

Entrepreneurship, Management and Economics		Semester	V
Course Code	BMM501	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		
Course objectives:			
<ul style="list-style-type: none"> To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing. To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions. 			
Teaching-Learning Process (General Instructions)			
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.			
<ul style="list-style-type: none"> Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. Chalk and Talk method for Problem Solving. Adopt flipped classroom teaching method. Adopt collaborative (Group Learning) learning in the class. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1		8 Hours	
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		8 Hours	
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		8 Hours	
Introduction: Engineering and economics, Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems.			
Module-4		8 Hours	
Present, future and annual worth and rate of returns: Basic present worth comparisons, Present worth-equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons. Asset life,			

Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Discussions and problems.

Module-5

8 Hours

Costing and depreciation: Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of 07.01.2023 2 mechanical process, idling time. Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems

Course outcome (Course Skill Set)

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

CO1: Understand needs, functions, roles, scope and evolution of Management

CO2: Understand importance, purpose of Planning and hierarchy of planning and also analyse its types.

CO3: Discuss Decision making, Organizing, Staffing, Directing and Controlling.

CO4: Select the best economic model from various available alternatives.

CO5: Understand various interest rate methods and implement the suitable one and Estimate various depreciation values of commodities.

CO6: Prepare the project reports effectively.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

- 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

Sl. No.	Title of the Book	Name of the Author/s	Name of the	Edition and Year
Textbook/s				
1	Mechanical estimation and	T.R. Banga& S.C. Sharma	Khanna Publishers	17th edition 2015
2	Engineering Economy	Riggs J.L	McGraw Hill	4th edition
3	Engineering Economy	Thuesen H.G	PHI	2002
4	Principles of Management	Tripathy and Reddy	Tata McGraw Hill	3 rd edition 2006
Reference book/s				
1	Mechanical estimation and	T.R. Banga& S.C. Sharma	Khanna Publishers	17th edition 2015
2	Engineering Economy	Riggs J.L	McGraw Hill	4th edition
3	Engineering Economy	Thuesen H.G	PHI	2002
4	Principles of Management	Tripathy and Reddy	Tata McGraw Hill	3 rd edition 2006
Web links and Video Lectures (e-Resources):				
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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning				
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Data Structures and Algorithm		Semester	V
Course Code	BMM502	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:			
<ul style="list-style-type: none"> • Understanding basic data structures and algorithms • To assess how the choice of data structures and algorithm design methods impacts the performance of programs • To solve problems using data structures such as linear lists, stacks, queues, binary trees and graphs. 			
Teaching-Learning Process (General Instructions)			
These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.			
<ul style="list-style-type: none"> • Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. • Chalk and Talk method for Problem Solving. • Adopt flipped classroom teaching method. • Adopt collaborative (Group Learning) learning in the class. • Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
MODULE-1			8 Hours
Introduction: Data Structures, Classifications (Primitive & Non-Primitive), Data structure Operations, Review of Arrays, Dynamic Memory Allocation Functions. Representation of Linear Arrays in Memory, dynamically allocated arrays, Array Operations: Strings: Basic Terminology, Storing, Operations and Pattern Matching algorithms. Programming Examples			

MODULE-2	8 Hours
Stacks and Queues Stacks: Definition, Stack Operations, Array Representation of Stacks, Stacks using Dynamic Arrays, Stack Applications: Polish notation, Infix to postfix conversion, evaluation of postfix expression, Recursion - Factorial, GCD, Fibonacci Sequence, Tower of Hanoi. Queues: Definition, Array Representation, Queue Operations, Circular Queues, Circular queues using Dynamic arrays, Dequeues, Priority Queues . Programming Examples	
MODULE-3	8 Hours
Linked Lists: Definition, Representation of linked lists in Memory, Memory allocation; Garbage Collection. Linked list operations: Traversing, Searching, Insertion, and Deletion. Doubly Linked lists, Circular linked lists, and header linked lists. Applications of Linked lists.	
MODULE-4	8 Hours
Trees: Terminology, Binary Trees, Properties of Binary trees, Array and linked Representation of Binary Trees, Binary Tree Traversals - In order, post order, preorder; Additional Binary tree operations. Threaded binary trees, Binary Search Trees – Definition, Insertion, Deletion, Traversal, Searching.	
MODULE-5	8 Hours
Graphs: Definitions, Terminologies, Matrix and Adjacency List Representation Of Graphs, Elementary Graph operations, Traversal methods: Breadth First Search and Depth First Search. Hashing: Hash Table organizations, Hashing Functions, Static and Dynamic Hashing. Files and Their Organization: Data Hierarchy, File Attributes, Text Files and Binary Files, Basic File Operations, File Organizations and Index+	

