Fundamentals of Robotics and Applications		Semester	III
Course Code	**BRA301**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**3:0:0:0**	SEE Marks	50
Total Hours of Pedagogy	**42**	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 various path planning techniques.
4. Illustrate the working of innovative robotic devices

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
Path Planning: Definition-Joint space technique, Use of P-degree polynomial-Cubic,polynomial-Cartesian space technique, parametric descriptions, straight line and circular paths, position and orientation planning.
Module-5
Robotics Applications: Material Handling: pick and place, palletizing and depalletizing, machining loading and unloading, welding & assembly, Medical, agricultural and space applications, unmanned vehicles: ground, ariel and underwater applications, robotic for computer integrated manufacturing. Types of robots: Manipulator, Legged robot, wheeled robot, aerial robots, Industrial robots, Humanoids, Cobots, Autonomous robots, and Swarm robots
Course Outcomes (COs) (Course Skill Set) At the end of the course, the student will be able to : CO1: Understand the significance, social impact and future prospects of robotics and automation in various engineering applications. CO2: Identify and describe the components and anatomy of robotic system. CO3: Know about various path planning techniques and analyze different motions of robotics system CO4: Use the suitable drives and end-effectors for a given robotics application. CO5: Apply robotics concept to automate the monotonous and hazardous tasks and 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 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'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).**

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

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.

Web links and Video Lectures (e-Resources):

1. https://roboticscasual.com/ros-tutorial-pick-and-place-task-with-the-moveit-c-interface/
2. https://roboticscasual.com/ros-tutorial-simulate-ur5-robot-in-gazebo-urdf-explained/
3. https://roboticscasual.com/the-best-degrees-to-work-in-robotics/
4. https://roboticscasual.com/robotics-tutorials/
5. https://www.ieee-ras.org/educational-resources-outreach/educational-material-in-robotics-and-automation
6. https://www.academia.edu/20361073/Web_Based_Control_and_Robotics_Education_pdf
7. https://github.com/Developer-Y/cs-video-courses
8. https://www.isa.org/
9. https://www.asme.org/engineering-topics/articles/bioengineering/top-6robotic- applications-in-medicine.

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

1. Adaptation Of Content From Different Disciplines
2. Constructivist Approaches To Learning
3. Situated Learning Methodology
4. Flipped Classroom
5. Gamification
6. Online Interactive Tools
7. Collaborative And Individual Project-Based Assessment
8. Quizzes/Assignment, etc

Fabrication Methods of Robotic Components		Semester	III
Course Code	**BRA302**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	**3:0:2:0**	SEE Marks	50
Total Hours of Pedagogy	**42 hours Theory + 28 hours of lab**	Total Marks	100
Credits	**04**	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course Objectives

The course will enable the students to:

1. Introduce students to different methods of fabrication used in the manufacturing of robotic components.
2. Develop an understanding of the materials used in robotic component fabrication and their properties. Familiarize students with traditional manufacturing processes commonly employed in the robotics industry.
3. Provide an overview of additive manufacturing techniques and their applications in robotics.
4. 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 PowerPoint 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 skillssuch as evaluating, generalizing, and analyzing information.
5. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1

Methods of Fabrication: Introduction to Fabrication Methods, Definition of fabrication methods, Importance of fabrication in robotics and automation, Overview of different fabrication techniques. Welding and Joining Techniques, Types of welding processes (arc welding, spot welding) Principles and applications of welding in robotic, component fabrication, Joint design considerations, Machining Processes, Introduction to machining operations (turning, milling, drilling, etc.).

Machining tools and equipment: used in robotic component fabrication, Cutting parameters and tool selection, Sheet Metal Fabrication, Basics of sheet metal fabrication, Techniques for bending, cutting, and forming sheet metal, Applications of sheet metal in robotic component manufacturing.

Module-2

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-3

Traditional Manufacturing: Casting and Molding, Principles and processes of casting and molding, Different types of casting techniques (sand casting, investment casting.) Molding techniques for robotic component production, Forming and Stamping, Introduction to forming and stamping processes, Presses and tools used in forming and stamping operations, Applications and advantages of forming and stamping in robotics.

Machining and CNC Operations: Advanced machining techniques for robotic component fabrication, Introduction to Computer Numerical Control (CNC) machines, Programming basics for CNC machining.

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 useof 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:** Organize workshop for students in designing and 3D printing simple robotic components using different materials and printing techniques.
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 on their properties.

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

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

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%. 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:

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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:

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

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	**BRA303**	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 to 10 Lab slots**	Total Marks	100
Credits	**04**	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course Objectives:

This course will enable students to:

1. To understand the basics and applications of diodes and transistors
2. To understand the basics and applications of OPAMPS
3. To Illustrate simplification of Algebraic equations using Karnaugh Maps and Quine-McClusky Techniques.
4. To Design Decoders, Encoders, Digital Multiplexer, Adders, Subtractors and Binary Comparators.
5. 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 a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various analog and digital circuits.
3. Encourage collaborative (Group) Learning in the class.
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students understanding.

Module-1

Clippers, Clampers, RC Coupled Amplifier, Feedback Amplifiers: Voltage Series, Voltage Parallel, Current Series, Current Parallel.

Module-2

OP AMP: Block Diagram, OP AMP Configuration, Binary Weighted Resistor D/A Converter, Successive Approximation A/D Converter.

Module-3

Principles of combinational logic: Definition of combinational logic, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4,5 variables, Incompletely specific functions (Don't care terms) Simplifying Max term equations, Quine-McClusky techniques – 3 & 4 variables.

Module-4

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

Module-5

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

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

Sl.NO	Experiments
1	To construct and observe clipping for different configurations.
2	To construct and find bandwidth of RC coupled amplifier
3	To construct and check oscillation frequency for RC phase shift oscillator.
4	To construct and obtain OPAMP Astable multivibrator
5	Design and implement (i) Half Adder & Full Adder using i) basic gates. ii) NAND gates (ii) Half Subtractor & Full Subtractor using i) basic gates ii) NAND gates.
6	Design and implement 4-bitParallelAdder/Subtractor using IC 7483.
7	Design and Implementation of 1-bit Comparator.
8	Realize4-variable function using IC74151 (8:1MUX).
9	Realize the following flip-flops using NAND Gates. JK, D Flip-Flop.
10	Realize 4 bit SISO, SIPO, PIPO using D Flip flop.
11	Realize 3 bit asynchronous counter using JK flip flop.
12	Realize 3 bit synchronous counter using D flip flop

Course Outcomes (COs)(Course Skill Set):

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

CO1: Understand analyse clippers, clampers, amplifier and D/A and A/D converter circuits.
CO2: Explain opamp basics and Analyse OPAMP applications.
CO3: Explain the concept of combinational and sequential logic circuits.
CO4: Design the combinational logic circuits.
CO5: Design the sequential circuits using SR, JK, D, T flip-flops

Assessment Details (both CIE and SEE)

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

1. PCC means practical portion integrated with the theory of the course.
2. CIE marks for the theory component are 25 marks and that for the practical component is 25 marks.
3. 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.
4. 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).
5. 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

1. 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.
2. 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.
3. 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.
4. 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.
5. Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for 25 marks.
6. 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.

Suggested Learning Resources:

Text Book:

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, Pearson Education, 20015.
3. John M Yarbrough,-Digital Logic Applications and Design, Thomson Learning, 2001.
4. Donald D. Givone, —Digital Principles and Design, McGraw Hill, 2002.
5. Charles H Roth Jr., Larry L. Kinney —Fundamentals of Logic Design, Cengage Learning, 7th Edition, 2013.

