Industrial Management & Entrepreneurship		Semester	5
Course Code	**BMT501**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- Understand the basic concepts of management, planning, organizing, staffing, directing and controlling.
- Identify various types of supporting agencies and financing available for an entrepreneur
- Prepare project report and decide selection of industrial ownership.

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 plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
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

Management: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought- early management approaches – Modern management approaches.

Planning: Nature, importance and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans.

Module-2

Organizing and Staffing: Nature and purpose of organization Principles of organization - Types of organization - Departmentation Committees Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing--Process of Selection & Recruitment (in brief).

Directing & Controlling: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief).

Module-3

Entrepreneur: Meaning of Entrepreneur; Evolution of the Concept; Functions of an Entrepreneur, Types of Entrepreneurs, Entrepreneur - an emerging. Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship – its Barriers.

Module-4

Small Scale Industries: Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start and SSI - Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GA TT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry

Module-5

Institutional Support: Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC.

Preparation of Project: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study

Course outcome (Course Skill Set)

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

1. Understand the fundamental concepts of Management and planning function.
2. Describe the functions of Managers, and Entrepreneurs.
3. Understand the concepts of entrepreneur and entrepreneurship.
4. Describe the concept of the small-scale industries.
5. Explain the support system and funding opportunities for an entrepreneur to start an industry.
6. escribe feasibility study to choose a project, project preparation and conduction.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Principles of Management, P. C.Tripathi,P.N. Reddy, Tata McGraw Hill,
2. Dynamics of Entrepreneurial Development & Management, Vasant Desai, Publishing House.
3. Entrepreneurship Development, Poornima. M.Charantimath, Small Business Enterprises –Pearson, 2006.
4. Management Fundamentals-Concepts, Application , Skill , RobersLusier –Thomson
5. Entrepreneurship Development, S.S.Khanka, S.Chand& Co
6. Management, Stephen Robbins, Pearson Education/PHI, 17th Edition, 2003

Web links and Video Lectures (e-Resources):

- www.nptel.ac.in
- https://onlinecourses.nptel.ac.in/noc23_mg74/preview
- https://onlinecourses.nptel.ac.in/noc23_mg70/preview
- https://cleartax.in/s/small-scaleindustriesssi#:~:text=Small%20Scale%20Industries%20(SSI)%20are,50%20crore
- https://www.startupindia.gov.in/content/sih/en/startup-scheme.html

MICRO AND SMART SYSTEM TECHNOLOGY		Semester	5
Course Code	**BEMT502**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hrs + 10-12 Lab Sessions	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

CLO 1. Understand the operation and Importance of Micro and Smart Systems.

CLO 2. Understand the Working Principle and Operation of Various Kinds of Sensors and Actuators.

CLO 3. Understand the Fabrication Process of Micromachining.

CLO 4. Understand the operation of Electronics Circuits for Micro and Smart Systems.

CLO 5. Understand the Working Principle of Controllers for MEMS and BEL Pressure Sensor and Smart Structure in vibration control.

Teaching-Learning Process (General Instructions)

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

1. Power Point Presentation,
2. Chalk and Talk are used for Derivations and Correlations (In-general).
3. Video demonstration or Simulations,
4. Laboratory Demonstrations and Practical Experiments

MODULE-1

Introduction to Micro and Smart systems: Miniaturization, Microsystems versus MEMS, Micro-fabrication, Smart Materials, Structures & Systems, Integrated Microsystems, Application of Smart Materials & Microsystems.

MODULE-2

Micro and Smart Devices and Systems: Principles and Materials: Definitions and salient features of sensors, actuators, and systems. Sensors: silicon capacitive accelerometer, Piezoresistive pressure sensor, Portable blood analyzer, Conductometric gas sensor. Actuators: Micro mirror Array for Video Projection, Piezo-electric based inkjet print head, electrostatic comb-drive, Magnetic micro relay.

MODULE-3

Micromachining Technologies: Silicon as a Material for Micromachining, Silicon wafer preparation, thin-film deposition techniques, Lithography, Etching, Silicon micromachining: surface micromachining bulk micromachining. Specialized Materials for Microsystems.

MODULE-4

Electronics Circuits for Micro and Smart Systems. Semiconductor devices: Diode, Schottky diode, Tunnel diode, Bipolar Junction Transistor (BJT), MOSFET, and CMOS circuits: Inverter and NAND Gate, Electronics Amplifiers: Operational Amplifiers, Basic Op-Amp circuit, Op-Amp based circuits.

MODULE-5

Implementation of Controllers for MEMS & Case Studies of Integrated Microsystems.

Design Methodology, PID controller, Circuit Implementation, Digital controller, Microcontroller & PLC. Case Studies of Integrated Microsystems: BEL pressure sensor, design considerations, performance parameters, Smart Structure in vibration control.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Simulate for Maximum Stress and Displacement for a given structural member taking modulus of elasticity 200GPa, Poisson's Ratio 0.25 and Thickness of plate 10mm on ANSYS tool.
2	Simulate for Maximum Stress and Displacement for a given structural Bracket taking modulus of elasticity 190GPa, Poisson's Ratio 0.30 and Thickness of a bracket 10mm subjected to a load of 10KN, Pressure of 0.8MPa for the given region on ANSYS tool.
3	Simulate for Maximum Stress and Displacement for the given 3-D L bracket by taking modulus of elasticity of material 190GPa, thickness of the plate is 20mm and μ=0.29 on ANSYS tool.
4	Perform static analysis for an applied beam tip deflection of 10mm and determine the electrode voltage for the piezoelectric beam on ANSYS tool.
5	Perform static analysis for an applied voltage of 100V and determine the beam tip deflection for the piezoelectric beam on ANSYS tool.
6	Model the given object as a 3D entity of thickness 5mm and determine maximum electrode voltage for the piezoelectric of deflection of 25mm on ANSYS tool.
7	Perform static analysis for an applied voltage of 50V and determine the beam tip deflection for the piezoelectric beam on ANSYS tool.
8	Perform static analysis for an applied beam tip deflection of 15mm and determine the electrode voltage for the piezoelectric beam on ANSYS tool.
9	Rig up a Circuit to find the characteristics of a Typical 10 Bar Compensated Pressure Sensor to determine Offset Voltage, Sensitivity and Non-Linearity.
10	Rig up a Circuit to find the characteristics of a typical 5 Bar BEL Pressure Sensor to determine Sensitivity and Non-Linearity
11	Rig up a Circuit to find the characteristics of a typical 5 Bar BEL Pressure Sensor to determine Sensitivity and Non-Linearity
12	Rig up a Circuit to find the characteristics of a typical 20 Bar BEL Pressure Sensor to determine Sensitivity and Non-Linearity.
13	Rig up a Circuit to find the characteristics of a Compensated Pressure Sensor to determine Offset Voltage, Sensitivity and Non-Linearity.

Course outcomes (Course Skill Set):

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

- **CO1.** Demonstrate the working methodology of smart materials, Microsystems, electronic circuitry in MEMS devices.
- **CO2.** Illustrate the process of silicon wafer preparation, thin film deposition techniques, lithography, etching, bulk & surface micromachining involved in MEMS fabrication.
- **CO3.** Examine the behavior of piezoresistive & piezoelectric materials required to fabricate pressure sensor & vibration control structures.
- **CO4.** Measure the performance of pressure sensor & vibration control structure in real time applications.
- **CO5.** Analyze the behavior of smart materials for different parameters to has sensor and an actuator.
- **CO6.** Determine the sensitivity, non-linearity and offset voltage of raw pressure sensors and compensated pressure sensor.

Assessment Details (both CIE and SEE)

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

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

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each

of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.

- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

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

SEE for IPCC

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

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

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

Suggested Learning Resources:

Books

1. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat, V.K.Aatre,Wiley India 2010.
2. Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Goplakrishnan, Wiley.
3. MEMS- Nitaigour Premchand Mahalik, TMH 2007.
4. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill.

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

1. Students are segregated in groups of 5members made to Prepare models of FCC structure of Silicon and Patterns to demonstrate the process of Photolithography.
2. Students are segregated in groups of 5members made to Prepare models of Cantilever Beam to analyze the vibration control and Patterns to demonstrate the process of Etching.
3. Quiz

CONTROL THEORY AND VIRTUAL INSTRUMENTATION		Semester	5
Course Code	**BMT503**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hrs +10-12 Lab sessions	Total Marks	100
Credits	04	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

CLO 1. Gain fundamental knowledge of control systems, mathematical modelling of physical system

CLO 2. Solve the control system problems using block diagram reduction technique and Mason's gain formula

CLO 3. Understand the importance of Virtual Instrumentation and various operation of DAQ devices

CLO 4. Identify and analyse the basic programming concepts in Lab View

CLO 5. Compare types of I/O module, Data Acquisition System and Communication Networks (Bus Systems) using Standard Protocol, and examine analysis tools

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. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1

MODELLING OF SYSTEMS AND BLOCK DIAGRAM:

Introduction to control systems, types of control systems, with examples. concept of mathematical modelling of physical systems- mechanical, translational (mechanical accelerometer, systems excluded), and rotational systems, analogous systems based on force voltage analogy and force current analogy.

