THERMAL ENGINEERING		Semester	7
Course Code	**BMT701**	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 Hr
Examination nature (SEE)	Theory		

Course Learning objectives: This course will enable students to,
CLO 1. Gain fundamental concepts of thermodynamics.
CLO 2. Apply the first and second laws of thermodynamics.
CLO 3. Gain fundamental knowledge of air standard cycle and heat transfer
CLO 4. Formulate and determine conduction and convection heat transfer.
CLO 5. Determine convection and radiation heat transfer.

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. Adopt flipped classroom teaching method.
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

Thermodynamics - Fundamental Concepts & Definitions: Thermodynamics: definition and scope, Microscopic and Macroscopic approaches. Engineering thermodynamics: definition, some practical applications of engineering thermodynamic. System (Closed system) and Control Volume (open system): Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic presses; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium. Statement of Zeroth law of thermodynamics. (No Numerical).

Work and Heat: Thermodynamic definition of work; examples, sign convention. Displacement work: at part of a system boundary, at whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work, Electrical work. Other types of work, Heat; definition, units and sign convention, simple problems

Module-2

First Law of Thermodynamics: Statement of the First law of thermodynamics, extension of the First law to non-cyclic process, energy as a property, modes of energy, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications, simple problems.

Second Law of Thermodynamics: Thermal Reservoir, Concepts of Heat Engine, Heat Pump, coefficients of performance. Keivin – Planck statement of the Second law of Thermodynamics; PMM II and PMM I, Claussius statement of second law of Thermodynamics, equivalence of the two statements; reversible hat engines, Carnot cycle, Carnot principles. Thermodynamic temperature scale, simple problems.

Module-3

Air Standard cycles: Carnot, Otto, Diesel, Dual and Stirling cycles, P-V and T-S diagrams, description, efficiencies and mean effective pressures, Comparison of Otto, Diesel and dual cycles, simple problems**.**

Heat Transfer - Introductory Concepts and Definitions: Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity; convective heat transfer coefficient; radiation heat transfer; combined heat transfer mechanics. Boundary conditions of 1st, 2nd and 3rd Kind, simple problems.

Module-4

Conduction: Derivation of general three dimensional conduction equations in Cartesian coordinate, special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation). One dimensional conduction equations in rectangular, cylindrical and spherical coordinates for plane and composite walls. Overall heat transfer coefficient. Thermal contact resistance, Simple problems.

Free or Natural Convection: Application of dimensional analysis for free convection- physical significance or Grashoff number; use of correlations of free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres, Simple problems.

Module-5

Forced Convections: Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers, Simple problems.

Radiation Heat Transfer: Thermal radiation; definitions of various terms used in radiation heat transfer, Stefan-Boltzman law, Kircoff's law. Planck's law and Wein's displacement law. Radiation heat exchange between two parallel infinite black surface, between two parallel infinite gray surfaces; effect of radiation shield; intensity of radiation and solid angle, Simple problems.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Determination of Thermal Conductivity of a Metal Rod.
2	Determination of Overall Heat Transfer Coefficient of a Composite wall.
3	Determination of Effectiveness on a Metallic fin.
4	Determination of Heat Transfer Coefficient in a free Convection on a vertical tube.
5	Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
6	Determination of Emissivity of a Surface.
7	Determination of Stefan Boltzmann Constant.
8	Determination of LMDT and Effectiveness of Heat Exchangers.
9	Performance Tests on I.C. Engine: Four stroke Diesel Engine.
10	Performance Tests on I.C. Engine: Four stroke Petrol Engine (Demo)

Course outcome (Course Skill Set)

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

CO1. Understand the concepts of system, properties, energy interaction, laws of thermodynamics, and heat transfer, and boundary conditions.

CO2. Apply laws of thermodynamics and laws of heat transfer to engineering system. Define the thermodynamic process and cycle. Determine the energy interaction.

CO3. Develop heat conduction and temperature distribution equation and describe thermal resistance concept. Determine the rate of heat transfer and temperature at any point in the heat transfer domain.

CO4. Dimensional analysis of heat transfer and use of dimensional number. Study the effect of contact resistance and addition of insulation.