Web links and Video Lectures (e-Resources):

1. E-book versions are available at 'https://www.knimbus.com/' of the VTU consortium.
2. Remote login available through respective college IDs.
3. https://youtu.be/Y5a43s0mXto

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

1. Visit to electronics industry.

Mechanics of Solids and Fluids		Semester	III
Course Code	**BRA304**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	SEE Marks	50
Total Hours of Pedagogy	**40 Hours**	Total Marks	100
Credits	**03**	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course Objectives:

The course will enable the students to

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

Teaching-Learning Process (General Instructions)

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

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt 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 analysing information.
5. 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 (circular and rectangular), Elongation due to selfo-weight, Principle of super position. Volumetric strain, expressions for volumetric strain for bars with uniform circular and rectangular cross sections. Simple shear stress and shear strain, Elastic constants (No derivation for relationship between elastic constants).

Module-2

Bending Moment and Shear Force in Beams: Introduction - types of beams, loads and reactions, Shear force and bending moment, Sign conventions, Relationship between load intensity, shear force and bending moment; Shear force and Bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams.

Module-3

Torsion of Circular Shafts: Introduction, Torsion equation - assumptions and derivation, Torsional rigidity / Stiffness of shafts. Power transmitted by solid and hollow circular shafts, Simple numerical problems.

Columns: Introduction, End conditions, Assumptions in deriving Euler's equations, Sign conventions for bending moments, Euler's formulas (no derivation) for axially loaded elastic long columns, Limitations of Euler's theory, Rankine's formula.

Module-4

Properties of Fluids: Introduction, Properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure and cavitation.

Fluid Statics: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute,gauge, Atmospheric and vacuum pressures, simple manometers and differential manometers. Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid.

Module-5

Fluid Kinematics: Types of fluid flow, continuity equation in 2D and 3D (Cartesian Coordinates only), velocity and acceleration

Fluid Dynamics: Introduction equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation.

Course Outcome (COs) (Course Skill Set)

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

CO1: Provide the basic concepts and principles of mechanics of materials.

CO2: Calculate stresses and deformations of objects under external loadings.

CO3: Apply the knowledge of mechanics of materials applications and design 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 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:

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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.
3. 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.
4. 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. Strength of Materials by R K Rajput, S. Chand and Company Pvt, 2014.
2. Strength of Materials", S.S. Rattan, Tata McGraw Hill, 2009.
3. Fundamentals of Strength of Materials by P N Chandramouli, PHI Learning Pvt. Ltd,2013.
4. Mechanics of Materials by R C Hibbeler, Pearson, Latest edition
5. A Text Book of Fluid Mechanics and Hydraulic Machines" Dr R.K Bansal Laxmi Publishers.
6. "Fluid Mechanics (SI Units)" Yunus A. Cengel John M.Cimbala, TataMcGraw Hill 3rd Edition, 2014.

Web links and Video Lectures (e-Resources):

1. https://sm-nitk.vlabs.ac.in/List%20of%20experiments.html
2. https://archive.nptel.ac.in/courses/112/105/112105269/
3. https://archive.nptel.ac.in/courses/112/107/112107146/
4. https://nptel.ac.in/courses/112107146

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

1. Tensile Testing and Material Properties: Conduct hands-on tensile testing experiments where students can test different materials to determine their mechanical properties, such as yield strength, ultimate strength, and modulus of elasticity.
2. Strain Measurement Techniques: Introduce students to various strain measurement techniques, such as strain gauges or extensometers
3. Failure Analysis Case Studies: Assign students real-world case studies of structural failuresand ask them to analyze the reasons behind the failures. They can investigate factors like material properties, design flaws, and loading conditions.
4. Bernoulli's Principle Demonstrations: Conduct demonstrations to illustrate Bernoulli'sprinciple and its applications.

Robotic Systems Drawing and Standards Lab		Semester	III
Course Code	BARL305	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	35	Total Marks	100
Credits	01	Exam Hours	03
Examination nature (SEE)	**Practical**/Viva-Voce		

Course Objectives:

This course will enable students to:

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

Teaching-Learning Process (General Instructions)

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

1. Power Point Presentation,
2. Chalk and Talk are used for Problem Solving.
3. Video demonstration.
4. Laboratory Demonstrations and Practical Experiments.
5. Model building.

Module-1(only for CIE)

Review of basic concepts of Engineering Visualization

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

Module-2 (only for IE)

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

Module-3 (only for CIE)

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

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

Rivets Keys: Parallel key, Taper key, Feather key, Gib-head key and Wood ruff key

Module-4 (03Sessions)

Assembly of Joints, couplings and clutches (with GD&T) using 2D environment Joints: Like Cotter joint (socket and spigot), knuckle joint (pin joint).

Couplings: Like flange decoupling, universal coupling.

Clutches: Like Single Plate clutch, cone clutches.

Module-5

Assembly of Components (with GD&T) using 3Denvironment *(Part drawings shall be given)*

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

Course outcome (Course Skill Set)
At the end of the course the student will be able to:

CO1: Interpret the Machining and surface finish symbols on the component drawings.
CO2: Apply limits and to learn to assemble and choose appropriate fits for given assemblies.
CO3: Illustrate various machine components through drawings
CO4: Create assembly drawings as per the conventions

Assessment Details (both CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 print out	**Preparatory sketching**
Module1	10	05	05
Module2	15	10	05
Module3	25	20	05
Module4	25	20	05
Module5	25	25	00
Total	**100**	**80**	**20**

Semester End Evaluation (SEE):
SEE marks for the practical course is **50 Marks.**

1. The duration of SEE is 03 hours. **Questions shall be set worth of 3hours**
2. SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the University.
3. SEE shallbeconductedandevaluatedformaximummarks100.MarksobtainedshallbeaccountedforSEE final marks, reducing t to50marks.
4. Question paper shall be set jointly by both examiners and made available for each batch as per schedule.
5. Questions are to be set preferably from Text Books.
6. Evaluation shall be carried jointly by both the examiners.
7. Scheme of Evaluation: To be defined by the examiners jointly and the same shall be submitted to the University along with question paper.
8. One full question shall be set from Modules 4 and 5 as per the below tabled weightage details.
9. However, the student may be awarded full marks, if he/she complete solution on computer display without sketch

Module	Max. Marks Weightage	Evaluation Weightage in marks	
		Computer display printout	Preparatory sketching
Module4	40	30	10
Module5	60	50	10
Total	**100**	**80**	**20**

Suggested Learning Resources:
Books:

1.K L Narayana, P Kannaiah, K Venkata Reddy, "Machine Drawing", New Age International, 3rd Edition. ISBN-13:978-81-224-2518-5,2006

2.N D Bhatt , "Machine Drawing", Charotar Publishing House Pvt. Ltd.,50th Edition, ISBN-13: 978-9385039232,2014

Reference Books:

1. Sadhu Singh, P. L. Sah, "Fundamentals of Machine Drawing", PHI Learning Pvt. Ltd, 2nd Edition, ISBN:9788120346796,2012
2. Ajeet Singh, "MACHINEDRAWING", Tata McGraw Hill Education,, ISBN:9781259084607,2012.