Module-2

BLOCK DIAGRAM:

Introduction to block diagram algebra and numerical problems

SIGNAL FLOW GRAPH: Introduction to Signal Flow graph, Mason's gain formula. Obtaining Transfer functions for the given SFG using Mason's gain formula.

Module-3

CONCEPT OF VIRTUAL INSTRUMENTATION AND DAQ SYSTEMS:

Concepts of Instrumentation and Measurements Historical perspective – Need of VI – Advantages of VI – Define VI – Block diagram & Architecture of VI – Data flow techniques – Graphical programming in data flow – Comparison with conventional programming.

PC based data acquisition, Signal conditioning functions, calibration, resolution, ADC, DAC, Single-ended and differential inputs, Sampling fundamentals – sampling, sampling theorem, sampling frequency

Module-4

CONCEPTS OF GRAPHICAL PROGRAMMING:

Lab-view software – Concept of VIs and sub VI, Loops (While Loop and For Loop), Structures (Case, Formula node, and sequence structures) Arrays Operations, Strings Operations, and file I/O. Examples on each.

Module-5

INTERFACING OF EXTERNAL INSTRUMENTS TO A PC:

RS232, RS 422, RS 485 and USB standards – IEEE 488 standard – ISO-OSI model for serial bus – Introduction to bus protocols of MOD bus and CAN bus.

Course outcome (Course Skill Set)

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

CO1. Demonstrate the concepts of control systems and its specifications for mathematical modelling

CO2. Understand the structured LabVIEW programming concepts in developing Virtual Instrumentation and use general purpose interface bus and Serial communication Interface.

CO3. Develop the mathematical model for mechanical and electrical systems.

CO4. Analyse various applications on Real time monitoring using DAQ boards

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

TEXT BOOKS:

1. "Virtual Instrumentation using LabVIEW" Jovitha Jerome, PHI publication
2. Virtual Instrumentation, LABVIEW", Sanjay Gupta, TMH,NewDelhi,2003
3. "Control Systems Engineering", I.J. Nagarath and M. Gopal ,New Age International (P) Limited, Publishers, Fifth edition – 2012.
4. "Modern Control Engineering ", K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002.

REFERENCE BOOKS

1. PC Interfacing for Data Acquisition and Process Control & S.Gupta and JP Gupta InstrumentSocietyofAmerica,1994
2. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.
3. "Automatic Control Systems", Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8th Edition, 2008.
4. "Feedback and Control System", Joseph J Distefano III et al., Schaum's Outlines, TMH, 2nd Edition 2007.

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

- Group activity
- Quiz

VIRTUAL INSTRUMENTATION LAB		Semester	5
Course Code	**BMT504L**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2	SEE Marks	50
Total Hours of Pedagogy	14 Lab sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		

Course objectives:

CLO 1. Understand the fundamental concepts of Scientific Programming using Lab View

CLO 2. Build VI using LabView for solving real-world problems

CLO 3. Develop proficiency in handling loops and structures

CLO 4. Design applications that uses plug in DAQ boards and built-in analysis functions to process the data

Sl.NO	Experiments
1	Creating Virtual Instrumentation for simple applications- invert the state of Boolean indicator twice until program is stopped by user
2	Create a Virtual Instrumentation for continuous monitoring of Temperature (Generated using Random no 0<t<100). for every 250ms
3	Design a simple calculator using case structure in virtual instrumentation
4	Design a VI for flat sequence and formula node
5	Design 1D array and reverse 1D array obtained by random numbers
6	Design On – Off Controller Using Switch Button
7	Develop an Analog Signal using Potentiometer and DAQ card
8	Developing voltmeter using DAQ cards
	Demonstration Experiments (For CIE)
9	Develop a VI for file input output system
10	Develop a VI to display random number into 3 different CHARTS (STRIP, SLOPE, and SWEEP)
11	Design a Controller using Proximity Switch for ON-OFF Controller
12	Design an Audio I/O system using DAQ card

Course outcomes (Course Skill Set):

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

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

CO1. Develop LabVIEW programming which employs simulating and analysing the data for real time automation

CO2. Create different control applications using tools available in LabVIEW.

CO3. Design applications that use plug in DAQ boards and built-in analysis functions to process the data.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners, One internal examiner from the same institute and an external examiner from other institute, who are appointed by the university.
- 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.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

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

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

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. "Virtual Instrumentation using LabVIEW" Jovitha Jerome, PHI publication
2. Virtual Instrumentation, LABVIEW", Sanjay Gupta, TMH,NewDelhi,2003

THEORY OF MACHINES AND MACHINE DESIGN		Semester	5
Course Code	**BMT515A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

CLO 1. To gain knowledge of Kinematics associated with machines and inversions of machines.
CLO 2. To calculate power loss in belt drives and to Construct different cam profiles.
CLO 3. To design a machine, elements against static loads.
CLO 4. To design a machine element under Fluctuate in loads considering stress concentration factor.
CLO 5. To design spur and helical gears for dynamic and wear loads.

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 Derivations and Correlations (In-general).
3. Video demonstration or Simulations,

Module-1

Introduction to machine theory: Mechanisms: Definitions: Link, types of links, joint, types of joints kinematic pairs, Constrained motion, kinematic chain, mechanism and types, degrees of freedom of planar mechanisms, Equivalent mechanisms, Groshoff's criteria and types of four bar mechanisms, inversions of four bar chain, slider crank chain, Doubler slider crank chain and its inversions, Grashoff's chain. Mechanisms: Quick return motion mechanisms Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Straight line motion mechanisms, Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, condition for correct steering, Ackerman steering gear mechanism

Module-2

Belt Drivers: Belt Drives: Flat Belt Drives, Ratio of Belt Tensions, Centrifugal Tension, power Transmitted and simple numerical.

Cams: Types of cams, Types of followers. Displacement, Velocity and, Acceleration time curve for cam profiles. Disc cam with reciprocating follower having knife-edge, roller follower, Follower motions including SHM, Uniform acceleration and retardation and Cycloidal motion.

Module-3

Design against static load: Machine design, classification of machine design, design consideration, Tri axial stresses, Stress Tensor. Codes and Standards. Factor of Safety, design procedure for simple and combined stresses (No Numerical). Modes of failures. Concurrent engineering. Design synthesis.

Introduction to Theories of failure: Maximum Normal Stress Theory, Maximum Shear Stress Theory, Distortion Energy Theory.

Module-4

Design against fluctuating loads. Introduction to Stress Concentration, Stress concentration Factor and its effects (Simple problems). **Fatigue Loads:** Endurance limit, S-N Diagram, Low cycle fatigue, High cycle fatigue, modifying factors: size effect, surface effect. Stress concentration effects, Notch sensitivity, fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.

Module-5

Design of Spur Gears: Beam strength of spur gear, Stresses in gear teeth (Lewis's equation), dynamic tooth load, design for wear

Design of helical gears: Beam strength of helical gear, Stresses in gear teeth (Lewis's equation), dynamic tooth load, and design for wear.

Course outcome (Course Skill Set)

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

CO 1. Illustrate Kinematics of Machines, theories of failures and stress concentration

CO 2. Determine the mobility, power loss due in belt drives.

CO 3. Calculate the stresses, parameters of machine elements subjected to various loads also make proper assumptions with respect to material, FOS for various machine components.

CO 4. Design machine elements like, gears and other simple machine elements

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Theory of Machines: Sadhu Singh, Pearson Education, 2nd edition, 2007.
2. Theory of Machines: Rattan S.S Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2006.
3. Theory of Machines, R. S. Khurmi, J. K. Gupta, Eurasia Publishing House, 2008 Revised Edition.
4. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6thEdition 2009.
5. Design of Machine Elements, V.B. Bhandari, Tata Mc GrawHill Publishing Company Ltd., New Delhi, 3rd Edition 2010. 3.
6. Machine Design, by Dr. P C Sharma and Dr. D K Aggarwal, S. K. Kataria & Sons, 11th Edition 2009

DESIGN DATA HANDBOOK:

1. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication.
2. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2ndEdition.

Design Data Hand Book, H.G. Patil, I. K. International Publisher, 2010.

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

- Quiz
- Presentation
- Group Activity

COMPUTER INTEGRATED MANUFACTURING		Semester	5
Course Code	**BMT515B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- Gain knowledge of basics concepts of CIM
- Understand the concepts of high volume production, flow line analysis and line balancing,
- Gain knowledge on automated assembly system, computerized manufacturing planning & CNC centres
- Understand computerised manufacturing planning system
- Apply CIM technology for providing manufacturing solutions.

Teaching-Learning Process (General Instructions)

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

1. Through Power Point Presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Encourage collaborative (Group) Learning in the class.
4. Ask at least three 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 analyse information rather than simply recall it.