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

Sl.N O	Experiments
1	Design, Develop and Implement a menu driven Program in C for the following Array operations a. Creating an Array of N Integer Elements b. Display of Array Elements with Suitable Headings c. Inserting an Element (ELEM) at a given valid Position (POS) d. Deleting an Element at a given valid Position(POS) e. Exit.
2	Design, Develop and Implement a Program in C for the following operations on Strings a. Read a main String (STR), a Pattern String (PAT) and a Replace String (REP) b. Perform Pattern Matching Operation: Find and Replace all occurrences of PAT in STR with REP if PAT exists in STR.Report suitable messages in case PAT does not exist in STR Support the program with functions for each of the above operations
3	Design, Develop and Implement a menu driven Program in C for the following operations on STACK of Integers(Array Implementation of Stack with maximum size MAX) a. Push an Element on to Stack b. Pop an Element from Stack c. Demonstrate how Stack can be used to check Palindrome d. Demonstrate Overflow and Underflow situations on Stack e. Display the status of Stack f. Exit
4	Design, Develop and Implement a Program in C for converting an Infix Expression to Postfix Expression.Program should support for both parenthesized and free parenthesized expressions with the operators: +, -, *, /,%(Remainder), ^(Power) and alphanumeric operands.

5	Design, Develop and Implement a Program in C for the following Stack Applications a. Evaluation of Suffix expression with single digit operands and operators: +, -, *, /, %, ^ Solving Tower of Hanoi problem with n disks
6	Design, Develop and Implement a menu driven Program in C for the following operations on Circular QUEUE of Characters (Array Implementation of Queue with maximum size MAX) a. Insert an Element on to Circular QUEUE b. Delete an Element from Circular QUEUE c. Demonstrate Overflow and Underflow situations on Circular QUEUE d. Display the status of Circular QUEUE e. Exit
7	Design, Develop and Implement a menu driven Program in C for the following operations on Singly Linked List(SLL) of Student Data with the fields: USN, Name, Branch, Sem, Ph No a. Create a SLL of N Students Data by using front insertion. b. Display the status of SLL and count the number of nodes in it c. Perform Insertion / Deletion at End of SLL d. Perform Insertion / Deletion at Front of SLL(Demonstration of stack) e. Exit
8	Design, Develop and Implement a menu driven Program in C for the following operations on Doubly Linked List(DLL) of Employee Data with the fields: SSN, Name, Dept, Designation, Sal, PhNo a. Create a DLL of N Employees Data by using end insertion. b. Display the status of DLL and count the number of nodes in it c. Perform Insertion and Deletion at End of DLL d. Perform Insertion and Deletion at Front of DLL e. Demonstrate how this DLL can be used as Double Ended Queue f. Exit'
9	Can be Demo experiments for CIE
10	Can be Demo experiments for CIE
11	Can be Demo experiments for CIE
12	Can be Demo experiments for CIE

Course outcomes (Course Skill Set):

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

- Explain different types of data structures, operations and algorithms
- Apply searching and sorting operations on files
- Make use of stack, Queue, Lists, Trees and Graphs in problem solving
- Develop all data structures in a high-level language for problem solving

Assessment Details (both CIE and SEE)

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

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**)