We blinks and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=TJ4jGyDWCw
2. https://www.youtube.com/watch?v=dmt6n7Sgcg
3. https://www.youtube.com/watch?v=MQScnLXL0M
4. https://www.youtube.com/watch?v=3WXPanCq9LI
5. https://www.youtube.com/watch?v=fvjk7PlxAuo
6. http://www.me.umn.edu/coursesme2011/handouts/engg%20graphics.pdf
7. https://www.machinedesignonline.com

ActivityBasedLearning(SuggestedActivitiesinClass)/PracticalBasedlearning

1. Puzzles, Games, Role play, demonstrations using real objects, model building, taking students on an educational tour, playing a subject-related video, and showing a documentary in the classroom are all examples of activity-based learning/teaching methods

Basic Communication Systems		Semester	III
Course Code	**BRA306A**	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:

1. To prepare students with fundamental knowledge in the field of Communication systems.
2. Use of different modulation and demodulation techniques used in the communication.
3. Analyze transmitter and receiver circuits.
4. Compare design issues, advantages, disadvantages and limitations of communicationsystems.

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 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

Analog Communication

Introduction to Communication Systems – Modulation – Types – Need for Modulation. Theory of Amplitude Modulation – Evolution and Description of SSB Techniques – Theory of Frequency and Phase Modulation – Comparison of Analog Communication Systems.

Module-2

Data and Pulse Communication

Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse Code Modulation (PCM) – Comparison Of Various Pulse Communication System .Data Communication: History Of Data Communication – Standards, Organizations For Data Communication- Data Communication Circuits – Data Communication Codes – Data Communication Hardware – Serial And Parallel Interfaces.

Module-3

Digital Modulation

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK)–Phase Shift Keying(PSK) – BPSK – QPSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM– Bandwidth Efficiency– Comparison of various Digital Communication System.

Module-4

Source And Error Control Coding

Entropy, Source Encoding Theorem, Shannon Fano Coding, Huffman Coding, Mutual Information, Channel Capacity, Error Control Coding, Linear Block Codes, Cyclic Codes –ARQ Techniques

Module-5

Multi-User Radio Communication

Global system for mobile communications (GSM) – Code Division Multiple Access (CDMA) – Cellular concept and Frequency Reuse – Channel Assignment and Handover Techniques – Overview of Multiple Access Schemes – Satellite Communication – Bluetooth.

Course Outcome (COs) (Course Skill Set)

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

CO1: Analyze digital and Analog communication circuits

CO2: Compare the various AM and FM modulation techniques and analyze the related degree of modulation factors, bandwidth, etc., given the voltage/frequency amplitudes of the carrier signals and the intelligence signals.

CO3: Apply pulse code modulation techniques to a given analog signal.

CO4: Examine how analog-to-digital and digital-to-analog converters are used in a give communication system

Assessment Details (both CIE and SEE)

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

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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. Wayne Tomasi, "Advanced Electronic Communication Systems", 6th Edition, Pearson Education, 2009.
2. B.P.Lathi,"Modern Analog and Digital Communication Systems", 3 rd Edition,Oxford University Press,2007.

Reference :

1. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, 2004
2. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education,2007.
3. H.Taub, D L Schilling and G Saha, "Principles of Communication", 3rd Edition, PearsonEducation, 2007.
4. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.
B.Sklar,"Digital Communication Fundamentals and Applications"2nd Edition PearsonEducation2007

Web links and Video Lectures (e-Resources):

1. https://www.digimat.in/nptel/courses/video/117105143/L01.html
2. https://www.digimat.in/nptel/courses/video/117105144/L01.html

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

1. Generation and detection of AM and FM
2. Experiments on PAM, PPM, PWM, Sampling, PCM
3. Experiments on ASK, FSK and PSK
4. Simulation of error control coding schemes
5. Simulation of Communication link

Robot Vision		Semester	III
Course Code	**BRA306B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**3:0:0:0**	SEE Marks	50
Total Hours of Pedagogy	**42**	Total Marks	100
Credits	**03**	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course Objectives:

The objectives of this course are:

1. To learn fundamental image processing and algorithms in vision systems
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)

1. These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.
2. 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.
3. Utilize videos and animations to illustrate the functioning of different techniques used in the manufacturing of smart materials.
4. Foster collaborative learning exercises within the classroom to encourage group participation and engagement.
5. Pose a minimum of three Higher Order Thinking (HOT) questions during class discussions to stimulate critical thinking among students.
6. 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 techniques Basic 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 features Image 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 reconstruction Visual 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 (COs) (Course Skill Set)

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

CO1: Understand the fundamentals of robotics and its applications.

CO2: Give an understanding of image processing for computer vision

CO3: Focus on early processing of images and the determination of structure: edges, lines, shapes

CO4: Apply computer vision to recognize objects, its trajectory and the basics of visual learning for the purpose of classification.

CO5: 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 Evaluation:

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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

Web links and Video Lectures (e-Resources):

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

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

1. Quizzes
2. Assignments
3. Worksheets
4. Vision-Based Learning from Demonstration System for Robot Arms

Linear Integrated Circuits		Semester	III
Course Code	**BRA306C**	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 wave form Generators using operational amplifiers circuits
4. Compared sign 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 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 communication systems.
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. Realization of monolithic ICs and packaging. Fabrication of diodes, 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, Logand Antilog Amplifiers- Analog multiplier & Divider, first and second order active filters, comparators, multivibrator, wave form 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

Timers:

Functional block, characteristics of 555 Timer and its PW application—IC-566 voltage controlled oscillator IC; 565-phase locked loop IC, AD 633Analog multiplier ICs.

Module-5

Applications:

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, 723Variability voltage regulators, switching regulator-SMPS—ICL8038 function generator IC.

Course Outcome (COs) (Course Skill Set)

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

CO1. Design linear and non-linear applications of OP–AMPS

CO2. Design ADC and DAC using OP–AMPS

CO3. Generate wave forms using OP–AMP Circuits

CO4. 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) 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:

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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. D. Roy Choudhry, ShailJain,"Linear Integrated Circuits", New Age International Pvt. Ltd., Fifth edition 2018.
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Forth Edition, Tata McGraw-Hill, 2014.

Reference:

1. Ramakant A.Gayakwad, "OP-AMP and Linear ICs", 4th Edition, Prentice Hall/ Pearson Education, 2001.
2. RobertF.Coughlin, Frederick F. Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Sixth Edition, PHI, 2001.

Web links and Video Lectures (e-Resources):

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

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

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

Data Structures and Applications		Semester	III
Course Code	**BRA306D**	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. Explain fundamentals of data structures and their applications essential forprogramming/problem solving
2. Illustrate linear representation of data structures: Stack, Queues, Lists, Trees and Graphs.
3. Demonstrate sorting and searching algorithms.
4. Find suitable data structure during application development/Problem Solving

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 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

Introduction: Data Structures, Classifications (Primitive & Non Primitive), Data structure Operations, Review of Arrays, Structures, Self-Referential Structures, and Unions. Pointers and Dynamic Memory Allocation Functions. Representation of Linear Arrays in Memory, Dynamically allocated arrays.

Array Operations: Traversing, inserting, deleting, searching, and sorting. Multidimensional Arrays, Polynomials and Sparse Matrices.

Strings: Basic Terminology, Storing, Operations and Pattern Matching algorithms. Programming Examples.

Module-2

Stacks: Definition, Stack Operations, Array Representation of Stacks, Stacks using Dynamic Arrays, Stack Applications: Polish notation, Infix to postfix conversion, evaluation of postfix expression. Recursion - Factorial, GCD, Fibonacci Sequence, Tower of Hanoi, Ackerman's function.

Queues: Definition, Array Representation, Queue Operations, Circular Queues, Circular queues using Dynamic arrays, Dequeues, Priority Queues, A Mazing Problem.