Module-1

Introduction- Automation definition, Types of automation, CIM, processing in manufacturing, Production concepts, **Mathematical Models**-Manufacturing lead time, production rate, components of operation time, capacity, Utilization and availability, Work in-process, WIP ratio, TIP ratio, High Volume Production **Introduction Automated flow line**-symbols, objectives, Work part transport-continuous, Intermittent, synchronous, Pallet fixtures, Transfer Mechanism-Linear-Walking beam, roller chain drive, Rotary-rack and pinion, Rachet & Pawl, Geneva wheel, Buffer storage, control functions-sequence, safety, Quality,

Module-2

Analysis Of Automated Flow Line & Line Balancing- Properties General terminology and analysis, Analysis of Transfer Line without storage upper bound approach, lower bound approach and problems, Analysis of Transfer lines with storage buffer, Effect of storage, buffer capacity with simple problem, Partial automation with numerical problems, flow lines with more than two stages, Manual Assembly lines, Minimum Rational Work Element Work station process time, Cycle time, precedence constraints. Precedence diagram, Balance delay methods of line balancing-largest Candidate rule, Kilbridge and Westers method, Ranked positional weight method

Module-3

Automated Assembly Systems- Design for automated assembly systems, types of automated assembly system, Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feedback, escapement and placement analysis of Multistation Assembly Machine analysis of single station assembly. **Automated Guided Vehicle System**: Introduction, Vehicle guidance and routing, System management, Quantitative analysis of AGV's with numerical problems and application.

Module-4

Computerized Manufacturing Planning System- Introduction, Computer Aided Process Planning, Retrieval types of process planning, Generative type of process planning, Material requirement planning, Fundamental concepts of MRP inputs to MRP, Capacity planning.

Module-5

CNC Machining Centers: Introduction to CNC, elements of CNC, CNC machining centers, part programming, fundamental steps involved in development of part programming for milling and turning.

Course outcome (Course Skill Set)

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

CO 1: have fundamental knowledge of CIM

CO 2: understand the concepts of high-volume production, flow line analysis and line balancing, automated assembly system,

CO 3: understand computerized manufacturing planning & CNC centres.

CO 4: apply CIM technology for providing manufacturing solutions

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Automation, Production system & Computer Integrated manufacturing, M. P. Groover Person India, 2007 2nd edition.
2. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, Prentice Hall India
3. Computer Integrated Manufacturing, J. A. Rehg & Henry. W. Kraebber.
4. CAD CAM by Zeid, Tata McGraw Hill.

Web links and Video Lectures (e-Resources):

- NPTEL course on Computer Integrated Manufacturing
- Videos on Industrial Automation

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

- Visit CNC lab and understand the working of CNC machine centres.
- Visit any automated production Industry and visualize production system and importance of CIM in Industrial Environment

AI FOR MECHATRONICS		Semester	5
Course Code	**BMT515C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

CLO 1. Students are exposed to the fundamentals of Artificial Intelligence.
CLO 2. Students will understand the Process of Robot Vision.
CLO 3. Students are made to understand the principles of AI in Robotics Perception.
CLO 4. Students are made to understand the Planning of Robotics Movement.
CLO 5. Students are made to understand the working principles of Robotics Movement.

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 Derivations and Correlations (In-general).
3. Video demonstration or Simulations.

Module-1

Artificial Intelligence: Introduction, Intelligence, Progress of Artificial Intelligence, Modelling, Simulation and AI, Intelligent Systems.

Module-2

Robot Vision: Introduction, Steering an automobile, Two Stages Of Robot Vision, Image Processing, Scene Analysis, Stereo Vision and Depth Information.

Module-3

AI in Robotics1: Introduction, Robot Hardware: Sensors, Effectors. Robotic perception: Localization and mapping, Other types of perception, Machine learning in robot perception.

Module-4

AI in Robotics2: Planning to move: Introduction, Configuration Space, Cell Decomposition Methods, Modified Cost Functions, Skeletonization Methods, Planning Uncertain Movements.

Module-5

AI in Robotics3: Moving: Introduction, Dynamics And Control, Potential-Field Control, Reactive Control, Reinforcement Learning Control, Robotic Software Architectures: Subsumption, Three-layer, Pipeline. Application Domains.

Course outcome (Course Skill Set)

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

CO1. Recognize the fundamentals of Artificial Intelligence.
CO2. Understand the Process of Robot Vision.
CO3. Understand the principles of AI in Robotics Perception.
CO4. Understand the Planning of Robotics Movement .
CO5. Understand the working principles of Robotics Movement.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Artificial Intelligence And Intelligent Systems by N.P.Padhy, Oxford University Press.
2. Artificial Intelligence- A new Synthesis by Nils J. Nilsson, Morgan Kaufmann Publishers, Elsevier.
3. Artificial Intelligence- A Modern Approach , 3rd Edition, by Stuart J. Russell and Peter Norvig, Pearson Education.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program.

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

- Gaining hands on Knowledge to work on Robo studio.
- Simulation on Robo studio for various Robot applications.
- Programming Robot for various Robot applications.

Mechatronics System Design		Semester	5
Course Code	**BMT515D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 HOURS	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course Learning Objectives:

CLO 1. Gain knowledge of basics of Mechatronics system design.
CLO 2. Understand modelling and simulation of physical elements
CLO 3. Understand the working of actuating devices and signals and systems
CLO 4. Understand signal conditioning methods and convert the data in real time interfacing.
CLO 5. Understand real time mechatronic system design through case study

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 analyzing information.
5. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1

Mechatronics System Design:

Mechatronics Definition, integrated design issues in Mechatronics, the Mechatronics design process, the key elements, Application of Mechatronics.

Module-2

Modeling and Simulation of Physical Elements:

Operator notation and transfer functions, Block diagrams, manipulations and simulation, block diagram modeling-Direct method and analogy approach, Electrical systems, Mechanical systems (Rotational and Translational)

Module-3

Actuating Devices, Signals, Systems:

Direct Current Motors, Permanent magnet stepper motor Introduction to signals, systems and Controls, Laplace transform solution of ordinary differential equations, System representation, Time Delays

Module-4

Signal Conditioning and Real time Interfacing:

Introduction, elements of Data Acquisition and Control System, Transducers and Signal Conditioning, Devices for data conversion, Data conversion process

Module-5

Case Studies:

A pick-and-place robot, Car park barriers, Digital camera, Automotive control systems, Hard disk drive,

Course outcome (Course Skill Set)

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

CO 1. Gain knowledge of basics of Mechatronics system design.
CO 2. Understand modelling and simulation of physical elements
CO 3. Understand the working of actuating devices and signals and systems
CO 4. Understand signal conditioning methods and convert the data in real time interfacing and real time mechatronic system design through case study

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

5. The question paper will have ten questions. Each question is set for 20 marks.
6. 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.
7. The students have to answer 5 full questions, selecting one full question from each module.
8. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books:

1. Mechatronics System Design by Devdas Shetty and Richard A Kolk, Second edition, Thomson Learning Publishing Company, Vikas publishing house, 2001.
2. W. Bolton, "Mechatronics" - Addison Wesley Longman Publication, 1999.
3. Shetty and Kolk "Mechatronics System Design"- Cengage Learning, 2010

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

- Group activity
- Presentation
- Quiz

PROGRAMMABLE LOGIC CONTROLLER AND SCADATECHNOLOGY		Semester	6
Course Code	**BMT601**	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	3
Examination nature (SEE)	Theory		

Course objectives:

CLO 1. Understand the basics and different types of PLC
CLO 2. Solve various logical operations using relay logic and construct equivalent ladder diagram
CLO 3. Analyse the working of counters, timers and comparators
CLO 4. Diagnosis the problem related types of I/O module, Data Acquisition System and Communication Networks (Bus Systems) using Standard Protocol.
CLO 5. Understand basic concepts of SCADA and analyse its architectures

Teaching-Learning Process (General Instructions)

These are sample Strategies; that 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. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1

What is a plc, technical definition of plc, what are its advantages, characteristics functions of a plc, chronological evolution of plc, types of plc, unitary plc, modular plc, small plc, medium plc, large plc, block diagram of plc: input/output (i/o) section, processor section, power supply, memory central processing unit: processor software / executive software, multi-tasking, languages, ladder language

MODULE-2

Bit Logic Instructions: introduction: Input and Output contact program symbols, Numbering system of inputs and outputs, Program format, introduction to logic: Equivalent Ladder diagram of AND gate, Equivalent ladder diagram of or Gate, equivalents Ladder Diagram of NOT gate, equivalent ladder diagram of XOR gate, equivalent ladder diagram of NAND gate, equivalent ladder diagram of NOR gate, equivalent ladder diagram to demonstrate De Morgan theorem. Ladder
design. Examples: Training Stopping, Multiplexer, DE multiplexers

MODULE-3

PLC Timers and Counters: On Delay and OFF delay timers, Timer-on Delay, Timer off delay, Retentive and non-retentive timers. Format of a timer instruction. PLC Counter: Operation of PLC Counter, Counter Parameters, Counters Instructions Overview Count up (CTU) Countdown (CTD).
Advanced instructions: Introduction: Comparison instructions, discussions on comparison instructions, "EQUAL" or "EQU" instruction, "NOT EQUAL" or "NEQ" instruction, "LESS THAN" or "LESS" instruction, "LESS THANOR EQUAL' or "LEQ" instruction, GREATER THAN" OR "GRT" instruction, "GREATER THAN OR EQUAL
TO" or "GRO" instruction, "MASKED COMPARISON FOR EQUAL" or "MEQ" instruction, "LIMIT TEST" or "LIM" instruction.