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**)

9. The question paper will have ten questions. Each question is set for 20 marks.
10. 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.
11. The students have to answer 5 full questions, selecting one full question from each module.
12. Marks scoredby 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. Basic and applied Thermodynamics, P. K. Nag, Tata McGraw Hill Pub. 2002.
2. Heat transfer-A basic approach, Ozisik, Tata McGraw Hill 2002.

Reference Books:

1. Engineering Thermodynamics, J. B. Jones and G. A. Hawkins, John Wiley and Sons.
2. Basic Engineering Thermodynamics data hand book by B. T. Nijaguna. (To be supplied in the examination)
3. Thermodynamics, An Engineering approach, Yunus a. Cenegal and Michael a.Boles, Tata McGraw Hill publications, 2002.
4. Heat transfer, P. K. Nag, Tata Mc Graw Hill 2002.
5. Heat transfer, a practical approach, Yunus a- Cengel Tata Mc Graw Hill.
6. Heat & Mass transfer, Tirumaleshwar, Pearson education 2006.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/103/112103316/
- https://archive.nptel.ac.in/courses/112/106/112106314/
- https://archive.nptel.ac.in/courses/103/105/103105140/
- https://archive.nptel.ac.in/courses/103/101/103101137/

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

- Case studies
- Quiz
- Topic Seminar presentation
- Assignments

Introduction to HDL		Semester	7th
Course Code	**BMT702**	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 different data typrs and description styles in HDL

CLO 2. Understand the flow of data flow description style

CLO 3. Understand the flow of behavioral description style

CLO 4. Understand the flow of structured description style

CLO 5. Understand state machine and parameter statements

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. 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

Introduction to HDL:

Why HDL? A Brief History of HDL, Structure of HDL Module, Operators, Data types, Types of Descriptions, simulation and synthesis, Brief comparison of VHDL and Verilog

MODULE-2

Data-Flow Descriptions:

Highlights of Data-Flow Descriptions, Structure of Data-Flow Description, Data Type – Vectors

MODULE-3

Behavioral Description:

Behavioral Description highlights, structure of HDL behavioral Description, The VHDL variable –Assignment Statement,sequential statements

MODULE-4

Structural Description:

Highlights of structural Description, Organization of the structural Descriptions, Binding

MODULE-5

State Machines, Generate, Generic, and Parameter statements.

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

Sl.NO	Experiments
1	Write HDL code to realize all the logic gates
2	Write HDL program for 2 to 4 decoder and 8 to 3 encoder
3	Write HDL program for multiplexer, de-multiplexer and comparator
4	Write a HDL code to describe the functions of a Full Adder Using three modelling styles.
5	Develop HDL code to carry out arithmetic operations and logical operations
6	Develop the HDL code for the following flip-flops, SR, D, JK, T.
7	Develop a HDL code for UP counter and DOWN counter

8	Develop a HDL code for synchronous counter and asynchronous counter
9	Write HDL code to display messages on the given seven segment display and LCD and accepting Hex key pad input data.
10	Write HDL code to control speed, direction of DC and Stepper motor.
11	Write HDL code to accept 8 channel Analog signal, Temperature sensors and display the data on LCD panel or Seven segment display.
12	Write HDL code to generate different waveforms (Sine, Square, Triangle, Ramp etc.,) using DAC change the frequency and amplitude.

Course outcomes (Course Skill Set):

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

CLO 1. Understand different data typrs and description styles in HDL

CLO 2. Understand the flow of data flow description style

CLO 3. Understand the flow of behavioral description style

CLO 4. Understand the flow of structured description style, state machine and parameter statements

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 scoredby the student shall be proportionally scaled down to 50 Marks

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

Suggested Learning Resources:

TEXT BOOKS:

1. **HDL Programming (VHDL and Verilog**)- Nazeih M.Botros- John Weily India Pvt. Ltd. 2008.