Module-3

Linked Lists: Definition, Representation of linked lists in Memory, Memory allocation; Garbage Collection. Linked list operations: Traversing, Searching, Insertion, and Deletion. Doubly Linked lists, Circular linked lists, and header linked lists. Linked Stacks and Queues. Applications of Linked lists – Polynomials, Sparse matrix representation. Programming Examples.

Module-4

Trees: Terminology, Binary Trees, Properties of Binary trees, Array and linked Representation of Binary Trees, Binary Tree Traversals – In order, post order, pre order; Additional Binary tree operations. Threaded binary trees, Binary Search Trees – Definition, Insertion, Deletion, Traversal, Searching, Application of Trees-Evaluation of Expression, Programming Examples.

Module-5

Gr**aphs:** Definitions, Terminologies, Matrix and Adjacency List Representation Of Graphs, Elementary Graph operations, Traversal methods: Breadth First Search and Depth First Search. Sorting and Searching: Insertion Sort, Radix sort, Address Calculation Sort. Hashing: Hash Tableorganizations, Hashing Functions, **Static and Dynamic Hashing:** Files and Their Organization: Data Hierarchy, File Attributes, Text Files and Binary Files, Basic File Operations, File Organizations and Indexing.

Course Outcome (COs) (Course Skill Set)
At the end of the course, the student will be able to :

CO1. Use different types of data structures, operations and algorithms.
CO2. Apply searching and sorting operations on files.
CO3. Use stack, Queue, Lists, Trees and Graphs in problem solving.
CO4. Implement all data structures in a high-level language for problem solving.

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:

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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. Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures in C, 2nd Ed,Universities Press, 2014.
2. Seymour Lipschutz, Data Structures Schaum's Outlines, Revised 1st Ed, McGraw Hill,2014.

Reference :

1. Gilberg & Forouzan, Data Structures: A Pseudo-code approach with C, 2nd Ed, Cengag Learning,2014.
2. Reema Thareja, Data Structures using C, 3rd Ed, Oxford press, 2012.
3. Jean-Paul Tremblay & Paul G. Sorenson, An Introduction to Data Structures withApplications, 2 nd Ed, McGraw Hill, 2013.
4. A M Tenenbaum, Data Structures using C, PHI, 1989 5. Robert Kruse, Data Structures andProgram Design in C, 2nd Ed, PHI, 1996

Web links and Video Lectures (e-Resources):

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

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

1. Array implementation of List Abstract Data Type (ADT)
2. Linked list implementation of List ADT
3. Cursor implementation of List ADT
4. Array implementations of Stack ADT
5. Linked list implementations of Stack ADT
6. Implement the application for checking 'Balanced Paranthesis' using array implementationof Stack ADT (by implementing files (a) and (b) given above)
7. Implement the application for checking 'Balanced Paranthesis' using linked list implementation of
8. Stack ADT (by using file (a) from experiment 6 and implementing file (c))
9. Implement the application for 'Evaluating Postfix Expressions' using array and linked list implementations of Stack ADT (by implementing file (d) and using file (b), and then by usingfiles (d) and (c))
10. Queue ADT
11. Search Tree ADT - Binary Search Tree
12. Heap Sort
13. Quick Sort

Template for Practical Course and if AEC is a practical Course

Introduction to Python		Semester	III
Course Code	**BRA358A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**0:0:2:0**	SEE Marks	50
Teaching Hours Pedagogy	**14 sessions**	Total Marks	100
Credits	**01**	Exam Hours	03
Examination nature (SEE)	**Practical**		

Course objectives:

The objectives of this course are to:

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

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

Course Outcome (COs) (Course Skill Set)

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

CO1: Demonstrate proficiency in handling of loops and creation of functions.

CO2: Identify the methods to create and manipulate lists, tuples and dictionaries.

CO3: Discover the commonly used operations involving regular expressions and file system.

CO4: Examine working of PDF and word file formats

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

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

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-up on time.
5. Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
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 students

Semester End Evaluation (SEE):

1. 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.
2. 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.
3. The duration of SEE is 03 hours 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.
4. The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3" 1 st Edition, CreateSpace Independent Publishing Platform, 2016. (http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf).

2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2 nd EditiGreen Tea Press, 2015. http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Download pdf files from the above links).
3. Al Sweigart, "Automate the Boring Stuff with Python",1 st Edition, No Starch Press, 2015. (Available under CC-BYNC-SA license at https://automatetheboringstuff.com/).
4. Reema Thareja "Python Programming Using Problem Solving Approach" Oxford University Press.

Template for Practical Course and if AEC is a practical Course

Applications of MAT LAB		Semester	III
Course Code	BRA358B	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	14 Lab sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination nature (SEE)	**Practical**		

Course objectives:

The objectives of this course are to:

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

Sl.NO.	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

Course Outcomes (COs) (Course Skill Set):

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

CO1: Having an ability to apply mathematics and science in engineering applications.
CO2: Having a clear understanding of the subject related concepts and of contemporary issues.
CO3: Having problem solving ability- solving social issues and engineering 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 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**.

1. 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.
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 down to **30 marks** (60% of maximum marks).
4. Weightage to be given for neatness and submission of record/write-up on time.
5. Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
6. 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.
7. The suitable rubrics can be designed to evaluate each student's performance and learning ability.
8. 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):

1. SEE marks for the practical course are 50 Marks.
2. SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
3. 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 schedule mentioned in the academic calendar of the University.
4. All laboratory experiments are to be included for practical examination.
5. (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.
6. Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
7. Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

Template for Practical Course and if AEC is a practical Course

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

Suggested Learning Resources:

1. https://www.mathworks.com/matlabcentral/answers/401100-where-can-i-find-resources-for-learning-matlab
2. https://www.youtube.com/watch?v=1PSFLKiEV7U
3. https://www.mathworks.com/videos/matlab-for-teaching-81562.html
4. https://www.mathworks.com/videos/matlab-fundamentals-online-course-overview-1608805840236.html

Fundamentals of Virtual Reality and App Development		Semester	III
Course Code	**BRA358C**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	**0:2:0:0**	SEE Marks	50
Total Hours of Pedagogy	**30**	Total Marks	100
Credits	**01**	Exam Hours	01
Examination nature (SEE)	**Theory**		

Course objectives:
The objectives of this course are to:

1. Describe how VR systems work and list the applications of VR.
2. Understand the design and implementation of the hardware that enables VR systems to be built.
3. Understand the system of human vision and its implication on perception and rendering.
4. Explain the concepts of motion and tracking in VR systems.
5. 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 PowerPoint 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 analysing information.

Module - 1

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

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 Sources of Information. Visual Rendering -Ray Tracing and Shading Models, 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 (COs) (Course Skill Set)

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

CO1: Describe how VR systems work and list the applications of VR.
CO2: Understand the design and implementation of the hardware that enables VR systems to be built.
CO3: Understand the system of human vision and its implication on perception and rendering.
CO4: Explain the concepts of motion and tracking in VR systems.
CO5: Describe the importance of interaction and audio in VR systems.

Assessment Details (both CIE and SEE)

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

Continuous internal Examination (CIE)

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

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester Two assignments each of 10 Marks
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

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

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

Semester End Examinations (SEE)

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

Suggested Learning Resources:

Books

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

Reference Books:

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

Web links and Video Lectures (e-Resources):

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

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

1. Mini Project
2. Course seminars
3. YouTube video learning approach

Introduction to C++		Semester	III
Course Code:	**BRA358D**	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	03
Examination nature (SEE)	**Practical**		

Course objectives

The objectives of this course are to:

1. Understanding about object oriented programming and Gain knowledge about the capability to store information together in an object.
2. Understand the capability of a class to rely upon another class and functions.
3. Understand about constructors which are special type of functions.
4. Create and process data in files using file I/O functions
5. 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 andmake 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 during file operations.

