-Defined Functions (UDF): The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The For Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function The Excel Object Model, For Each Next Structure
8	VBA Subroutines or Macros: Recording a Macro, Coding a Macro Finding Roots by Bisection, Using Arrays, Adding a Control and Creating User Forms
	Demonstration Exercises
9	Numerical Integration Using Excel: The Rectangle Rule, The Trapezoid Rule, The Simpson's Rule, Creating a User-Defined Function Using the Simpson's Rule.
10	Differential Equations: Euler's Method, Modified Euler's Method, The Runge-Kutta Method, Solving a Second Order Differential Equation

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

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

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

1. Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
2. Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
3. Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
4. Weightage to be given for neatness and submission of record/write-upon time.
5. Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the8th week of the semester and the second test shall be conducted after the 14th week of the semester.

6. In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
7. The suitable rubrics can be designed to evaluate each student's performance and learning ability.
8. The average of 02 tests is scaled down to 20 marks (40% of the maximum marks). The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University. All laboratory experiments are to be included for practical examination. (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. OR based on the course requirement evaluation rubrics shall be decided jointly by examiners. Students can pick one question (experiment) from the question slot prepared by the internal/external examiners jointly. Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners. General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners) Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03hours

Suggested Learning Resources:

- Suggested Learning Resources: McFedries Paul Microsoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition

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

- Course seminars
- Mini projects, etc

Embedded C Basics

Course Code	**BRI456B**	SEMESTER	IV
		CIE Marks	50
Teaching Hours/Week(L:T:P:S)	0:0:2*:0	SEE Marks	50
TotalHours ofPedagogy	15 Lab Sessions	Total Marks	100
Credits	01	Exam Hours	03

Additional One hour may be considered for instructions if required

Course objectives:
This course will enable students to:

- Understand the basic programming of Microprocessor and microcontroller.
- To develop the microcontroller-based programs for various applications.

Sl.NO	Experiments
	Conduct the following experiments by writing C Program using Keilmicro vision simulator (any 8051 microcontroller can be chosen as the target).
1	Write a 8051 C program to multiply two 16 bit binary numbers.
2	Write a 8051 C program to find the sum of first 10 integer numbers.
3	Write a 8051 C program to find factorial of a given number.
4	Write a 8051 C program to add an array of 16 bit numbers and store the 32 bit result in internal RAM
5	Write a 8051 C program to find the square of a number (1 to 10) using look-up table
6	Write a 8051 C program to find the largest/smallest number in an array of 32 numbers
7	Write a 8051 C program to arrange a series of 32 bit numbers in ascending/descending order
8	Write a 8051 C program to count the number of ones and zeros in two consecutive memory locations.
9	Write a 8051 C program to scan a series of 32 bit numbers to find how many are negative.
10	Write a 8051 C program to display “Hello World” message (either in simulation mode or interface an LCD display).
11	Write a 8051 C program to convert the hexadecimal data 0xCFh to decimal and display the digits on ports P0, P1 and P2 (port window in simulator).

Course outcomes (Course Skill Set):

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

1. Write C programs in 8051 for solving simple problems that manipulate input data using different instructions of 8051 C.
2. Develop testing and experimental procedures on 8051 Microcontroller, analyze their operation under different cases.
3. Develop programs for 8051 Microcontroller to implement real world problems.
4. Design and Develop Mini projects

AssessmentDetails(bothCIEandSEE)

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

ContinuousInternalEvaluation(CIE):

CIEmarksforthepracticalcourseis **50Marks**.

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will beevaluatedfor10marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-upon time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th}week of thesemesterandthesecondtestshallbeconductedafterthe14^{th}weekof thesemester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20marks** (40%of the maximum marks).

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

Semester End Evaluation(SEE):

SEE marks for the practical course is 50 Marks.

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

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

Students can pick one question (experiment) from the question slot prepared by the internal/external examiners jointly. Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners. General rubrics suggested for SEE are mentioned here, write up-20%, Conduction procedure and result in-60%,Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and15% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

SuggestedLearningResources:

1. "The 8051 Microcontroller: Hardware, Software and Applications", V Udayashankara and M S MallikarjunaSwamy, McGraw Hill Education, 1st edition, 2017.
2. https://www.quora.com/What-are-the-best-resources-to-learn-Embedded-C
3. https://github.com/aaronjense/Learn-Embedded-Systems
4. https://www.reddit.com/r/embedded/comments/va0qoh/good_resource_for_embedded_c/
5. https://www.youtube.com/watch?v=G1c_WMD_5pU

Supervisory Control and Data Acquisition System (SCADA)			
Course Code	**BRI456C**	Semester	IV
		CIE Marks	50
Teaching Hours/Week(L:T:P:S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

This course will enable students to:

- Understand the importance of IoT for consumers and SCADA for entrepreneurs
- Understand and apply the concept of SCADA for heavy machineries and its intelligent management system is going to be completely taken over by the technology of SCADA
- Apply the knowledge of SCADA system for its technologies possess and to give the education of the best practices followed for securing important data in small and large scale industries.