REFERENCE BOOKS:

1. **Fundamentals of HDL** – Cyril P.R. Pearson/Sanguin 2010.
2. **VHDL** -Douglas perry-Tata McGraw-Hill
3. **A Verilog HDL Primer**- J.Bhaskar – BS Publications
4. **Circuit Design with VHDL**-Volnei A.Pedroni-PHI

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

- Group discussion
- Presentation
- Quiz

INDUSTRIAL AUTOMATION		Semester	**7**
Course Code	**BMT703**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	4:0:0	SEE Marks	50
Total Hours of Pedagogy	52 hrs	Total Marks	100
Credits	04	Exam Hours	3 Hr
Examination type (SEE)	Theory		

Course Learning Objectives:

CLO 1. Acquire the basic understanding of automation in production system

CLO 2. Acquire a basic understanding of material handling and identification technologies

CLO 3. Understanding of Automated Manufacturing systems

CLO 4. Acquire a basic understanding of computer based industrial automation

CLO 5. Acquire a basic understanding of Distributed Control Systems

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 throughPowerPoint 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: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break- Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in process

Module-2

Material handling and identification technologies: Overview of material handling systems, Types of material handling equipment, Design of the system, Conveyor system, Automated guided vehicle system, Automated storage systems, Interfacing handling and storage with manufacturing, Overview of Automatic Identification Methods.

Module-3

Automated Manufacturing Systems: Components, Classification and overview of manufacturing systems, Cellular manufacturing, Flexible manufacturing system (FMS), FMS and its planning and implementation, Automated assembly system – design and types of automated assembly systems, Analysis of multi station and single station assembly machine.

Module-4

Introduction to computer based industrial automation- Direct Digital Control (DDC), Distributed Control System (DCS) and supervisory control and data acquisition (SCADA) based architectures. SCADA for process industries includes understanding of RTUs, Pumping stations, Evacuation processes, Mass Flow Meters and other flow meters, Leak-flow studies of pipelines, Transport Automation

Module-5

Distributed Control System: Local Control Unit (LCU) architecture, LCU Process Interfacing Issues, Block diagram and Overview of different LCU security design approaches, Networking of DCS. Introduction to communication protocols- Profibus, Field bus, HART protocols. Data gathering, Data analytics, Real-time analysis of data stream from DCS, Historian build, Integration of business inputs with process data, Leveraging RTU (as different from PLCs and DCS)

Course outcome (Course Skill Set)

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

CO 1. Understand the need and basics of Industrial Automation,

CO 2. Understand knowledge on Automated Manufacturing system

CO 3. Analyze different types of automated manufacturing systems

CO 4. Design material handling system in Manufacturing 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:

- 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. M.P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 5th Edition, Pearson Education, 2009

2. Curtis D. Johnson, "Process Control Instrumentation Technology", 8th Edition, Pearson New International, 2013.
5. Lukas M.P, "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986.

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

- Industrial visit to any automated production system
- Practical examples of automation used in Industries
- Group discussion on possibility of converting conventional manufacturing system to automated manufacturing system with advantages and Limitations

Digital Image Processing and Robot Vision		Semester	7
Course Code	**BMT714A**	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 Hr
Examination type (SEE)	Theory		

Course Learning objectives

CLO 1. Understand the fundamentals of digital image processing.
CLO 2. Understand the image enhancement techniques in spatial domain used in digital image processing.
CLO 3. Understand the Color Image Processing and frequency domain enhancement techniques in digital image processing.
CLO 4. Understand the image compression techniques and methods used in digital image processing.
CLO 5. Relate to the vision techniques used in robotics.

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 image processing concepts.
2. Encourage cooperative (Group) Learning through puzzles, diagrams, coding etc., in the class.
3. Encourage students to ask questions and investigate their own ideas helps improve their problem-solving skills as well as gain a deeper understanding of academic concepts.
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
5. Students are encouraged to do coding-based projects to gain knowledge in image processing.
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 multiple representations.

Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding

Module-1

Digital Image Processing Fundamentals: What is Digital Image Processing?, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Elements of an Image Processing System, **Digital Image Fundamentals:** Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Tonal and Spatial Resolutions, Image File Formats: BMP, TIFF and JPEG. RGB Color model.

Module-2

Enhancement in Spatial Domain: Some Simple Intensity Transformations, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters Frequency domain image enhancement techniques.