Module-5

Exception Handling: Introduction to Exception - Benefits of Exception handling- Try and catch block Throw 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-oriented programming 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 and Polymorphism

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

Programming Assignments:

1. Write a C++ program to sort the elements in ascending and descending order.
2. Write a C++ program to find the sum of all the natural numbers from 1 to n.

3. Write a C++ program to swap 2 values by writing a function that uses call by reference technique.

4. Write a C++ program to demonstrate function overloading for the following prototypes.

add(int a, int b)
add(double a,
double b)

5. Create a class named Shape with a function that prints "This is a shape". Create another class named Polygon inheriting the Shape class with the same function that prints "Polygon is a shape". Create two other classes named Rectangle and Triangle having the same function which prints "Rectangle is a polygon" and "Triangle is a polygon" respectively. Again, make another class named Square having the same function which prints "Square is a rectangle". Now, try calling the function by the object of each of these classes.

6.Suppose we have three classes Vehicle, Four Wheeler, and Car. The class Vehicle is the base class, the class Four Wheeler is derived from it and the class Car is derived from the class Four Wheeler. Class Vehicle has a method 'vehicle' that prints 'I am a vehicle', class Four Wheeler has a method 'Four Wheeler' that prints 'I have four wheels', and class Car has a method 'car' that prints 'I am a car'. So, as this is a multi-level inheritance; we can have access to all the other classes methods from the object of the class Car. We invoke all the methods from a Car object and print the corresponding outputs of the methods.

So, if we invoke the methods in this order, car(), Four wheeler(), and vehicle(), then the output willbe

I am a car

I have four wheelsI

am a vehicle

Write a C++ program to demonstrate multilevel inheritance using this.

7. Write a C++ program to create a text file, check file created or not, if created it will write some textinto the file and then read the text from the file.

8.Write a C++ program to write and read time in/from binary file using fstream

9. Write a function which throws a division by zero exception and catch it in catch block. Write a C++program to demonstrate usage of try, catch and throw to handle exception.

10. Write a C++ program function which handles array of bounds exception using C++.

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:

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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:

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

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

1. Assign small tasks to Develop and demonstrate using C++
2. Course Seminars

Measurement Systems (Including Sensors)		Semester	IV
Course Code	**BRA401**	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:

This course will enable students to:

1. To understand the concept of metrology and standards of measurement.
2. To equip with knowledge of limits, fits, tolerances and gauging
3. To understand the knowledge of measurement systems and methods with emphasis on different Transducers, intermediate modifying and terminating devices.
4. To understand the concept of control system.

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 traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their owncreative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning

Module-1

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

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

Module-2

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

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

Intermediate Modifying and Terminating Devices: Mechanical systems, Inherent problems, Electrical intermediate modifying devices, Input circuitry, Ballast circuit, Electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs.

Module-3
Micro And Smart Devices And Systems: Principles And Materials: Definitions and salient features of sensors, actuators, and systems. **Sensors:** silicon capacitive accelerometer, piezo-resistive pressure sensor, blood analyzer, conductometric gassensor, fiber-optic gyroscope and surface-acoustic-wave based wireless strain sensor. **Actuators:** silicon micro-mirror arrays, piezo-electric based inkjet print- head, electrostatic comb-drive andmicromotor, magnetic micro relay, shape- memory-alloy based actuator, electro-thermal actuator. **Systems:** micro gas turbine, portable clinical analyzer, active noise control in a helicopter cabin.
Module-4
Modeling: Scaling issues. Elastic deformation and stress analysis of beams and plates. Residual stresses and stress gradients. Thermal loading. Heat transfer issues. Basic fluids issues. Electrostatics. Coupled electro mechanics. Electromagnetic actuation. Capillary electro-phoresis. Piezo-resistive modeling. Piezoelectric modeling. Magnetostrictive actuators.
Module-5
Electronics, Circuits And Control: Carrier concentrations, semiconductor diodes, transistors, MOSFET amplifiers, operational amplifiers. Basic Op-Amp circuits. Charge-measuring circuits. Examples from microsystems. Transfer function, state-space modeling, stability, PID controllers, and model order reduction. Examples from smart systems and micro machined accelerometer or a thermal cycler.
Course outcome (COs) (Course Skill Set) At the end of the course, the student will be able to : CO1: Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters. CO2: Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design CO3: Explain measurement systems, transducers, intermediate modifying devices and terminating devices. CO4: Understand basics of control system. CO5: Ability to perform stability analysis of a control system.
Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing marks 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:** 1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks. 2. 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 3. 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. 4. 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. Mechanical Measurements, Beckwith Marangoni and Lienhard Pearson Education 6th Ed., 2006
2. Instrumentation, Measurement and Analysis B C Nakra, K K Chaudhry McGraw–Hill 4th Edition.
3. Discrete-Time Control systems Ogata K 2nd Edition, PHI Learning Pvt. Ltd 2009.
4. Digital Control Systems Kuo B.C 2nd Edition, Oxford University Press 2007
5. MEMS & Microsystems: Design and Manufacture, Tai-Ran Tsu, Tata Mc-Graw-Hill.
6. "Micro and Smart Systems" by Dr. A.K.Aatre, Prof. Ananth Suresh, Prof.K.J.Vinoy, Prof. S. Gopalakrishna,, Prof. K.N.Bhat.,John Wiley Publications.

Reference Books:

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

Web links and Video Lectures (e-Resources):

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

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

Visit QC section of nearby small scale industries.

1. http://sl-coep.vlabs.ac.in/

Microcontrollers		Semester	IV
Course Code	**BRA402**	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**/practical/Viva-Voce		

Course objectives:
This course will enable students to:

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

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

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.

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.

Module-4
8051 Timers and Serial Port: 8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode- 2 on a port pin. 8051 Serial Communication- Basics of Serial Data Communication, RS- 232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.
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.

Practical Component of IPCC *(May cover all / major modules)*

Sl.NO.	Experiments
1	Programs to generate delay, Programs using serial port and on-Chip timer/counter. Code conversion: BCD – ASCII.
2	Write a C program to (i) transmit and (ii) to receive a set of characters serially by interfacing 8051 to a Terminal.
3	Write ALPs to generate waveforms using ADC interface
4	Write ALP to interface an LCD display and to display a message on it. . Write ALP to interface a Stepper Motor to 8051 to rotate the motor.
5	Write ALP to interface ADC-0804 and convert an analog input connected to it.
6	Programs to generate delay, Programs using serial port and on-Chip timer/counter. Code conversion: ASCII – Decimal.
7	Programs to generate delay, Programs using serial port and on-Chip timer/counter. Code conversion: Decimal - ASCII
8	Programs to generate delay, Programs using serial port and on-Chip timer/counter. Code conversion: HEX - DecimaL.
9	Write ALP to interface a Stepper Motor to 8051 to rotate the motor.
10	Programs to generate delay, Programs using serial port and on-Chip timer/counter. Code conversion Decimal -HEX.
11	Write ALP to add two numbers.
12	Write ALP to multiply two numbers.

Course Outcomes (COs) (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: 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)

1. IPCC means practical portion integrated with the theory of the course.
2. CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
3. 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.
4. 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)**.
5. 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

1. **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.
2. 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.
3. 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**.
4. 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.**
5. Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
6. 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.