- 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 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

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Fundamentals of Data Structures in C	Ellis Horowitz and artaj Sahni	Universities Press	2nd edition, 2014
2	Data Structures	Seymour Lipschutz	Schaum's Outline Series', McGraw Hill Education,	2014
Reference Books				
1	Data Structures: A Pseudocode Approach with C	Richard Gilberg, Behrouz A Forouzan	Course Technology Inc	2nd edition, 2004

2	Data Structures using C	Reema Thareja,	Oxford University Press	2nd edition, 2014
3	An Introduction to Data Structures with Applications	Jean-Paul Tremblay & Paul G. Sorenson	McGraw Hill	2nd edition, 2014
Web links and Video Lectures (e-Resources):				
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning				

Design of Machine Elements		Semester	V
Course Code	BMM503	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	52 hours Theory	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory		
Course objectives:			
<ul style="list-style-type: none"> To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components. To illustrate to students the variety of mechanical components available and emphasize the need to continue learning. To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems. 			
Teaching-Learning Process (General Instructions)			
These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.			
<ul style="list-style-type: none"> Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. Chalk and Talk method for Problem Solving. Adopt flipped classroom teaching method. Adopt collaborative (Group Learning) learning in the class. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
MODULE-1			
Introduction to Mechanical Design – Course Overview, Design Process; Materials – Material Properties, Materials Selection, Combined Loading, Failures Resulting from Static Loading – Static Strength, Stress Concentration, Failure Theories for Ductile and Brittle Materials, Cyclic Stress, Fatigue Regimes.			
MODULE-2			
Fatigue of Structures: S.N. curves, Endurance limit, Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentrations, Neuber's stress concentration factors, plastic stress concentration factors – Notched S-N curves..			

MODULE-3

Design of couplings: Couplings: Rigid and flexible coupling-types and applications, design of Flange coupling, and Bush and Pin type coupling.

Introduction Permanent Joints: Types of permanent joints-Riveted and Welded Joints.

Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets.(only Theory)

MODULE-4

Springs: Types of springs - stresses in Helical coil springs of circular and non-circular cross sections. Tension and compression springs, springs under fluctuating loads, Leaf Springs: Stresses in leaf springs. Equalized stresses, Energy stored in springs, Torsion, Belleville and Rubber springs.

MODULE-5

Fracture Mechanics: Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin - Orwin extension of Griffith's theory to ductile materials, Stress analysis of cracked bodies.

Course outcomes (Course Skill Set):

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

- CO1. Apply the principle of solid mechanics to design machine member under variable loading.
- CO2. Introduce fatigue failure of materials
- CO3. Ability to design Couplings and joints for industrial applications.
- CO4. Ability to design various Springs for strength and stiffness.
- CO5. Correctly apply fracture mechanics to predict brittle fracture. Identify and describe the basic fracture and fatigue mechanisms

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 220B2.4, 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**).

- 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

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Design of Machine Elements,	V B Bhandari	Tata McGraw Hill	4th Ed., 2016.
2	Machine Design	Shigley, J.E	McGraw Hill	
3	Fracture Mechanics Fundamentals and Applications	T.L. Anderson	Taylor and Francis Group Ltd.,	1s Ed., 2016

Reference Books

1	Machine Design- anintegrated approach	Robert L. Norton	Pearson Education	2 nd edition.
2	Design of Machine Elements	V.M. Faires		
3	Machine Design	Hall, Holowenko, Laughlin(Schaum's Outline series)	Tata McGraw Hill Publishing	Special Indian Edition, 2008
4	Elements of Machine Design	H.G.Patil, S.C.Pilli, R.R.Malagi, M.S.Patil	IK International	First edition, 2019
5	Elements of Fracture Mechanics	Prashant Kumar	Tata McGraw Hill, New	

Design Data Hand Book:

- [1] Design Data Hand Book, Dr.K lingaiah vo, I and II, Tata McGraw-Hill Education India
 [2] Design Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS publication