MODULE-4

PLC input output (I/O) modules and power supply: Introduction: Classification of I/O, I/O system overview, practical I/O system and its mapping addressing local and expansion I/O, input-output systems, direct I/O, parallel I/O systems serial I/O systems. Sinking and sourcing. Discrete input module. Rectifier with filter, threshold detection, Isolation, logic section, specifications of discrete input module, types of analog input module, special input modules, analog output module, I/O modules in hazardous locations power supply requirements, power supply configuration, filters.

MODULE-5
Introduction, definition and history of Supervisory Control and Data Acquisition typical SCADA System Architecture, Communication Requirements, Desirable properties of SCADA system, Features, advantages, disadvantages and applications of SCADA. SCADA Architecture (First Generation-Monolithic, Second Generation-Distributed, Third Generation-Networked Architecture), SCADA systems in operation and control of interconnected power system, Power System Automation, Petroleum Refining Process, Water Purification System, Chemical.

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

Sl.NO	Experiments
1	Design PLC ladder diagram for basic gate operation
2	Interfacing of Lamp & button with PLC for ON&OFF Operation. Verify all logic gates.
3	Design PLC ladder diagram for De-Morgan's theorem
4	Design PLC ladder diagram for 4:1 MUX and 1:4 DE-MUX
5	Design PLC ladder diagram for ON delay timer for ON/OFF controller of motor
6	Design PLC ladder diagram for OFF delay timer for ON/OFF controller of motor
7	Design PLC ladder diagram for UP COUNTER for ON/OFF controller of motor
8	Design PLC ladder diagram for DOWN COUNTER for ON/OFF controller of motor
9	Design PLC ladder diagram for ON and OFF delay timer for ON/OFF controller of motor with Micro Logix1400
10	Design PLC ladder diagram for UP COUNTER and DOWN COUNTER for ON/OFF controller of motor with Micro Logix 1400
11	Design PLC based temperature sensing using RTD
12	Design parameter reading of PLC in SCADA
13	Design temperature sensing using SCADA

Course outcomes (Course Skill Set):

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

CO1. Demonstrate the concepts of basic programming skills of PLC using logical instructions

CO2. Apply the architecture process involved in programmable logic controller and basic programming skillsof PLC using logical instructions

CO3. Examine the various operation involved in the PLC input/output module and SCADA system

CO4. Construct the ladder diagram for PLC using logical instructions, timer and counters, Data Handlinginstructions and build the SCADA System for Real time industrial process.

CO5. Develop the Logical Instructions Involved in development of programmable logic controller for various operations

CO6. Construct the ladder logic for various operations using PLC and SCADA for Industrial 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.

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

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

- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods

mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.

- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for thetheory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

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

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common questionpapers 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 havea CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

1. "PLC and Industrial application", Madhuchhandan Gupts and SamarjitSen Gupta, pernram international pub. (Indian) Pvt. Ltd., 2011.
2. Ronald L Krutz, "Securing SCADA System", Wiley Publication

REFERENCE BOOKS

1. GaryDunning,"Introduction to Programmable Logic Controllers", Thomson,2 nd Edition.
2. John W Webb, Ronald A Reis,"Programmable Logic Controllers: Principles and Application", PHI Learning, Newdelhi, 5 th Edition
3. Stuart A Boyer, "SCADA Supervisory Control and Data Acqusition", ISA, 4 th Revised edition

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

- Group activity
- Quiz
- Presentation

INDUSTRIAL ROBOTICS		Semester	6
Course Code	**BMT602**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	52 hours	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory		

Course objectives:

CLO 1. To gain knowledge on basics of Robotics

CLO 2. To understand Robot Kinematics and Dynamics, Sensors used in Robots

CLO 3. To understand basics of Robot programming and Artificial Intelligence **CLO 4**. To gain knowledge on robot layout and cell design

CLO 5. To relate the knowledge on robotics and understand the application of Robots in Industries

Teaching-Learning Process (General Instructions)

These are sample Strategies; that 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. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.

MODULE-1

Fundamentals of Robotics: robot anatomy, work volume, robot drive systems, control systems, precision of movement, end effectors, robotic sensors, robot programming and work cell control, robot applications, problems. Basic control systems and components: Basic control systems concepts and models, control system analysis, robot sensors and actuators.

MODULE-2

Robot Motion Analysis: Introduction to manipulator kinematics, homogeneous transformations and robot kinematics, D-H convention, manipulator path control, robot dynamics, configuration of a robot controller.
Robot End Effectors: types of end effecters, mechanical grippers, other types of grippers, tools as end effectors, robot/end effector interface, consideration in gripper selection and design, problems.
Sensors in Robotics: Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors, uses of sensors in robotics, problems.

MODULE-3

Robot Programming: Methods of robot programming, lead -through programming methods, a robot program as a path in space, motion interpolation, wait, signal and delay commands, branching, capabilities and limitations of lead-through methods, problems.
Artificial Intelligence (AI): Introduction & goals of AI in research, AI techniques, LISP programming, AI & robotics, LISP in factory, robotic paradigms, problems.

MODULE-4

Robot Cell Design & Control: Robot cell layouts, multiple robots and machine interference, considerations in work -cell design, work-cell control, interlocks, error detection and recovery, work -cell controller, robot cycle time analysis, graphic simulation of robotic work cells, problems.

MODULE-5

Robots in Automatic Processing Operations: Introduction, spot welding, continuous arc welding, spraycoating, other processing operations.
Assembly & Inspection: Assembly and robotic assembly automation, parts presentation methods, assembly operations, compliance and remote centre compliance (RCC) device, assembly system configurations, adaptable Programmable assembly system, designing for robotic assembly, inspection automation.

Course outcomes (Course Skill Set):

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

CO 1. To understand the basics of robotics, sensors, Programming and Applications of Robots

CO 2. To illustrate the different applications of robotics in Industries

CO 3. To analyze simple robot kinematics and dynamics

CO 4. To design general robot cell layouts

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

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

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the 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. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, "Industrial Robotics: Technology, Programming and Applications", 2nd Edition, Tata McGraw Hill, 2012.
2. Roland Siegwart, Illah R. Nourbakhsh, and Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2nd Edition, PHI, 2011.

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

- Industrial visit to understand the importance of robots in Industries

ROBOTICS LAB		Semester	6
Course Code	**BMT606L**	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	3
Examination type (SEE)	Practical		

Course objectives:

1. Understand the Importance & Applications of Robots in Virtual Environment.
2. Design the Robots system for Real-time Applications.

Sl.NO	Experiments
1	Design the Robot programming for Point to Point using two Cubes.
2	Design the Robot programming for Drilling Operation using Cube and Cylinder.
3	Design the Robot programming using Smart Components.
4	Design the Robot programming for Multimove Operation.
5	Design the Robot programming for Conveyor Tracking System.
6	Design the Robot programming for Continuous Path Operation on Cylinder
7	Design a Robot System for Pick and Place Operation.
8	Design a Robot System for Point to Point operation.[Cube]
	Demonstration Experiments (For CIE)
9	Design a Robot System for Continuous Path Operation.
10	Design a Robot System for Circle Path Operation.
11	Design a Robot System for Drilling Operation of Cube.
12	Design a Robot System for Continuous Path Operation for any 3 Objects [Cube, Box, Circle]

Course outcomes (Course Skill Set):

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

CO1: Analyse the design parameters of Robot for Industrial applications on Robo studio.
CO2: Develop Robotics Model & workbench prototype for required specifications on Robo studio.
CO3: Develop & Implement the programs on Industrial Robot for various Real time applications.
CO4: Evaluate the performance of industrial robot for various application programs.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

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

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

- Each experiment is to be evaluated for conduction with an observation sheet and recordwrite-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.

- Record should contain all the specified experiments in the syllabus and each experimentwrite-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximummarks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experimentslisted in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and proceduralknowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learningability.
- 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 thetotal CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners, one from other institute as external and one from the same institute as internal examiner, are appointed by the university.
- 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.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answerscript to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for100 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 partare to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta,"Industrial Robotics: Technology, Programming and Applications", 2 nd Edition, Tata McGraw Hill, 2012.
2. Roland Siegwart, Illah R. Nourbakhsh, an d Davide Scaramuzza, "Introduction to AutonomousMobile Robots", 2 nd Edition, PHI, 2011

POWER ELECTRONICS		Semester	6
Course Code	**BMT613A**	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	3
Examination type (SEE)	Theory		

Course objectives:

CLO 1. To study and understand the importance of power electronics circuits and their applications.
CLO 2. To understand the construction, working, and switching characteristics of various power devices.
CLO 3. Learn the applications of power devices in AC voltage regulators, controlled rectifiers, choppers and inverters
CLO 4. Analyze their working under various load conditions.
CLO 5. To familiarize with the performance parameters of controlled rectifiers, chopper and inverters.