Suggested Learning Resources:

Books

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

Reference Books:

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

Web links and Video Lectures (e-Resources):

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

- https://youtu.be/7mtt4bdfQk4

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

1. Programs to generate delay, Programs using serial port and on-Chip timer/counter.
2. Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII; HEX - Decimal and Decimal - HEX.
3. Write a C program to (i) transmit and (ii) to receive a set of characters serially by interfacing 8051 to a terminal.
4. Write ALPs to generate waveforms using ADC interface.
5. Write ALP to interface an LCD display and to display a message on it. 5. Write ALP to interface a Stepper Motor to 8051 to rotate the motor.
6. Write ALP to interface ADC-0804 and convert an analog input connected to it.

Robot Kinematics, Dynamics and Control		Semester	IV
Course Code	**BRA403**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**3:0:2:0**	SEE Marks	50
Total Hours of Pedagogy	**42 hours Theory + 28 hours Lab**	Total Marks	100
Credits	**04**	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course Objectives:

This course will enable students to:

1. To identify and enumerate different link-based mechanisms with basic understanding of motion
2. To interpret and analyse various velocity and acceleration diagrams for various mechanisms
3. To understand and illustrate various power transmission mechanisms using suitable method
4. To design and evaluate the performance of different cams and followers

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 traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such asthe 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 thestudents' understanding.

Individual teacher can device the innovative pedagogy to improve the teaching-learning

Module-1

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

Module-2

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

Module-3

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-4

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

equation.
Module-5
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.

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

Sl.NO.	Experiments
1	**Forward Kinematics:** Implement a program to calculate the forward kinematics of a robot manipulator using Denavit-Hartenberg (DH) parameters. Verify the results by physically moving the robot and comparing the computed end effector position and orientation.
2	**Inverse Kinematics:** Develop an algorithm to solve the inverse kinematics problem for a robot manipulator. Use it to determine the joint angles required to achieve a desired end effector position and orientation.
3	**Jacobian Matrix:** Derive and implement the Jacobian matrix for a given robot manipulator. Use it to analyze the robot's manipulability and demonstrate its effect on the robot's ability to reach different points in the workspace.
4	**Trajectory Planning:** Design a trajectory planning algorithm to generate smooth and collision-free paths for a robot manipulator. Implement it to control the robot and observe its performance in executing desired trajectories.
5	**Robot Dynamics:** Develop a dynamic model for a robot manipulator using Lagrange's equations. Use simulation software or a physical robot to study the robot's motion and behavior under different external forces and torques.
6	**Computed Torque Control:** Design a computed torque controller to achieve precise trajectory tracking for a robot manipulator. Experiment with different control gains and observe the impact on tracking performance. Can be Demo experiments for CIE
7	**Force/Torque Control:** Implement a force/torque control scheme for a robot manipulator. Use a force sensor or external load to apply controlled forces or torques on the robot's end effector and observe the resulting robot behaviour. Can be Demo experiments for CIE
8	**Singularities Analysis:** Investigate singularities in robot manipulators by analyzing the Jacobian matrix. Identify singular configurations and examine their impact on the robot's performance and motion capabilities. Can be Demo experiments for CIE
9	**End Effector Calibration:** Perform a calibration procedure to accurately determine the transformation between the robot's end effector and the world frame. Use this calibration to improve the accuracy of the robot's positioning and manipulation tasks. Can be Demo experiments for CIE

Course Outcome (COs) (Course Skill Set)

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

CO1: To identify and enumerate different link-based mechanisms with basic understanding of motion.
CO2: To understand and illustrate various power transmission mechanisms using suitable 20 methods.
CO3: To understand and illustrate various Governing mechanisms using suitable methods.
CO4: To design and evaluate the performance of different cams and followers.

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)

1. PCC means practical portion integrated with the theory of the course.
2. CIE marks for the theory component are 25 marks and that for the practical component is 25 marks.
3. 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.
4. 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).
5. 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

1. 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.
2. 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.
3. 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.
4. 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.
5. Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for 25 marks.
6. 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.

Suggested Learning Resources:

Text Book:

1. Theory of Machines Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, Ed 2009
2. Theory of Machines Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Ed 2006

Reference Books:

1. Theory of Machines. Thomas Bevan. CBS Publication 1984.
2. Design of Machinery Robert L. Norton, McGraw Hill 2001

Web links and Video Lectures (e-Resources): 1. https://nptel.ac.in/courses/112/106/112106270
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning 1. Visit mechanical labs to access different links and joints employed for various purposes

Template for Practical Course and if AEC is a practical Course

Robot Programming & Simulation Lab		Semester	IV
Course Code	**BRAL404**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**0:0:2:0**	SEE Marks	50
Teaching Hours of Pedagogy	**42**	Total Marks	100
Credits	**01**	Exam Hours	03
Examination nature (SEE)	**Practical**		

Course objectives:

This course will enable students to:

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

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

Course outcomes (Course Skill Set):

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

CO1: 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 are **50 Marks**.

1. The split-up of CIE marks for record/ journal and test are in the ratio 60:40.
2. 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.
3. Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
4. Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
5. Weightage to be given for neatness and submission of record/write-up on time.
6. Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
7. 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.
8. The suitable rubrics can be designed to evaluate each student's performance and learning ability.

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):

1. SEE marks for the practical course is 50 Marks.
2. SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University
3. All laboratory experiments are to be included for practical examination.
4. (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.
5. Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
6. Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
7. General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%.
8. 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).
9. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
10. The duration of SEE is 03 hours
11. Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. https://www.coppeliarobotics.com/
2. https://www.youtube.com/watch?v=MX3VXvZFk0U
3. https://www.mdpi.com
4. https://www.fer.unizg.hr/en/course/rpas
5. https://www.hindawi.com/journals/jr/2018/2312984/
6. https://unity.com/solutions/automotive-transportation-manufacturing/robotics

Fuzzy Logic for Robotics		Semester	IV
Course Code	21BRA405A	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	42	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course Objectives:

This course will enable students to:

1. To learn the concept of fuzziness involved in various systems.
2. To provide adequate knowledge about fuzzy set theory
3. To teach Modelling of non-linear systems using fuzzy models
4. To make students to understand to the concepts of feed forward neural networks.
5. To provide adequate knowledge about feedback networks

Teaching-Learning Process (General Instructions)

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

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

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: 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 (COs) (Course Skill Set)

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

CO1: Compare and contrast the biological neural network and ANN.

CO2: Discuss the ANN for pattern classification.

CO3: Develop and configure ANN's with different types of functions and learning algorithms.

CO4: Apply ANN for real world problems.

CO5: Discuss the fundamentals of fuzzy logic, implementation and their functions

CO6: Apply fuzzy logic concepts in building automated control systems.

Assessment Details (both CIE and SEE)

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

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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:

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:

1. LaureneFausett, Englewood cliffs, N.J., 'Fundamentals of Neural Networks', Pearson Education, 2008.
2. Simon Haykin, 'Neural Networks', Pearson Education, 2003.
3. George.J.Klir, 'Fuzzy Sets and Fuzzy Logic – Theory and Applications', Pearson, 2015.
4. Rajasekaran, VijayalakshmiPai, "Neural Networks, Fuzzy Systems and Evolutionary Algorithms", PHI Learning, 2017.