Web links and Video Lectures (e-Resources):

1. Design of Machine Elements I, IIT Kharagpur, <https://nptel.ac.in/courses/112105124>

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

Smart Manufacturing Lab-1		Semester	V
Course Code	BMM504L	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	12 -14 sessions	Total Marks	100
Credits	01	Exam Hours	100
Examination nature (SEE)	Practical		
Course objectives:			
<ul style="list-style-type: none"> • Learn CAD Modelling Techniques for RP • Generating STL files from the CAD Models • Fabricate using RP Machine • Develop the skill to operate the Robot • Learn different Robotic programming languages 			
Sl.NO	Experiments		
1	Review of CAD Modelling Technique and Introduction to RP.		
2	Forming Groups and Assigning creative Idea.		
3	Generating STL files from the CAD Models and Working on STL files.		
4	Modeling Creative Designs in CAD Software		
5	Assembling Creative Designs in CAD Software.		
6	Processing the CAD data in catalyst software(Selection of Tool path generation).		
7	Simulation in Catalyst (or any other)software.		
8	Sending the tool path data to FDM RP(or any other)machine.		
9	Fabricating the physical part on FDM RP machine.		
10	Removing the supports& post processing (Cleaning the Surfaces)		
11	Demonstrating Creative working Models.		
12	Converting CT/MRI Scan data into STL files using MIMICS software (Demo)		
Demonstration Experiments (For CIE)			
1	Forward and inverse kinematics of two axis planar articulated robot using analytical and DH algorithm usingLego NXT.		
2	Forward and inverse kinematics to control hand movements in NAO.		
3	Study and Selection of Gripper.		
4	Implementation of trajectory planning algorithm for straight line motion using Matlab and executing PID basedcontrol of two axis planar articulated robot in Lego NXT.		
5	Analysis and Simulation using FANUC Robo guide software(or any other)and real time programming of Fanuc M710i.		
6	Robot (or any other).		
7	Programming of Adept Cobra S600 SCARA robot (or any other).		
8	Forward and inverse kinematics of two axis planar articulated robot using analytical and DH algorithm usingLego NXT.		
Course outcomes (Course Skill Set):			
At the end of the course the student will be able to:			
<ul style="list-style-type: none"> • Optimize the process parameters of FDM Machine to improve the quality of the parts produced. • Build complex engineering assemblies in plastic materials with less process planning. • Improve surface finish of fabricated plastic components for the engineering applications. • Design and fabricate working models for the conceptual testing applications. • Apply forward and inverse kinematic solutions. • Implement trajectory planning algorithm. 			
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 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 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:

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Robotics and Automation		Semester	V
Course Code	BMM515A	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		
Course objectives:			
<ul style="list-style-type: none"> • This course synthesizes the disciplines of Mechanical and Electrical Engineering to provide a comprehensive overview of the various technologies and tools used to develop mechatronic devices. 			
Teaching-Learning Process (General Instructions)			
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.			
<ul style="list-style-type: none"> • Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. • Chalk and Talk method for Problem Solving. • Adopt flipped classroom teaching method. • Adopt collaborative (Group Learning) learning in the class. • Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1			8 Hours
Mechatronic and Measurement Systems: Overview of mechatronic systems and devices in manufacturing, overview of sensors, transducers and control systems in manufacturing			
Module-2			8 Hours
Elements and Analysis of Electric Circuits, Diode, transistor, and thyristor Circuits, operational Amplifier (Op-Amp) Circuits, digital Logic and logic Families			
Module-3			8 Hours
Data Monitoring using Arduino: Basic structure - Input / Output processing - Programming - Mnemonics Timers, Internal relays and counters - Analog-to-Digital (A/D) and Digital-to-Analog (D/A) Conversion			
Module-4			8 Hours
Robotics in Automation: Robot classification and anatomy, forward and inverse kinematics, DH matrix transformation Analog input / output, Programming and interfacing with Sensors in manufacturing applications.			
Module-5			8 Hours
Robotics in Automation motion: Jacobian and differential motion, Trajectory planning, Static and dynamic analysis, applications in manufacturing.			