Pedagogy(General Instructions)

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

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

Module-1

Introduction to SCADA system: Network Segmentation and Segregation , Boundary Protection, Firewalls , Logically Separated Control Network , Network Segregation, Recommended Defence-in-Depth Architecture, General Firewall Policies for ICS , Recommended Firewall Rules for Specific Services , Network Address Translation (NAT), Specific ICS Firewall Issues , Unidirectional Gateways , Single Points of Failure , Redundancy and Fault Tolerance

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

Module-2

Network Segregation: Dual-Homed Computer/Dual Network Interface Cards (NIC) , Firewall between Corporate Network and Control Network , Firewall and Router between Corporate Network and Control Network , Firewall with DMZ between Corporate Network and Control Network , Paired Firewalls between Corporate Network and Control Network , Network Segregation Summary

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

Module-3	
Recommended Firewall Rules for Specific Services: Domain Name System (DNS) , Hypertext Transfer Protocol (HTTP) ,FTP and Trivial File Transfer Protocol (TFTP) ,Telnet ,Dynamic Host Configuration Protocol (DHCP) , Secure Shell (SSH) ,Simple Object Access Protocol (SOAP) , Simple Mail Transfer Protocol (SMTP), Simple Network Management Protocol (SNMP) ,Distributed Component Object Model (DCOM),SCADA and Industrial Protocols: DNP3 Protocol. Smart Grid Security.	
Pedagogy	Power point presentation along with chalk and board Real time examples through video
Module-4	
Information Hiding Techniques: Introduction to Steganography, Watermarking. Differences between Watermarking and Steganography, A Brief History. Digital Steganography, Applications of Steganography, Covert Communication, Techniques of steganography (for Text and Image). Steganography Software: S-Tools, StegoDos, EzStego, Jsteg-Jpeg.	
Pedagogy	Demonstrating videos related to the topic Power point presentation along with chalk and board Real time examples through video
Module-5	
Digital Water Marking: Classification in Digital Watermarking, Classification Based on Characteristics: Blind versus Non-blind, Perceptible versus Imperceptible, Private versus Public, Robust versus Fragile, Spatial Domain-Based versus Frequency Domain-Based. Classification Based on Applications: Copyright Protection Watermarks, Data Authentication Watermarks, Fingerprint Watermarks, Copy Control Watermarks, Device Control Watermarks. Watermarking Techniques for Visible and Invisible Watermarks. Watermarking tools: uMark, TSR Watermark. Steganalysis	
Pedagogy	Animation, Power point presentation along with chalk and board Real time examples through video

Course outcome (Course Skill Set)

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

1. Understand the concept of SCADA system and the importance of Firewall and other safety systems.
2. Explain the importance of different control network systems applied to different sectors
3. Understand the importance and explain the concept of firewall safety applications for a specified task
4. Understand the concept of various information hiding techniques used in actual control system.
5. Ability to perform the specified task on digital water marking for various applications

Assessment Details (both CIE and SEE)

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 Examination (CIE)

• For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.

• The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered

• Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for

the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.

• For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

• SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions).

• The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

1. Macaulay, T. & Singer, B. (2016). Cybersecurity for industrial control systems: SCADA, DCS, PLC, HMI, and SIS. Boca Raton, FL: CRC Press.
2. Langner, R. (2011). Robust control system networks: How to achieve reliable control after Stuxnet. New York: Momentum Press.
3. Knapp, E.D. &Langill, J.T. (2011). Industrial network security: Securingcritical infrastructure networks for smart grid, SCADA , and other industrial control systems. Waltham, MA: Syngress Media, U.S.
4. Katzenbeisser, S. & Fabien A P. (2000). Information Hiding Techniques forSteganography and Digital Watermarking. Petitcolas, Artech House. 5. Cox, I., Miller, M., Bloom, J., Fridrich, J. &Kalker, T. (2007). Digital WatermarkingandSteganography (2nd Ed.). Elsevier.

Latest research papers from refereed journals discussed by the faculty may also be referred.

Web resources:

- https://sscbs.du.ac.in/wp-content/uploads/2020/05/Paper-203-Supervisory-Control-and-Data-Acquisition-SCADA-System-and-Information-Hiding-Techniques-92911202.pdf
- https://www.advanceelectricaldesign.com/Syllabus-of-PLC-SCADA-Training-Course
- https://www.gradplus.pro/lessons/s071-plc-and-scada-systemopen-elective-1-syllabus/
- https://www.vturesource.com/vtu-syllabus/EE/2018/6/18EE652

Applications of Raspberry Pi Controllers

Course Code	**BRI456D**	Semester	IV
		CIEMarks	50
Teaching Hours/Week (L:T:P:S)	0:0:2*:0	SEEMarks	50
Total Hours of Pedagogy	15 Lab Sessions	TotalMarks	100
Credits	01	ExamHours	03

Additional One hour may be considered for instructions if required

Courseobjectives:

This course will enable students to:

- To understand and use Raspberry Pi controllers.

Sl.NO.	Experiments
1	Creating the sensor project.
2	Creating the actuator project.
3	Creating a controller.
4	Creating a camera.
5	To study the architecture of SOC Broadcom-2835 application board of Raspberry Pi.
6	To demonstration the OS (Debian) for RPiina SD card preparation, configuration of Raspberry Pi during first booting and use of remote SS Hlikeputty
7	To demonstrate the basic linux commands on Raspberry pi.
8	To create a data base & Store the value in Raspberry Pi.
9	To install Android on Raspberry Pi.
10	To Set up RPi first time without using screen, mouse, keyboard.
11	To interface ADC at GPIO so Raspberry Pi for measuring analog voltage.

LIST OF EQUIPMENTS BATCH OF 30 STUDENTS:

Raspberry Pi controller Kits–10 numbers 10 Systems with server

All related components with respect to the experiments.

Course outcomes (Course Skill Set):

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

- Apply Raspberry Pi controller in different fields.

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 (CIE):

CIE marks for the practical course are 50 Marks.

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

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

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

Semester End Evaluation (SEE):

● SEE marks for the practical course are 50 Marks.
● SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the Head of the Institute.
● The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedules mentioned in the academic calendar of the University.
● All laboratory experiments are to be included for practical examination.
● (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. OR based on the course requirement evaluation rubrics shall be decided jointly by examiners.
● Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
● Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
● General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
● Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero. The minimum duration of SEE is 02 hours