Module-3

Frequency Domain: Basics of Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters.

Colour Image Processing: Colour Fundamentals, Colour Models, Pseudo-colour Image Processing.

Module-4

Image Compression Fundamentals: Coding Redundancy, Inter-pixel Redundancy, Psycho visual Redundancy Lossless Compression Techniques: Run Length Coding, Huffman Coding, Lossy Compression Techniques: Predictive Coding, Improved Gray Scale Quantization, Transform Coding, JPEG Standard.

Module-5

Low-level vision: optical sensors, camera models, camera geometry in homogeneous coordinates, intensity transformations, thresholding, basic spatial domain image processing techniques such as edge operators and gradients.

High-level vision: Image segmentation, optimum thresholding, region and edge-based segmentation, split-merge techniques, feature extraction including boundary and region descriptors, three-dimensional image segmentation, pattern recognition and scene interpretation.

Course outcomes (Course Skill Set)

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

- **CO1.** Understand the fundamental concepts of image processing.
- **CO2.** Conduct independent study and analysis of Image Enhancement techniques.
- **CO3.** Apply image processing techniques in frequency (Fourier) domain.
- **CO4.** Describe the image compression techniques.
- **CO5.** Discuss the low-level and high-level vision concepts applied in robotics vision.

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. Digital Image Processing- Rafael C Gonzalez and Richard E Woods, PHI, 3rd Edition 2010.
2. Robotics: Control, Sensing, Vision, and Intelligence, K S Fu, R C Gonzalez, and C S G Lee, McGraw-Hill

Reference Book:

1. Digital Image Processing- S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2014.

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

- Simulink models for Image processing.

Digital Controllers		Semester	7
Course Code	**BMT714B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hr	Total Marks	100
Credits	03	Exam Hours	3 Hr
Examination type (SEE)	Theory		

Course Learning objectives

CLO 1. To develop the understanding of fundamental principles of digital control systems.
CLO 2. To disseminate the concept of stability and its assessment for discrete-time linear systems.
CLO 3. To introduce Z-transform methods and digital controller design.
CLO 4. To develop modern state-space methods in digital control systems design.

Teaching-Learning Process (General Instructions)

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

1. Encourage cooperative (Group) Learning through puzzles, diagrams, coding etc., in the class.
2. Encourage students to ask questions and investigate their own ideas helps improve their problem-solving skills as well as gain a deeper understanding of academic concepts.
3. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
4. Students are encouraged to do coding based projects to gain knowledge in control processing.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Topics will be introduced in multiple representations.

Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding

Module-1

Fundamentals of discrete-time signals and discretization Why study digital control systems? Advantages and limitations, comparison of continuous and discrete data control, block diagram of digital control system. Impulse sampling, Nyquist-Shannon sampling theorem, reconstruction discrete-time signals (Ideal filter). Realizable reconstruction methods (ZOH and FOH), transfer functions of ZOH and FOH.

Module-2

Modelling of Digital Control Systems Discretization approaches: Impulse invariance, step invariance, bilinear transformation, finite-difference approximation of derivative. Starred Laplace transform, Pulse transfer function and general procedures to obtain pulse transfer function.

Module-3

Stability Analysis and Digital Controller Design Mapping between s-plane and z-plane. stability analysis of digital systems in z-plane. Transient and steady-state analysis of time response. Digital controller design using the root-locus method; digital PID controller; deadbeat controller. Realization of digital controllers: direct programming, standard programming, series programming, parallel programming ladder programming.

Module-4

State-space Analysis of Discrete-time Systems Discretization of continuous-time state-space solution and discrete time state-space model. Representation of difference equation to state-space. Canonical forms for state-space representation and similarity transformations. Solution of discrete-time state-space equation. Computation of state-transition matrix (z-transform, Caley-Hamilton theorem, Diagonalization).

Module-5

Controller Design in State-space Concept of controllability, distinction between reachability and controllability, digital controller design using pole-placement methods (similarity transform, Ackerman's formula). Concept of observability, distinction between detectability and observability in discrete-time systems. Observer design (prediction and current observer), output feedback controller, introduction to separation principle.