Course outcome (Course Skill Set)

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

- Integrate various electromechanical devices in manufacturing.
- Automate a manufacturing system with various sensors, actuators and 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:

- 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. A. Smaili and F. Mrad, Applied Mechatronics, 1st edition, Oxford University Press, 2007. ISBN: 9780195307023.
2. J. Nussey, Arduino for Dummies, 1st edition, Wiley, 2013. ISBN: 9781118446379.
3. M. P. Groover, Industrial Robotics: Technology, Programming and Applications, 2nd edition, McGraw- Hill, 2012. ISBN: 9780070265097.

References

1. W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 4th edition, Pearson India, 2008. ISBN: 9788131732533.
2. D. G. Alciatore, M. B. Hstand, Introduction to Mechatronics and Measurement Systems, 3rd edition, Tata McgrawHill Education, 2007. ISBN: 9780070648142.

Web links and Video Lectures (e-Resources):

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

•

Mechanical Design Concepts		Semester	V
Course Code	BMM515B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		
<p>Course objectives: This is a basic course on mechanical engineering design focusing on the principles of design, load analysis, stress analysis and final failure analysis of mechanical systems.</p>			
<p>Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none"> • Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. • Chalk and Talk method for Problem Solving. • Adopt flipped classroom teaching method. • Adopt collaborative (Group Learning) learning in the class. • Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1		8 Hours	
Kinematics and Dynamics: Introduction to mechanisms; position, velocity and acceleration of planar mechanisms; dynamics of planar mechanisms; case studies			
Module-2		8 Hours	
Stress and Strain – axially loaded members; torsion of circular bars; bending of prismatic beams			
Module-3		8 Hours	
Failure Theories – failure of ductile and brittle materials under static loading; mechanism of fatigue failures; fatigue failure models			
Module-4		8 Hours	
Machine Elements – Design of non-permanent joints - threaded fasteners, mechanics of power screws;			
Module-5		8 Hours	
Design of permanent joints – welding; gears – nomenclature, force analysis, Lewis bending equation, design of spur and helical gears..			
<p>Course outcome (Course Skill Set) At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Explain the kinematics and dynamics of mechanisms of elements • Discuss the stress-strain behaviour of various members under loading • Explain various theories of failures. • Apply basic concepts related to mechanical design to design various mechanical systems in aerospace, automotive, naval, wind energy, chemical (nuclear) reactor, oil exploration, solid and fluid transportation 			

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

- L. Norton, Machine Design – an integrated approach, 5th edition, Pearson education Inc., 2014. ISBN-13: 9780133356717.
- J. E. Shigley, C. R. Mischke and R. G. Budynas, Mechanical Engineering Design, 7th edition McGraw-Hill, 2004. ISBN-13: 978-0071232708.

References

- R. C. Juvinall and K. M. Marshek, Fundamentals of Machine Component Design, 5th edition, Wiley-India, 2011. ISBN-13: 978-1118012895.
- M. F. Spotts, T. E. Shoup and L. E. Hornberger, Design of Machine Elements, 8th edition, Pearson education Inc., 2003. ISBN-13: 9780130489890.
- K. Mallik, A. Ghosh and G. Ditttrich, Kinematic analysis and synthesis of mechanisms, 1st edition, CRC Press, ISBN: 0-8493-9121-0.