5. Shigeo Abe, “Neural Networks and Fuzzy Systems”, Springer, 2012.

Web links and Video Lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/noc22_ge04/preview
2. https://onlinecourses.nptel.ac.in/noc23_ee21/preview

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

1. Visit to the industries/ reputed universities or colleges to explore the use of robots for various industrial applications

Unmanned Aerial Vehicles (UAV)		Semester	IV
Course Code	**BRA405B**	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 Outcome (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:

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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:

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):

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

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

1. Adaptation of Content from Different Disciplines
2. Constructivist Approaches to Learning
3. Situated Learning Methodology
4. Flipped Classroom
5. Gamification
6. Online Interactive Tools
7. Collaborative and Individual Project-Based Assessment

Sensors and Actuators		Semester	IV
Course Code	**BRA405C**	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 course will enable the students to

1. To summarize and analyze the different types of sensors, signal conditioning circuits, and actuators.
2. To introduce students the criteria for selecting a sensor for a particular measurement.
3. To elucidate students the types of actuators: electrical, pneumatic, and hydraulic and enlighten their operation.
4. To familiarize students with the basic techniques of designing the required signal conditioning for a particular sensor

Teaching-Learning Process (General Instructions)

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

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt 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 analysing information.
5. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1

Introduction to sensors and transducers, Principle of sensing and transduction, Difference between transducer and sensor, Classification of sensors. Principle of working and applications of light sensors, Potentiometers, force and pressure sensors, temperature sensors, proximity switches and Hall Effect sensors.

Module-2

Static characteristics: accuracy, precision, resolution, sensitivity, linearity, span and range -Dynamic characteristics, Mathematical model of transducer: zero, first and second, Response to impulse, step, ramp and sinusoidal inputs, Selection criteria of sensor.

Module-3

Mechanical actuation systems: Mechanical systems, types of motions, cams, gear trains, ratchet & pawl mechanism, belt and chain drives, mechanical aspect of motor selection.

Electrical actuation system: Electrical systems, Mechanical switches, solenoids, Relays, DC/AC motors, Stepper motors & Servo Motors

Module-4

Signal Conditioning: Introduction - Hardware - Digital 1/0, Analog to digital conversions, resolution, Filtering Noise using passive components - Registers, capacitors, amplifying signals using OP amps. Digital

Signal Processing - Digital to Analog conversion, Low pass, high pass, notch filtering.

Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods.

Module-5

Pneumatic and Hydraulic actuation system: Pneumatic and Hydraulic actuation system, classification of valves, pressure relief valves, pressure regulating valves, cylinders and rotary actuators.

DCV & FCV: Principle & construction details,

Course Outcome (COs) (Course Skill Set)

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

CO1: Comprehend, classify and analyse the behaviour of different types of sensors.
CO2: Analyse the characteristics and performance measures of sensors and select suitable sensor for the given industrial applications.
CO3: Gain the knowledge about the types of actuators: electrical, pneumatic, and hydraulic, performance criteria and selection.
CO4: Elucidate the construction and working of various industrial parameters / devices used to measure temperature, pressure, flow, level and displacement.
CO5: Implement the data acquisition systems with different sensors for real-time applications.
CO6: Conduct experiments and measurements in laboratory and realize hands-on experience on real components, sensors and actuators.

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):

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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:

Books

1. D. Patranabis, "Sensors and Transducers", 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, India, 2011.
2. Jon S. Wilson, "Sensor Technology Hand Book", Newnes Publishing Company, Boston, USA, 2005.
3. A.K. Sawhney, Puneet Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai and Co. Pvt. Ltd., New Delhi, India, 2014.
4. D. Patranabis, "Sensors and Actuators", 2nd Edition, PHI Learning, New Delhi, India, 2013.
5. Ramon Pallas-Areny, John G. Webster, "Sensors and Signal Conditioning", 2nd Edition, Wiley India Pvt. Ltd., India, 2012.

Web links and Video Lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/noc19_ee41/preview

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

1. Fire alarm system with Smoke, Temperature Sensor using Arduino
2. Door Opening System Automatically using IR Sensor & Microcontroller
3. Street lights that Glow on Detecting Vehicle Movement
4. Generating Alarm through Over Temperature by Fan ON

Smart Materials		Semester	IV
Course Code	**BRA405D**	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:
This course will enable students to:

1. To acquire a comprehensive understanding of smart materials.
2. To gain knowledge about smart sensors and their functionalities.
3. To develop an understanding of smart actuators and their applications.
4. To explore the concept of smart composites and their unique properties.
5. To acquire knowledge about smart structures and materials and their practical applications.

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 Smart Materials: Introduction to Smart Materials, Principles of Piezoelectricity, Perovskite Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magneto strictive materials, Giant Magnetostriction and Magneto-resistance Effect, Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers.

Module-2

High-Band Width, Low Strain Smart Sensors: Piezoelectric Strain Sensors, In-plane and Out-of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magneto strictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors.

Module-3

Smart Actuators: Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magneto volume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control

Module-4

Smart Composites: Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, Finite Element Modelling of Smart Composite Beams

Module-5
Advances In Smart Structures & Materials Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self-Healing Polymers, Intelligent System Design, Emergent System Design.

Course Outcome (COs) (Course Skill Set)

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

CO1: Have a deep understanding of smart materials, including their properties, characteristics, and applications in various industries.

CO2: Knowledge of smart sensors and their Functionalities will gain knowledge about smart sensors, their functions, and their role in monitoring and controlling systems.

CO3: Understanding of smart actuators and their applications will develop an understanding of smart actuators, their operating principles, and their diverse applications in fields such as robotics, automation, and healthcare.

CO4: Exploration of Smart Composites and Unique Properties will explore the concept of smart composites and their exceptional properties, such as self-healing, shape memory, and enhanced mechanical properties.

CO5: Practical Knowledge of Smart Structures and Materials will acquire practical knowledge about smart structures and materials, including their design, fabrication techniques, and real-world applications in areas such as civil engineering, aerospace, and biomedical engineering.

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):

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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:

Books

1. Brian Culshaw, Smart Structures and Materials, Artech House, 2000
2. Gauenzi, P., Smart Structures, Wiley, 2009.
3. Cady, W. G., Piezoelectricity, Dover Publications.

Smart Materials Intelligent System Design by Prof. Bishakh Bhattacharya Mechanical Engineering Indian Institute of Technology, Kanpur.

Web links and Video Lectures (e-Resources):

1. https://apm.iitm.ac.in/smart_materials.html
2. https://home.iitm.ac.in/aarajan/smc%20lab.html
3. https://youtu.be/ZIC5JFIHni4

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

1. Demonstrate composite materials based on MMC, PMC, CMC etc.
2. Demonstrate different of sensors like proximity, LED, and pressure sensor.
3. Make a working model comprising proximity, LED, and pressure sensor.

Introduction to AI&ML		Semester	IV
Course Code	**BRA456A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**1:0:0:0**	SEE Marks	50
Total Hours of Pedagogy	**30**	Total Marks	100
Credits	**01**	Exam Hours	01
Examination nature (SEE)	**Theory**		

Course Objectives:

This course will enable students to:

1. To impart artificial intelligence principles, techniques, and history.
2. To assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem-solving, and learning methods in solving engineering problems.
3. To develop intelligent systems by assembling solutions to concrete computational problems

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 a different type of teaching method may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving stations, and substations to give brief information about electrical power generation.
3. ShowVideo/animation films to explain the functioning of various machines
4. Encourage collaborative(GroupLearning)Learningintheclass
5. Ask at least three HOTS (HigherorderThinking) questions in the class, which promote critical thinking
6. Adopt Problem-Based Learning (PBL), which fosters students' Analytical skills, and the development of 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 creative ways to solve them.
9. Discuss how the concept can be applied to the real world and when that 'is possible, it helps improve the students 'understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Artificial Intelligence and its Issues: Definitions-Importance of AI, Evolution of AI-Applications of AI, Classification of AI systems concerning the environment, Knowledge Inferring systems and planning, Uncertainty and towards Learning Systems.