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.

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Module-1

Module–1: Introduction, Power semiconductor Devices: Applications of Power Electronics Power semiconductor devices, Control Characteristics, Types of power electronics circuits, Peripheral effects. Power MOSFETs – switching characteristics, gate drive, di/dt and dv/dt limitations, Isolation of gate and base drives, Simple design of gate and base drives.

Module-2

Thyristors: Introduction, characteristics, Two Transistor Model. Turn-on and turn-off, di/dt and dv/dt protection, Thyristor types, Thyristors firing circuits, Simple design of firing circuits using UJT. **Commutation Techniques:** Introduction. Natural Communication, Forced commutation: self- commutation, impulse commutation, resonant pulse commutation and complementary commutations.

Module-3

AC Voltage Controllers: Introduction. Principle of ON-OFF and phase control. Single-phase bidirectional controllers with resistive and inductive loads.
Controlled Rectifiers: Introduction. Principle of phase controlled converter operation. Single phase semi-converters. Full converters. Three-phase half-wave converters. Three-phase full-wave converters.

Module-4

DC Choppers: Introduction. Principle of step-down and step-up chopper with R-L load. Performance parameters. Choppers classification. Analysis of impulse commutated thyristor chopper (only qualitativeanalysis)

Module-5

Inverters: Introduction, Principle of operation. Performance parameters. Single-phase bridge inverters. Three phase inverters. Voltage control of single-phase Inverters single pulse width, multiple pulse width, and sinusoidal pulse width modulation.

Course outcome (Course Skill Set)

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

CO 1. Have knowledge of semiconductors devices, Thyristors, AC voltage controllers, choppers and inverters
CO 2. Understand the characteristics and working principles of Thyristors, AC voltage controllers, choppersand inverters.
CO 3. Apply control techniques to meet the desired operation of AC voltage regulators, rectifiers and commutation.
CO 4. Apply control techniques to meet the desired operation of coppers and Inverters.

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) andfor the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal AssessmentTest component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the secondtest will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based thenonly 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 ofassessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomyas 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 maximumof 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

Power Electronics: Circuits Devices and Applications Mohammad H Rashid, Pearson 4th Edition,2014

Reference Materials

1 Power Electronics: Converters, Applications and Design Ned Mohan et al Wiley 3rd Edition, 20142
Power Electronics: Daniel W Hart McGraw Hill 1 st Edition, 2011
3 Elements of Power Electronics :Philip T Krein Oxford Indian Edition, 2008

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

- Quiz
- Presentation
- Group Activity

SMART FACTORY AND INDUSTRY 4.0		Semester	6
Course Code	**BMT613B**	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	3
Examination type (SEE)	Theory		

Course objectives:

CLO 1. Understand the basics of smart factory and Manufacturing

CLO 2. Gain knowledge on different tools of smart design and fabrication

CLO 3. Understand basics of smart applications

CLO 4. Understanding Internet of things in Industries

CLO 5. Concepts of smart and empowered workers in Industries

Teaching-Learning Process (General Instructions)

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

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information

Module-1

Introduction to Smart Manufacturing - Dimensions -Demand-Driven and Integrated Supply Chains; Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations); Real-Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization, and reduction of GHG).

Module-2

Smart Design/Fabrication: Smart Design/Fabrication - Digital Tools, Product Representation and Exchange Technologies and Standards, Agile (Additive) Manufacturing Systems and Standards. Mass Customization, Smart Machine Tools, Robotics and Automation (perception, manipulation, mobility, autonomy), Smart Perception – Sensor Networks and Devices.

Module-3

Smart Applications: Online Predictive Modeming, Monitoring, and Intelligent Control ofMachining/Manufacturing and Logistics/Supply Chain Processes; Smart Energy Management of manufacturing processes and facilities,

Module-4

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Service, Cloud Computing and Industry 4.0, Data acquisition mechanisms, Data interpretation techniques and tools, Development of feedback systems.

Module-5

Smart and Empowered Workers: Eliminating Errors and Omissions, Deskilling Operations, Improving Speed/Agility, Improving Information Capture/Traceability, Improving Intelligent Decision Making under uncertainty Assisted/Augmented Production, Assembly, Quality control, Maintenance, Warehouse Operations, and Assisted Training.

Course outcome (Course Skill Set)

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

CO 1. To understand the concepts of smart design and manufacturing in Industries

CO 2. To know the importance of different components of smart factory systems

CO 3. To apply the concepts of Internet of Things technology in Industry

CO 4. To analyze the production and logistics process in Smart factory 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:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment for a total of 50 marks.

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. Michael Deng, Colin Koh, Smart Factory: Transforming Manufacturing for Industry 4.0 (Industry 4.0 inASEAN Region Series)- ISBN-13: 979-8583886425.
2. Banken, and Alasdair Gilchrist; Industry 4.0, Apress Berkeley, CA, ISBN978-1-4842-2047-4
3. Carlos Toro, Wei Wang, and Humza Akhtar, Implementing Industry 4.0, Springer Cham, ISBN978-3-030-67269-0.
4. Erwin Rauch and Manuel Woschank, Industry 4.0 for SMEs - Smart Manufacturing and Logistics forSMEs, ISBN 978-3-03936-567-8.

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

- Industrial visit to gain knowledge on smart factory and Industry 4.0

Projects involving Internet of things in industrial models

AUTOMOTIVE ELECTRONICS AND HYBRID VEHICLES		Semester	6
Course Code	**BMT613C**	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	3
Examination type (SEE)	Theory		

Course objectives:

CLO 1. To Gain knowledge of Ignition, Transmission, Brakes System in Automobile

CLO 2. To Understand the basic concepts and various Operation using Sensor and Actuators Used Automobile.**CLO 3.** To diagnosis the problem related types of, Data Acquisition System and Communication Networks (Bus Systems) Control system using Standard Technology.

CLO 4. To Understand the basic of Vehicle Cruise control and Collision Avoidance Radar warning Systems.

CLO 5. To Gain knowledge of Electric Vehicle, Hybrid Electric vehicle, Electric Hybrid Vehicle,Vehicle components

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. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1

Automotive Fundamentals Overview: Four Stroke Cycle, Engine Control, Ignition System, Spark plug,Spark pulse generation, Ignition Timing, Drive Train, Transmission, Brakes, Steering System, Battery, Starting System. Air/Fuel Systems Fuel handling. Air/ Fuel Management.

Module-2

Sensors and actuators: Sensors – Oxygen (02/EGO) Sensors, Throttle Position Sensor (TPS), EngineCrankshaft Angular Position (CKP)Sensors, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Manifold Absolute Pressure (MAP) Sensor– Strain gauge and Capacitor capsule,Engine Coolant Temperature (ECT) Sensor, Intake Air Temperature (IAT) Sensor, Knock Sensor, Airflow rate sensor, Throttleangle Sensor. Actuators: Fuel Metering Actuator, Fuel Injector, Ignition Actuator. Exhaust After-Treatment Systems – AIR, Catalytic Converter, Exhaust Gas Recirculation (EGR), Evaporative Emission Systems.

Module-3

Automotive Instrumentation and Communication: Sampling, Measurement & Signal Conversion of various parameters (Speed, fuel, pressure). Serial Data, Communication Systems, Protection, Body and Chassis is Electrical Systems, Remote Keyless Entry, GPS

Module-4

Vehicle Motion Control: Cruise control, Chassis, Power Brakes, Antilock Brake System (ABS), Electronic Steering Control, Power Steering, Traction Control, electronically controlled suspension. Automotive Diagnostics –Timing Light, Engine Analyzer, On- board diagnostics, Off-board diagnostics,Expert Systems.Future Automotive Electronics Systems: Alternative Fuel Engines, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Radio navigation, Advance DriverInformation System.

Module-5

Introduction to Alternative Vehicles: Electric Vehicle, Hybrid Electric vehicle, Electric Hybrid Vehicle,Vehicle components, Electric and Hybrid history EV/CEV Comparison. Alternative Vehicle Architecture: Electric Vehicles, Hybrid Electric Vehicles, Plug-in Hybrid Electric Vehicles, Power Train component Sizing, Mass Analysis & Packaging, Vehicle Simulation

Course outcome (Course Skill Set)

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

1. Understanding of Engine Parameters and a critical awareness of current problems within theautomotive electronics domain using Various Measurement Technology.
2. Apply the fundamental Concepts of automotive electronics on various Engine parts, Sensor, Actuator, Communication and Measurement System.
3. Determine the extent and nature of electronic circuitry in automotive systems including monitoringand control circuits for engines, transmissions, brakes, steering, suspension.
4. Analyze climate control, instrumentation and radios and accessories involved in Automotive Industry

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) andfor the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal AssessmentTest component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the secondtest will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based thenonly 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 ofassessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomyas 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 maximumof 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Willliam B. Ribbens: Understanding Automotive Electronics, 6th Edition, SAMS/Elsevier PublishingIqbal Husain "Electric and Hybrid Vehicles: Design fundamentals". CRC Press, 2011.
2. **Robert Bosch GmbH:** Automotive Electronics Systems and Components 5th Edition,John Wiley & Sons Ltd., 2007
3. James Laminie and John Lowry. "Electric Vehicle Technology – Explained', CRC Press 2010. Society ofAutomobile Engineers, "Hybrid Electric vehicles", CRC Press, 2011.