Course outcomes (Course Skill Set)

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

CO1. Apply sampling and reconstruction of analog signals.
CO2. Obtain discrete-time models of physical systems.
CO3. Evaluate the stability of digital control systems in time and frequency domain.
CO4. Design performance specification based digital controller for a given system.
CO5. Analyse the digital control systems using state-space methods and design digital state feedback controllers.

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).**

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

Suggested Learning Resources:

Text Books:

1. Katsuhiko Ogata, "Discrete-time Control Systems", Pearson Education.
2. M Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, 4th edition, 2012.

Reference Books:

1. Gene Franklin, J David Powell, Michael Workman, "Digital Control of Dynamic Systems", Addison Wesley, 3rd edition.
2. B C Kuo, "Digital Control Systems", Oxford University Press, 2nd edition.

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

- Simulink models for Digital Controller realization.

Control Systems and Engineering		Semester	7
Course Code	BMT714C	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hr	Total Marks	100
Credits	03	Exam Hours	3 Hr.
Examination type (SEE)	Theory		

Course objectives:

CLO1. Students will gain the knowledge on the concept of time response and frequency response of the control system.

CLO2. Students will able to explain different control system stability techniques.

CLO3. Students will able to apply root locus technique, bodeplot to determine stability of the control system

CLO4. Students will able to apply polar plot to techniques to determine stability of the control system.

CLO5. Students will know the concept of state variables and state model.

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 criticalthinking

Module-1

Time Response of control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers (excluding design).

Module-2

Frequency domain Analysis: Introduction to frequency domain analysis, Correlation between time & frequency response.

Concepts of stability: The Concept of stability. Necessary conditions for stability. Hurwitz stability criterion. Routh stability criterion. Relative stability analysis using RH Criterion.

Module-3

The Root Locus Technique: Introduction to Root locus concepts. Construction of root loci. Stability analysis using Root locus technique .Numerical problems on all topics.

Module-4

Frequency Domain Analysis: frequency domain specifications, polar plot, The Nyquist criterion. Construction of Bode plots and Stability analysis using Bode plots.

Module-5

State space Analysis: Concept of state, state variables and state model. State diagrams and State models for Linear continuous-time systems (Electrical systems): State space representation using Physical and Phase variables. Derivation of transfer functions from the state model. Numerical problems on all topics.

Course outcome (Course Skill Set)

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

CO1. Discuss Time and frequency domain analysis of the control systems

CO2. Discuss the concept of state variables and state model

CO3. Apply the RH criterion techniques and root locus techniques to solve the stability of the control systems

CO4. Analyze the stability of the systems using Bode Plots, Polar and Nyquist plot.

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).**

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

Suggested Learning Resources:

Books

1. "Control Systems Engineering", I.J. Nagarath and M. Gopal ,New Age International (P) Limited, Publishers, Fifth edition – 2012.2.
2. "Modern Control Engineering ", K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002.

Recommended Reference Materials

1. "Automatic Control Systems", Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8th Edition, 2008.
2. "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

- Case studies
- Quiz
- Topic Seminar presentation
- Assignments

ADDITIVE MANUFACTURING		Semester	7
Course Code	**BMT714D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hr.	Total Marks	100
Credits	03	Exam Hours	3 Hr.
Examination type (SEE)	Theory		

Course Learning objectives:

CLO 1. To know the principle methods, areas of usage, possibilities and limitations of the Additive Manufacturing technologies.

CLO 2. To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.

CLO 3. To know the principles of polymerization and powder metallurgy process, extrusion-based system printing processes, sheet lamination processes, beam deposition processes, direct write technologies Direct Digital Manufacturing.

CLO 4. To get exposed to process selection, software issues and post processing.

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. Adopt flipped classroom teaching method.
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.

Module-1

Introduction and basic principles: Need for Additive Manufacturing, Generic AM process, stereo lithography or 3dprinting, rapid proto typing, the benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology.

Development of Additive Manufacturing Technology: Introduction, computers, computer-aided design technology ,other associated technologies, the use of layers, classification of AM processes, metals systems, hybrid systems, milestones in AM development.