Module-2

Overview to Problem Solving:

Problem-solving by Search, Problemspace-Statespace, BlindSearch-Types, and Performance measurement.

Module-3

HeuristicSearch, Knowledge Representation, and Reasoning: Types, Gameplay in Gemini-max algorithm, Alpha-Beta Pruning. Logical Systems Knowledge-Based Systems, Proposition a lLogic Constraints, Predicate Logic First Order Logic, Inference in First-Order Logic, On to logical Representations and Applications.

Module-4

Uncertainty and knowledge Reasoning: Overview Definition of uncertainty, Bayes Rule Inference, Belief Network, Utility-Based System, Decision Network

Module-5

Learning Systems: Forms of Learning Types-Supervised, Unsupervised, Reinforcement Learning, Learning decision trees

Course Outcome (COs) (Course Skill Set)

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

CO1: Evaluate Artificial Intelligence(AI) methods and describe their foundations.
CO2: Apply basic principles of AI in solutions that require problem-solving, inference, perception, knowledge representation, and learning.
CO3: Demonstrate knowledge of reasoning and knowledge representation for solving real-world problems
CO4: Analyze and illustrate how search algorithms play vitalrole in problem solving
CO5: llustrate the construction of learning and expert system
CO6: Discuss the current scope and limitations of AI and societal implications

Assessment Details (both CIE and SEE)

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

Continuous Internal Examination (CIE)

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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:

Text Books:

1. Russell, S and Norvig, P. 2015. Artificial Intelligence-A Modern Approach,3rd edition, Prentice-Hall.
2. Poole, D and Mackworth, A. 2010. Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press.

Reference Books:

1. Ric, E., Knight, Kand Shankar, B.2009. Artificial Intelligence, 3rd edition, Tata Mc Graw Hill.
2. Design of Machinery Robert L.Norton, Mc Graw Hill 2001
3. Luger, G.F. 2008. Artificial Intelligence Structures and Strategies for Complex Problem Solving, 6th edition, Pearson.
4. Brachman, R. and Levesque,H .2004. Knowledge Representation and Reasoning, Morgan Kaufmann.
5. Alpaydin, E. 2010. Introduction to Machine Learning. 2nd edition, MIT Press.
6. Sutton R.S and Barto, A.G. 1998. Reinforcement Learning: An Introduction, MIT Press
7. Padhy, N.P.2009.Artificial Intelligence and Intelligent Systems, Oxford University Press

Web links and Video Lectures (e-Resources):
AI And Machine Learning Full Course 1. https://www.youtube.com/watch?v=wnqkfpCpK1g 2. https://pll.harvard.edu/course/cs50s-introduction-artificial-intelligence-python 3. https://azure.microsoft.com/en-us/resources/cloud-computing-dictionary/artificial-intelligence-vs-machine-learning 4. https://youtu.be/t4K6lney7Zw 5. https://www.youtube.com/watch?v=QDX-1M5Nj7s
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning 1. Course seminars 2. Mini projects, etc

Embedded C Basics		Semester	IV
Course Code	**BRA456B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**0:0:2:0**	SEE Marks	50
Credits	**01**	Exam Hours	03
Examination nature (SEE)	**Practical**		

Course Objectives:

This course will enable students to:

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

Sl. No	Experiments
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.
Demonstration Experiments (For CIE)	
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 (COs) (Course Skill Set):

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

CO1: Write C programs in 8051 for solving simple problems that manipulate input data using different Instructions of 8051 C.

CO2: Develop testing and experimental procedures on 8051 Microcontroller, analyze their operation under different cases.

CO3: Develop programs for 8051 Microcontroller to implement real world problems.

CO4: Design and Develop Mini projects

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**.

1. 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.
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 down to **30 marks** (60% of maximum marks).
4. Weightage to be given for neatness and submission of record/write-up on time.
5. Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
6. 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.
7. The suitable rubrics can be designed to evaluate each student's performance and learning ability.
8. 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):

1. SEE marks for the practical course are 50 Marks.
2. SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
3. 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 schedule mentioned in the academic calendar of the University.
4. All laboratory experiments are to be included for practical examination.
5. (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.
6. Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
7. 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

Suggested Learning Resources:

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)		Semester	IV
Course Code	**BRA456C**	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:

This course will enable students to:

1. Understand the importance of IoT for consumers and SCADA for entrepreneurs
2. 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
3. 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.

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 traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

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

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

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.

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, Stego Dos, Ez Stego, Jsteg-Jpeg.

Module-5

Digital Water Marking: Classification in Digital Watermarking, Classification Based on Characteristics: Blindversus Nonblind, 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 Visibleand Invisible Watermarks. Watermarking tools: uMark, TSR Watermark. Steganalysis

Course Outcome (COs) (Course Skill Set)

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

CO1: Understand the concept of SCADA system and the importance of Firewall and other safety systems.
CO2: Explain the importance of different control network systems applied to different sectors
CO3: Understand the importance and explain the concept of firewall safety applications for a specified task
CO4: Understand the concept of various information hiding techniques used in actual control system.
CO5: Perform the specified task on digital water marking for various 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 Examination (CIE)

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. 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.
4. 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. 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: Securing critical 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 for Steganography and Digital Watermarking. Petitcolas, Artech House.
5. Cox, I., Miller, M., Bloom, J., Fridrich, J. & Kalker, T. (2007). Digital Watermarking and Steganography (2nd Ed.). Elsevier.
6. Latest research papers from refereed journals discussed by the faculty may also be referred.

Web links and Video Lectures (e-Resources):

1. 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
2. https://www.advanceelectricaldesign.com/Syllabus-of-PLC-SCADA-Training-Course
3. https://www.gradplus.pro/lessons/s071-plc-and-scada-systemopen-elective-1-syllabus/
4. https://www.vturesource.com/vtu-syllabus/EE/2018/6/18EE652

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

1. Visit to nearby Industries to study various Data Acquisition Systems

Template for Practical Course and if AEC is a practical Course

Introduction to Raspberry Pi Controllers		Semester	IV
Course Code	**BRA456D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**0:0:2:0**	SEE Marks	50
Total Hours of Pedagogy	**15**	Total Marks	100
Credits	**01**	Exam Hours	03
Examination nature (SEE)	**Practical**		

Course Objectives:
This course will enable students to:

1. To understand the working and usage of Raspberry Pi controllers in different fields.

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 RPi in a SD card preparation, configuration of Raspberry Pi during first booting and use of remote SSH like putty
7	To demonstrate the basic linux commands on Raspberry pi.
8	To create a database & Store the value in Raspberry Pi.
Demonstration Experiments (For CIE)	
9	To install Android on Raspberry Pi.
10	To Setup RPi first time without using screen, mouse, keyboard.
11	To interface ADC at GPIOs of Raspberry Pi for measuring analog voltage.

Course Outcomes (COs) (Course Skill Set):
At the end of the course the student will be able to:

CO1: Understand and apply working of 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**.

1. 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.
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 down to **30 marks** (60% of maximum marks).
4. Weightage to be given for neatness and submission of record/write-up on time.
5. Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
6. 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.
7. The suitable rubrics can be designed to evaluate each student's performance and learning ability.
8. 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):

1. SEE marks for the practical course are 50 Marks.
2. SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
3. 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 schedule mentioned in the academic calendar of the University.
4. All laboratory experiments are to be included for practical examination.
5. (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.
6. Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
7. 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

Suggested Learning Resources:

1. https://youtu.be/BpJCAafw2qE
2. https://youtu.be/CXCjpJasvG0
3. https://youtu.be/zRKmlwA5law