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

- Quiz
- Presentations
- Group activity

SIGNAL PROCESSING		Semester	6
Course Code	**BMT613D**	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	3
Examination type (SEE)	Theory		

Course objectives:

The course aims to enable the students to:

- Understand the various aspects of signals and systems.
- Compute the response of discrete-time Linear and Time-Invariant Systems
- Represent the discrete-time signals and systems in frequency domain
- Design analog and digital filters for signal processing.

Teaching-Learning Process (General Instructions)

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

1. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching methodmay be adopted to develop the outcomes
2. Show Video/animation films to explain the functioning of various
3. Encourage collaborative (Group) Learning in the class to promote critical thinking
4. Topics for seminars on several MEMS related topics and their applications
5. Encourage the students to take up mini projects and main projects
6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve thestudents' understanding..

Module-1

Introduction: Signals and Systems-Definition and Examples, Basic Elements of a Digital Signal Processing System, Advantages of Digital Signal Processing over Analog Signal Processing, Classification of Signals, The Concept of Frequency in Continuous-Time and Discrete-Time Signals, Analog to Digital Conversion (Block Diagram Discussion)
Discrete-Time Signals: Elementary Discrete-Time Signals, Classification of Discrete-Time signals, Manipulation of Discrete-time Signals

Module-2

Discrete-Time Systems: Input-Output Description of Systems, Block Diagram Representation,Classification of Systems (From Text-1)
Analysis of Discrete-Time Systems: Representation of Discrete-Time Signals using Impulses, Response of LTI Systems-Convolution Sum, Properties of Convolution Sum and Interconnection of LTI systems, Stability and Causality of LTI Systems, Difference Equation Representation of LTI systems

Module-3

Z-Transforms: Definition, Properties, Rational Z-Transforms, Inverse Z-Transforms (Partial Fraction Expansion, Long Division methods), Analysis of LTI systems in Z-domain (Stability and Causality), Relationship between Impulse Response, System Function and Difference Equation Representation

Module-4

Design of FIR Filters: Characteristics of practical frequency-selective filters, Design of Linear-phase FIR (low pass and High pass) filters using windows – Rectangular and Hamming windows. Structure for FIR Systems: Direct form, Cascade form

Module-5

IIR Filter Design: Infinite Impulse response Filter Format, Bilinear Transformation Design Method, Analog Filters using Low pass prototype transformation, Normalized Butterworth Functions, Bilinear Transformation Design Procedure, Digital Butterworth (Lowpass and Highpass) Filter Design using BLT. Realization of IIR Filters in Direct form I and II, Cascade and Parallel forms

Course outcomes (Course Skill Set)

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

1. Classify the signals.
2. Perform operations on discrete-time signals, and classify the systems.
3. Compute the response and determine the properties of LTI systems using Z-transforms.
4. Design FIR and IIR Digital Filters.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Text Book:

John G Proakis and Dimitris G Manolakis, "Digital Signal Processing", Pearson, 4th Edition, 2012.

Reference Books:

1. Alan V Oppenheim and Ronald W Schafer, "Discrete Time Signal Processing", Pearson, 3rd Edition, 2014.
2. S Salivahanan, "Digital Signal Processing", Mc Graw Hill Education, 3rd Edition, 2017.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learningTo be conducted using MATLAB or any computational tool:

(i) Generate standard signals and plot them
(ii) Obtain Z-transform of step-sequence, exponential sequence and sinusoidal sequence
(iii) Perform Linear convolution of two sequences and verify commutative, distributive and associative laws
(iv) Design and implementation of IIR (Butterworth) low pass filter to meet given specifications.
(v) Design and implementation of IIR (Butterworth) high pass filter to meet given specifications.

AUTOMATION IN MANUFACTURING		Semester	6
Course Code	**BMT654A**	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	3
Examination type (SEE)	Theory		

Course Learning objectives: To Gain the knowledge of
CLO 1. Gain knowledge of fundamental concepts of automation in manufacturing.
CLO 2. Understand the techniques of industrial control and quality control in manufacturing.
CLO 3. Understand automated manufacturing and support system for industry operations. **CLO 4.** Gain knowledge of inspection technologies.
CLO 5. Understand group technologies and flexible manufacturing systems.

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

1. Show Video/animation films to explain the functioning of various functions.
2. Encourage collaborative (Group) Learning in the class
3. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
4. Project based learning: Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather thansimply recall it.

Module-1

Introduction: Production System Facilities, Manufacturing Support systems, Automation in Production systems, Automation principles & Strategies. **Manufacturing Operations:** Manufacturing Operations, Product/Production Relationship, Production concepts and Mathematical Models & Costs ofManufacturing Operations.

Module-2

Industrial Control System: Basic Elements of an Automated System, Advanced Automation Functions &Levels of Automation, Continuous versus Discrete control, Computer Process control, Forms of ComputerProcess Control.
Quality Control Systems: Traditional and Modern Quality Control Methods, Taguchi Methods in Quality Engineering. Introduction to SQC Tools.

Module-3

Automated Manufacturing Systems: Components of a Manufacturing systems, Classification of Manufacturing Systems, overview of Classification Scheme, Single Station Manned Workstations and Single Station Automated Cells.
Manufacturing Support System: Process Planning, Computer Aided Process Planning, Concurrent Engineering and Design for Manufacturing, Advanced Manufacturing Planning, Just-in Time Production System, Basic concepts of lean and Agile manufacturing.

Module-4

Inspection Technologies: Automated Inspection, Coordinate Measuring Machines Construction, operation & Programming, Software, Application & Benefits, Flexible Inspection System, InspectionProbes on Machine Tools.
Machine Vision, optical Inspection Techniques & Noncontact Non-optical Inspection Technologies.

Module-5

Group Technology & Flexible Manufacturing Systems: Part Families, Parts Classification and coding, Production Flow Analysis, Cellular Manufacturing.
Flexible Manufacturing Systems: What is an FMS, FMS Components, FMS Applications & Benefits, and FMS Planning & Implementation Issues.

Course outcome (Course Skill Set)

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

CO 1. Gain knowledge of fundamental concepts of automated flow lines, traditional and modern quality control methods.

CO 2. Gain knowledge of manufacturing supporting system, AMS, Inspection Technologies, group technologies, and FMS.

CO 3. Understand various automated flow lines, assembly systems and line balancing methods.

CO 4. Understand importance of automated material handling and storage systems and the importance of adaptive control systems, automated inspection 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) andfor the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal AssessmentTest component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the secondtest will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based thenonly 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 ofassessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomyas 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 maximumof 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books:

Recommended Text Books

1. Automation, Production Systems and Computer Integrated Manufacturing, M. P. Groover,Pearson education. Third Edition,2008
2. Principles of CIM, Vajpayee, PHI.

Reference Books:

1. Anatomy of Automation, Amber G.H & P. S. Amber, Prentice Hall.
2. Performance Modeling of Automated Manufacturing Systems, Viswanandham, PHI
3. Computer Based Industrial Control, Krishna Kant, EEE-PHI.

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

- Quiz
- Group activity
- Presentation

ELECTRIC AND HYBRID VEHICLES		Semester	6
Course Code	**BMT654B**	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	3
Examination type (SEE)	Theory		

Course objectives:

CLO 1. To gain knowledge of Performance characteristics of road vehicle and motors.
CLO 2. To understand Hybrid Architecture configuration and operation of AC motors
CLO 3. To understand Hybrid Power Plant specifications and engine fraction-engine downsizing
CLO 4. To understand Energy Storage Technology.
CLO 5. To understand concepts of fuel cells.

Teaching-Learning Process (General Instructions)

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

1. Show Video/animation films to explain the functioning of various functions.
2. Encourage collaborative (Group) Learning in the class
3. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
4. Project based learning: Adopt Problem Based Learning (PBL), which fosters students' Analyticalskills, develop thinking skills such as the ability to evaluate, generalize, and analyze informationrather than simply recall it..

Module-1

Introduction: Performance characteristics of road vehicles, calculation of road load, predicting fuel economy, Grid connected hybrids
DC motors: Series wound, shunt wound. Compound wound and separately excited.

Module-2

AC motors: Induction, synchronous, brushless DC motor, switched reluctance motors.
Hybrid Architecture: Series configuration- locomotive drives, series parallel switching, load tracking architecture. Pre transmission parallel and combined configurations-Mild hybrid, power assist,dual mode, power split, power split with shift, Continuously Variable transmission (CVT). Wheel motor.