Web links and Video Lectures (e-Resources):

<https://archive.nptel.ac.in/courses/112/105/112105124/>

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

Finite Element Analysis		Semester	V
Course Code	BMM515C	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		
<p>Course objectives:</p> <ul style="list-style-type: none"> To learn the basic principles of finite element analysis procedure To understand the design and heat transfer problems with application of FEM. Solve 1 D, 2 D and dynamic problems using Finite Element Analysis approach. To learn the theory and characteristics of finite elements that represent engineering structures. To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses 			
<p>Teaching-Learning Process (General Instructions)</p> <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none"> Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. Chalk and Talk method for Problem Solving. Adopt flipped classroom teaching method. Adopt collaborative (Group Learning) learning in the class. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1		8 Hours	
<p>Introduction to Finite Element Method: General steps of the finite element method. Engineering applications of finite element method. Advantages of the Finite Element Method.</p> <p>Boundary conditions: Homogeneous and non-homogeneous for structural, heat transfer and fluid flow problems. Potential energy method, Rayleigh Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretisation process</p>			
Module-2		8 Hours	
<p>Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes. Strain- displacement relations, Stress-strain relations, Plain stress and Plain strain conditions, temperature effects. Interpolation models: Simplex, complex and multiplex elements, linear interpolation polynomials in terms of global coordinates 1D, 2D, 3D Simplex Elements</p>			
Module-3		8 Hours	
<p>Introduction to the stiffness (Displacement) method: Introduction, Derivation of stiffness matrix, Derivation of stiffness matrix for a spring element, Assembly the total stiffness matrix by superposition. One-Dimensional Elements- Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for 1D, 2D elements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle.</p>			
Module-4		8 Hours	
<p>Beams and Shafts: Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler- Bernoulli beam theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and stepped beams using direct stiffness method with concentrated and uniformly distributed load.</p>			
Module-5		8 Hours	
<p>Dynamic Considerations: Formulation for point mass and distributed masses, Consistent element mass matrix of one-dimensional bar element, truss element, axi-symmetric triangular element, quadrilateral element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.</p>			

Course outcome (Course Skill Set)

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

- CO1: Identify the application and characteristics of FEA elements such as bars, beams, plane and iso- parametric elements.
- CO2: Develop element characteristic equation and generation of global equation.
- CO3: Formulate and solve Axi-symmetric problems.
- CO4: Apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, axi-symmetric and dynamic problems

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

- 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**).

- 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:

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	A first course in the Finite Element Method	Logan, D. L	Cengage Learning	6th Edition 2016
2	Finite Element Method in Engineering	Rao, S. S	Pergaman Int. Library of Science	5th Edition 2010
3	Finite Elements in Engineering	Chandrupatla T. R	PHI	2nd Edition 2013
Reference Books				
1	Finite Element Method	J.N.Reddy	McGraw -Hill International Edition	
2	Finite Elements Procedures	Bathe K. J	PHI	
3	Concepts and Application of Finite Elements Analysis	Cook R. D., et al.	Wiley & Sons	4th Edition 2003

Web links and Video Lectures (e-Resources):
E- Learning VTU
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Research Methodology & IPR			
Course Code	BRMK557	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hrs	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		
Course objectives:			
<ul style="list-style-type: none"> To develop understanding of the basic framework of research process. To develop an understanding of various research designs and techniques. To identify various sources of information for literature review and data collection. understand some basic concepts of research and its methodologies organize and conduct research in a more appropriate manner write a research report and thesis write a research proposal 			
Teaching-Learning Process (General Instructions)			
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.			
<ul style="list-style-type: none"> Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. Chalk and Talk method for Problem Solving. Adopt flipped classroom teaching method. Adopt collaborative (Group Learning) learning in the class. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1			8Hours
Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Problem. Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.			
Module-2			8Hours
Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art Bibliographic Databases, Web of Science, Google and Google Scholar, Effective Search: The Way Forward Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet. Attributions and Citations: Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations			
Module-3			8Hours