Additive Manufacturing Process chain: Introduction, the eight steps in additive manufacture, variations from one AM machine to another

Module-2

Fusion Deposition Modelling: Principle, Process parameter, Path generation, Applications.

Solid Ground Curing: Principle of operation, Machine details, Applications.

Laminated Object Manufacturing: LOM materials. application.

Module-3

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications. Thermal jet printer,3-D printer

Module-4

Rapid Tooling: Indirect Rapid tooling, Silicon rubber tooling, Aluminium filled epoxy tooling, Spray metal tooling, 3Q keltool, etc. Direct Rapid Tooling, Quick cast process, Sand casting tooling, Laminate tooling soft Tooling vs. Hard tooling.

Module-5

Guidelines for Process Selection: Introduction, selection methods for apart, challenges of selection, example system for preliminary selection, production planning and control.

Software issues for Additive Manufacturing: Introduction, preparation of cad models – the STL file, problems with STL files, STL file manipulation.

Post- Processing: Support material removal, surface texture improvements, preparation for use as a pattern, property enhancements using non-thermal techniques and thermal techniques.

Course outcome (Course Skill Set)

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

- **CO1.** Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
- **CO2.** Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
- **CO3.** Understand the various software tools, processes and techniques that enable advanced/additive manufacturing.
- **CO4.** Apply the concepts of additive manufacturing to design and create components that satisfy product development/prototyping requirements, using advanced/additive manufacturing devices and processes.
- **CO5.** Understand characterization techniques in additive manufacturing.

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).**

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

Suggested Learning Resources:

Books

1. Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing I. Gibson l D. W. Rosen l B. Stucker Springer New York Heidelberg Dordrecht, London ISBN: 978-1- 4419-1119-3 e-ISBN: 978- 1-4419-1120-9 DOI 10.1007/978 -1-4419- 1120-9
2. "Rapid Prototyping: Principles & Applications Chua Chee Kai, Leong Kah Fai World Scientific 2003
3. Rapid Prototyping: Theory & Practice Ali K. Kamrani, Springer 2006 Emand Abouel Nasr,
4. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling" D.T. Pham, S.S. Dimov Springer 2001
5. Rapid Prototyping: Principles and Applications in Manufacturing Rafiq Nooran John Wiley & Sons 2006
6. Additive Manufacturing Technology Hari Prasad, A.V. Suresh Cengage 2019
7. Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing Andreas Gebhardt Hanser Publishers 2011
8. Rapid Prototyping Materials, Gurumurthi, IISc Bangalore.
9. Rapid Automated, Lament wood. Indus press New York.

Open Elective Course

Introduction to Smart Factory and Industry 4.0		Semester	7
Course Code	**BMT755A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hr.	Total Marks	100
Credits	03	Exam Hours	3 Hr.
Examination type (SEE)	Theory		

Course objectives:

CLO 1. Gain knowledge on Automated Manufacturing system and smart manufacturing

CLO 2. Understand the importance of Manufacturing support system

CLO 3. Understand the concept of smart design and manufacturing

CLO 4. Understanding Internet of things in Industries

CLO 5. Concepts of online monitoring and logistics in the 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. Adopt different types of teaching methods to develop the outcomes throughPowerPoint 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.

Adopt Problem Based Learning (PBL), which fosters students Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information

Module-1

Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. **Introduction to Smart Manufacturing** - Dimensions -Demand-Driven and Integrated Supply Chains; Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations);

Module-2

Automated Manufacturing Systems: Components, Classification and overview of manufacturing systems, Cellular manufacturing, Flexible manufacturing system (FMS), FMS and its planning and implementation,

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-3

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-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

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

Course outcome (Course Skill Set)

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

CO 1. To understand the concepts Automated manufacturing, smart Manufacturing and IOT

CO 2. To know the importance of FMS, Smart design in Manufacturing

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:

- 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).**

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

Suggested Learning Resources:

Books

1. Michael Deng, Colin Koh, Smart Factory: Transforming Manufacturing for Industry 4.0 (Industry 4.0 in ASEAN 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 for SMEs, 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

VIRTUAL INSTRUMENTATION		Semester	7
Course Code	BMT755B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hr.	Total Marks	100
Credits	03	Exam Hours	3 Hr.
Examination type (SEE)	Theory		

Course objectives:

CLO 1. Understand the importance of Virtual Instrumentation and its architecture

CLO 2. Identify various operation of DAQ devices used in Virtual Instrumentation and Lab View.