Module-3

Hybrid Power Plant specifications: Grade and cruise targets. Launching and boosting, braking andenergy recuperation drive cycle implications, engine fraction-engine downsizing and range and performance, usage requirements.

Module-4

Sizing the Drive System: Matching electric drive and ICE, sizing the propulsion motor, sizing power Electronics
Energy Storage Technology: Battery basics, different types of batteries (lead-acid battery / Lithium / Alkaline), High discharge capacitors, flywheels, battery parameters.

Module-5

Fuel cells: Fuel cell characteristics, fuel cell types - alkaline fuel cell, proton exchange membrane,direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell,hydrogen storage systems, reformers, fuel cell EV.

Course outcome (Course Skill Set)

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

CO1. Understanding the working principle of hybrid vehicle and its main components, operating principle and properties of the most common types of electrical motors in hybrid technology.
CO2. Illustrate power storage system and fuel cells in electric vehicles.
CO3. Analyze the performance of a hybrid vehicle.
CO4. Analyze Hybrid Architecture drive system, power system and fuel cells in Hybrid electric vehicle.

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) andfor the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal AssessmentTest component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the secondtest will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based thenonly 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 ofassessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomyas 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 maximumof 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. The Electric Car: Development & Future of Battery, Hybrid &Fuel-Cell Cars - Dr Mike Westbrook, M H Westbrook, British library Cataloguing in Publication Data, UK, ISBN0 85296 0131.
2. Electric and Hybrid Vehicles - Robin Hardy, Iqbal Husain, CRC Press, ISBN 0-8493-1466-6.
3. Propulsion Systems for Hybrid Vehicles - John M. Miller, Institute of Electrical Engineers, London, ISBN0 863413366.

Reference Books:

1. Energy Technology Analysis Prospects for Hydrogen and Fuel Cells, International Energy Agency, France.
2. Hand Book of Electric Motors - Hamid A Taliyat, Gerald B Kliman, Mercel Dekker Inc., US, ISBN0-8247-4105-6

Web links and Video Lectures (e-Resources):

- . https://nptel.ac.in/

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

- Quiz
- Group activity
- Presentation

MECHATRONICS ENGINEERING		Semester	6
Course Code	**BMT654C**	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	3
Examination type (SEE)	Theory		

Course objectives:

CLO 1: To gain knowledge of measurement in control system in mechatronics engineering.
CLO 2: To understand the working and applications of transducers and sensors.
CLO 3: To gain the knowledge in signal conditioning, mechatronics, engineering.
CLO 4: To Gain the knowledge of electromechanical components and the operations of PLC.
CLO 5: To Understand mechatronics design process and its applications.

Teaching-Learning Process (General Instructions)

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

1. Show Video/animation films to explain the functioning of elements of Robotics
2. Encourage collaborative (Group)Learning in the class
3. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
4. Adopt Problem Based Learning(PBL),which fosters students' Analytical skills, develop thinking skills suchas the ability to evaluate, generalize, and analyze information rather than simply recall it.

Module-1

Introduction: Scope and elements of mechatronics, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine.

Module-2

Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.

Module-3

Signal Conditioning: Introduction – Hardware – Digital I/O, 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-4

Electro Mechanical Drives: mechanical systems. Types of motions. Electrical systems. Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrantservo drives, PWM's – Pulse Width Modulation.

Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timercounters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application.

Module-5

Mechatronics Design process: Mechatronics Definition, integrated design issues in Mechatronics, the Mechatronics design process, the key elements, Application of Mechatronics. Case studies of Mechatronicssystems – Pick and place Robot – Automatic car park barrier.

Course outcome (Course Skill Set)

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

CO 1: Illustrate various components of Mechatronics systems.

C0 2: explain the working principles of transducers and sensors in mechatronics.

CO 3: Apply the knowledge of electromechanical components and PLC in mechatronics applications.

CO 4: Outline the design process in mechatronics and Mechatronics integrated issues.

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) andfor the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal AssessmentTest component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the secondtest will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based thenonly 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 ofassessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomyas 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 maximumof 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Mechatronics–Electronic Control Systems in Mechanical and Electrical Engineering, W.Bolton Pearson Education 1stEdition, 2005
2. Mechatronics-Principles Concepts and Applications Nitaigour Premchan Mahalik Tata McGraw Hill 1stEdition, 2003.
3. Mechatronics: Integrated Mechanical Electronic Systems K.P. Ramachandran, G.K Vijayaraghavan, M.S. Balasundaram. Wiley India Pvt. Ltd. New Delhi 2008
4. Mechatronics System Design Devdas Shetty, Richard A. kolk Cengage publishers. Second edition

Web links and Video Lectures (e-Resources):

- NPTEL courses on mechatronics (https://archive.nptel.ac.in/noc/noc_course.html)

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

- Quiz
- Presentations
- Group activity

MICRO ELECTRO-MECHANICAL SYSTEMS		Semester	6
Course Code	**BMT654D**	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	3
Examination type (SEE)	Theory		

Course Learning Objectives:

CLO 1. Understand the operation and Importance of Micro and Smart Systems.
CLO 2. Understand the Working Principle and Operation of Various Kinds of Sensors and Actuators.
CLO 3. Understand the Fabrication Process of Micromachining.
CLO 4. Understand the operation of Electronics Circuits for Micro and Smart Systems.
CLO 5. Understand the Working Principle of Controllers for MEMS and BEL Pressure Sensor and SmartStructure in vibration control.

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 Derivations and Correlations (In-general).
3. Video demonstration or Simulations, Laboratory Demonstrations and Practical Experiments

Module-1

Introduction to Micro and Smart systems: Miniaturization, Microsystems versus MEMS, Micro-fabrication, Smart Materials, Structures & Systems, Integrated Microsystems, Application of SmartMaterials & Microsystems.

Module-2

Micro and Smart Devices and Systems: Principles and Materials: Definitions and salient features of sensors, actuators, and systems. Sensors: silicon capacitive accelerometer, Piezoresistive pressure sensor, Portable blood analyzer, Conductometric gas sensor. Actuators: Micro mirror Array for Video Projection, Piezo-electric based inkjet print head, electrostatic comb-drive, Magnetic micro relay.

Module-3

Micromachining Technologies: Silicon as a Material for Micromachining, Silicon wafer preparation, thin-film deposition techniques, Lithography, Etching, Silicon micromachining: surface micromachiningbulk micromachining. Specialized Materials for Microsystems.

Module-4

Electronics Circuits for Micro and Smart Systems. Semiconductor devices: Diode, Schottky diode, Tunneldiode, Bipolar Junction Transistor (BJT), MOSFET, and CMOS circuits: Inverter and NAND Gate,Electronics Amplifiers: Operational Amplifiers, Basic Op-Amp circuit, Op-Amp based circuits.

Module-5

Implementation of Controllers for MEMS & Case Studies of Integrated Microsystems.
Design Methodology, PID controller, Circuit Implementation, Digital controller, Microcontroller & PLC.Case Studies of Integrated Microsystems: BEL pressure sensor, design considerations, performance parameters, Smart Structure in vibration control.

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

CO.1 Demonstrate the working methodology of smart materials, Microsystems, electronic circuitry in MEMS devices.
CO.2 Illustrate the process of silicon wafer preparation, thin film deposition techniques, lithography, etching, bulk & surface micromachining involved in MEMS fabrication.
CO.3 Examine the behavior of piezoresistive & piezoelectric materials required to fabricate pressure sensor & vibration control structures.
CO.4 Measure the performance of pressure sensor & vibration control structure in real time 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) andfor the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal AssessmentTest component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the secondtest will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based thenonly 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 ofassessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomyas 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 maximumof 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat, V.K.Aatre,Wiley India 2010.
2. Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan,
3. K. J. Vinoy, S. Goplakrishnan, Wiley.
4. MEMS- Nitaigour Premchand Mahalik, TMH 2007.
5. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill.

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

1. Students are segregated in groups of 5members made to Prepare models of FCC structure of Silicon andPatterns to demonstrate the process of Photolithography.
2. Students are segregated in groups of 5members made to Prepare models of Cantilever Beam to analyze thevibration control and Patterns to demonstrate the process of Etching.
3. Quiz

MATLAB for Mechatronics		Semester	6
Course Code	BMT657A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	12 Lab sessions	Total Marks	100
Credits	01	Exam Hours	3
Examination type (SEE)	Practical		

Course objectives:

CLO 1. To obtain the Transfer Function and State Space Modelling and simulation of Physical systems

CLO 2. To study the time response of first and second order system

CLO 3 .To study the error analysis of different control system

CLO 4. To study the compensation techniques used to stabilize the system.

Sl.NO	Experiments
1	Mathematical (Transfer Function) modelling and simulation of any Mechanical System and any ElectricalSystem using Matlab® (Simulink) / Scilab (xcos) or similar software.
2	Mathematical (State Space) modelling and simulation of any Mechanical System and any Electrical System using Matlab / Scilab or similar software.
3	Mathematical (Transfer Function) modelling of DC Motor using Matlab (Simulink) / Scilab or similar software.
4	D.C. Motor Parameter Identification.
5	Experiment on components of control system.
6	Transient response of 1st order & 2nd order system.
7	Frequency response of 1st order & 2nd order system.
8	Time and Frequency Response simulation in Matlab/Scilab.
	Demonstration Experiments (For CIE)
9	Steady state error analysis of different types of systems.
10	Stability analysis of a given Transfer Function based on Bode plot / Root locus / Nyquist plots using Matlab.
11	Design of Proportional Controller of Velocity for a DC Motor in Matlab/Scilab.
12	Frequency Response based Design of PD Position Control of a DC Motor in Matlab/Scilab.

Course outcomes (Course Skill Set):

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

- Model and simulate physical systems using software tools
- Perform Parameter Identification
- Define the open loop and closed loop system
- Simulate time and frequency response of first and second order systems.
- Simulate the control system for getting different responses.
- Design the controller for position/velocity control of DC Motor

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

- CIE marks for the practical course are **50 Marks**.
- The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the university.
- 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.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answerscript to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for100 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 partare to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- Vijay Madisetti, Arshdeep Bahga, Internet of Things. "A Hands on Approach", University Press
- Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
- Pethuru Raj and Anupama C Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
- Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
- Adrian McEwen, "Designing the Internet of Things", Wiley
- Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill

EMBEDDED SYSTEMS		Semester	6
Course Code	**BMT657B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	12 Lab sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		

Course objectives:

CLO 1. Understand the instruction set of ARM Cortex M3, a 32-bit microcontroller, and the software tool required for programming in Assembly and C language.

CLO 2. Program ARM Cortex M3 using the various instructions in assembly level language for differentapplications.

CLO 3. Interface external devices and I/O with ARM Cortex M3.

CLO 4. Develop C language programs and library functions for embedded system applications.

Sl.NO	Experiments
1	Write an ALP (Assembly Language Program) to multiply two 16-bit binary numbers
2	Write an ALP to find the sum of first 10 integer numbers.
3	Write an ALP to find determine whether the given 16 bit is even or odd
4	Develop an Interface a DAC and generate Triangular and Square waveforms.
5	Write and execute a program to display the "Hello world" message using internal UART
6	Develop an Interface and control the speed of a DC Motor.
7	Develop and Interface a Stepper motor and rotate it in the clockwise and anti-clockwise direction
8	Develop a program to use of an external interrupt to toggle an LED On/ Off
	Demonstration Experiments (For CIE)
9	Interface a 4x4 keyboard and display the key code on an LCD.
10	Interface a simple Switch and display its status through Relay, Buzzer, and LED
11	Display the Hex digits 0 to F on a 7 -segment LED interface, with an appropriate delay
12	Measure Ambient temperature using a sensor and SP1 ADC IC

Course outcomes (Course Skill Set):

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

CO1. Understand the instruction set of 32-bit microcontroller ARM Cortex M3, and the software tool required forprogramming in Assembly and C language.

CO2. Develop assembly language programs using ARM Cortex M3 for different applications. Interface externaldevices and 1/0 with ARM Cortex M3.

CO3. Develop C language programs and library functions for embedded system applications.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the university.
- 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.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answerscript to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for100 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 partare to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1) ARM Assembly Language: Fundamentals and Techniques by William Hohl.

2) Getting Started with MDK by ARMKEIL.

3) LPC1768 User Manual.

4) The Designer's Guide to the Cortex-M Processor Family :A Tutorial Approach by Trevor Martin.

FINITE ELEMENT MODELLING AND ANALYSIS		Semester	6
Course Code	**BMT657C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	12 Lab sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		

Course Learning Objectives:

CLO1. To acquire basic understanding of Modeling and Analysis software

CLO2. To understand the concepts of different kinds of loading on bars, trusses and beams, and analyze the resultspertaining to various parameters like stresses and deformations.

CLO3. To lean to apply the basic principles to carry out dynamic analysis to know the natural frequencies of different kind of beams.

CLO4. To understand Piezoelectric analysis of cantilever beam.

Sl.NO	Experiments
1	Demonstrate FEA package and modeling the different structural elements.
2	Modeling and stress analysis of a rectangular plate with a circular hole
3	Modeling and stress analysis of "L" Bracket for pressure load.
4	Modeling and stress analysis of Bars of constant cross section area.
5	Modeling and stress analysis of Bars of tapered cross section area.
6	Modeling and stress analysis of stepped bar.
7	Stress analysis of Beams – Simply supported, cantilever, beams with point load.
8	Stress analysis Trusses.
	Demonstration Experiments (For CIE)
9	Dynamic Analysis to find natural frequency of beam with fixed – fixed end condition
10	Dynamic Analysis to find response of beam with fixed – fixed end conditions subjected to forcing function.
11	Demonstrate at least two different types of examples to model and analyze bars or plates made fromcomposite material.
12	Piezoelectric analysis: cantilever beam.

Course outcomes (Course Skill Set):

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

CO1. Use the modern tools to formulate the problem, create geometry, descritize, apply boundary conditions to solve problems of bars, truss, beams, and plate to find stresses with different-loading conditions.

CO2. Demonstrate the ability to obtain deflection of beams subjected to point, uniformly distributed and varying loads and use the available results to draw shear force and bending moment diagrams.

CO3. Carry out dynamic analysis and finding natural frequencies of beams, for various boundary conditions and carry out dynamic analysis with forcing functions.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners areappointed by the university.
- 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.
- All laboratory experiments are to be included for practical examination.
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- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
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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 for100 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 partare to be made zero.

- The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. ANSYS Workbench Tutorial Release 14, Structural and Thermal Analysis Using Ansys Mechanical APDL Release 14 Environment, Kent Lawrence, Schroff Development Corporation, Website: www.SDCpublications.com
2. Practical Finite Element Analysis,Nitin S. Gokhale, Sanjay S. Despande, Dr. Anand N. Thite, Finite To Infinite, ISBN 978-81-906195-0-9, E-mail: finite@vsnl.com, Website: www.finitetoinfinite.com
3. FINITE ELEMENT ANALYSIS USING ANSYS®, SrinivasPaleti, Sambana, Krishna Chaitanya, Datti, Rajesh Kumar, PHI Publication, ISBN: 978-81- 203-4108-1

AI AND ML Lab		Semester	6
Course Code	**BMT657D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	12 Lab sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	**Practical**		

Course objectives:

CLO 1. To realize the basic techniques to build intelligent systems

CLO 2.To apply appropriate search techniques used in problem solving

CLO 3. To create knowledge base for uncertain data

CLO 4. Compare and contrast the learning techniques like ANN approach, Bayesian learning and reinforcement learning.

CLO 5. To impart the knowledge of clustering and classification Algorithms for predictions and evaluating Hypothesis.

Prerequisite: Installation of Python and setting up a programming environment such as Anaconda and Spyder, Jupyter notebook, etc.

Sl.NO	Experiments
1	Write a Program on uninformed search methods.
2	Write a Program on informed search methods.
3	Write a Program on Game playing algorithms.
4	Write a Program for first-order Logic
5	Write a Planning Programming
6	Write a program to Implement Bayes Belief Network
7	Illustrate and demonstrate the working model and principle of the Find-S algorithm
8	To construct the Decision tree using the training data sets under supervised learning concept.
	Demonstration Experiments (For CIE)
9	To understand the working principle of Artificial Neural network with feed forward and feed backward principle.
10	Implement and demonstrate the working model of K-means clustering algorithm with Expectation Maximization Concept.
11	Understand and analyse the concept of Regression algorithm techniques.
12	Implement and demonstrate classification algorithm using Support vector machine Algorithm.

Course outcomes (Course Skill Set):

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

CO1. Understand and implement uninformed and informed searching techniques for real world problems.

CO 2.Create a knowledge base using any AI language.

CO 3.Design and implement expert systems for real world problems.

CO 4.Understand the Importance of different classification and clustering algorithms.

CO 5. Demonstrate the working of various algorithms with respect to training and test data sets.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation (CIE):

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

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- Each experiment is to be evaluated for conduction with an observation sheet and recordwrite-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.
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- The suitable rubrics can be designed to evaluate each student's performance and learningability.
- 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 thetotal CIE marks scored by the student.

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

- The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. Stuart J Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson Education, 2020.
2. Tom M Mitchell, "Machine Lerning",1st Edition, McGraw Hill Education, 2017.
3. Nello Cristianini, John Shawe Taylor, An Introduction to Support Vector Machines and Other Kernel-based Learning Methods, Cambridge University Press, 2013
4. Allen B Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015. (Available under CC-BY-NC license at

Suggested Web Links / E Resource

1. https://www.kaggle.com/general/95287
2. https://web.stanford.edu/~hastie/Papers/ESLII.pdf
3. http://greenteapress.com/thinkpython2/thinkpython2.pdf