CLO 3. Analyze the basic programming concepts in Lab View

CLO 4. Categorize types of I/O module, Data Acquisition System and Communication Networks (Bus Systems) using Standard Protocol.

CLO 5. Examine analysis tools and applications of Virtual Instrumentation

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 analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1

CONCEPT OF VIRTUAL INSTRUMENTATION

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 – Typical on board DAQ card, Sampling, Sampling Theorem, sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs

Module-2

DATA ACQUISITION BASICS

Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution Data acquisition interface requirements.

Module-3

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-4

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.

Module-5

USE OF ANALYSIS TOOLS AND APPLICATION OF VI

Fourier transform – Power spectrum - Correlation – Windowing and filtering tools – Simple temperature indicator –ON/OFF controller – P-I-D controller - CRO emulation - Simulation of a simple second order system – Generation of HTML page.

Course outcome (Course Skill Set)

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

- **CO1.** Understand the structured LabVIEW programming concepts in developing Virtual Instrumentation.
- **CO2.** Build applications employed in various debugging techniques, simulating and analysing the data and use general purpose interface bus and Serial communication Interface.
- **CO3.** Create applications that uses plug in DAQ boards and built-in analysis functions to process the data.
- **CO4.** Design and analyze 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).**

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

Suggested Learning Resources:

Books

TEXT BOOKS:

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

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.

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

- Group activity
- Quiz
- Presentation

ROBOTICS FOR INDUSTRY		Semester	7
Course Code	**BMT755C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hr.	Total Marks	100
Credits	03	Exam Hours	3 Hr.
Examination type (SEE)	**Theory**		

Course objectives:

CLO 1. Have fundamental knowledge of Automation and Robots
CLO 2. Understand different power source and transmission methods in Robotics
CLO 3. Gain Knowledge on End effectors and Grippers used in Robots
CLO 4. Understand different methods used in robot programming
CLO 5. Understand the different applications of robots 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 throughPowerPoint 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.

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 Automation and Robotics: Automation and robotics, Robotics in Science Fiction, Brief history of robotics**.** Robot anatomy, work volume, robot drive systems, control systems, robot applications,

Module-2

Power Sources and Sensors:

Hydraulic, pneumatic and electric drives. determination of HP of motor and gearing ratio, variable speed arrangements

Sensors in Robotics: Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors, uses of sensors in robotics, problems.

Module-3

Manipulators, Actuators and Grippers:

Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.

Module-4

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.

Module-5

Industrial Automation:

List basic Devices in Automated Systems. Distinguish Different Controllers Employed in Automated Systems. Identify Safety in Industrial Automation

Applications: Robot applications in Material Handling, Robots in Automatic Processing Operations, Robots in Assembly and Inspection.

Course outcome (Course Skill Set)

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

CO 1. To have fundamental knowledge of Robots and Role of robots in Industrial Automation
CO 2. To list out and differentiate the different methods of robot programming
CO 3. To illustrate the functions of different components used in Robots
CO 4. To choose robots for different industrial applications

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill Singapore, 1996.
2. Automation, Production system & Computer Integrated manufacturing, M. P. Groover Person India, 2007 2nd edition.
3. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.

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

- Practical examples of automation and Implementation Robots in industries
- Group discussion Advantages and Limitations of using robots in Industries

PLC AND SCADA TECHNOLOGY		Semester	7
Course Code	**BMT755D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hr.	Total Marks	100
Credits	03	Exam Hours	3 Hr.
Examination type (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, 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, Arrange visits to show the live working models other than laboratory topics.
3. Adopt collaborative (Group Learning) Learning in the class.
4. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
5. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1

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

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.

Course outcome (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 skills of 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 Handling instructions and build the SCADA System for Real time industrial process.

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).**

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

Suggested Learning Resources:

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