Building Intellectual Property Rights, Law of Patents, **Fundamentals of Patent Law** - Evolution of the patent system, Patentability Requirements; Patentable Subject Matter; Industrial Applicability/Utility; Novelty; Anticipation by publication; Anticipation by public knowledge and public use; Anticipation by public display; Anticipation by sale; Inventive Step/Non-Obviousness; Novelty Assessment; Inventive Step Assessment; Specification, **Drafting of A Patent Specification** - Introduction Patent Specification; Provisional Specification Complete Specification, Parts of the complete specification; **Patent Procedure in India** - PATENT PROCEDURE; Registration and Renewal fee payment; **Patent Infringement** - Infringement of a patent; Literal Infringement; Equivalence Infringement; Indirect Infringement; Defenses - Experiment - Research or Education - Bolar Exemption- Government use- Patent Exhaustion- Patent Misuse- Inequitable Conduct - Remedies- Injunction- Account of profits- Costs; **International Patent Regimes** - International Instruments; Paris Convention; TRIPS AGREEMENT; PCT; BUDAPEST TREATY, **Patenting Biotechnology Inventions** - Unique nature of Biotechnology; Patentability Requirements and Biotechnology Inventions; Patentable Subject Matter- USA- Europe- India; **Patentability of Software Inventions** - Patentability of Software Inventions in USA; Patentability of software inventions in Europe; Patentability of Software Inventions in India.

Module-4

8Hours

Law of Copyright and Designs, Understanding Copyright Law - Historical Overview - Justification For Copyright Law - The Natural Law Justification - The Economic Rationale of Copyright Clause, Basic Concepts Underlying copyright Law - Idea - Expression Dichotomy Originality / Creativity - Fixation **Term of Protection, Subject - Matter of Copyright** - Literary Works - Dramatic Works - Musical Work - Artistic Works - Cinematograph Films and Sound recordings, **Acquisition of Copyright in India**, Rights of the Copyright Owner - Economic Rights - Moral Right or Droid Moral Right of Authorship or Paternity Rights - Rights against Distortion or Mutilation of the Original Works or Integrity Rights - Limitations - Limitations set under International Regime - Berne Convention - Rome Convention - Trips Agreement - Three Step Test, Infringement of Copyright -Transfer of copyright - License and Assignment - License and consent -Duration of a License Form and Content - Disputes in Respect of Licence -Types of Licenses - Exclusive and Non-Exclusive Licenses.

Module-5

8Hours

Basic Principles of Design Rights - Justification for Protecting Designs - Historical Perspective - Features of Shape, configuration, Pattern or Ornament - or Composition of lines or colour - New or Original - Applied to an Article, **Excluded Subject - Matter** - Method or Principle of Construction - Features Dictated Solely by Function - Mechanical Device - Trademark, or Property Mark, or Artistic Work - immoral Designs and Designs Contrary to Public order-**Rights of the Owner of Designs and Tests for Infringement. Assignment of Design Rights, Infringement of Designs**

Course outcome (Course Skill Set)

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

- Discuss research methodology and the technique of defining a research problem .
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review. .
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections. .
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports o Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments

concerning IPR.

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**).

- 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

VI SEMESTER

Industrial Internet of Things		Semester	VI
Course Code	BMM601	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		
<p>Course objectives:</p> <ul style="list-style-type: none"> • Understanding the concept of IOT. • Understanding the interconnection and integration of the physical world and the cyberspace. • Exposure to design & development of IOT Devices 			
<p>Teaching-Learning Process (General Instructions)</p> <p>These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none"> • Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. • Chalk and Talk method for Problem Solving. • Adopt flipped classroom teaching method. • Adopt collaborative (Group Learning) learning in the class. • Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
MODULE-1		8 Hours	
<p>Introduction and Concepts: What is IOT, Genesis of IOT, IOT and Digitization, IOT Impact, Convergence of IT and IOT, IOT Challenges, IOT Network Architecture and Design, Drivers behind new network architectures, Comparing to architectures, A simplified IOT architecture, the core IOT functional Stack, IOT Data Management and compute stack.</p>			
MODULE-2		8 Hours	
<p>Smart Objects: The “Things” in IOT, Sensors, Actuators and smart objects, Sensor networks, Connecting smart objects, communication criteria, IOT Access Technology. Domain Specific IoT's: Home Automation, cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health and lifestyle.</p>			
MODULE-3		8 Hours	
<p>IP as the IoT network layer: The business case for IP, The need for optimization, optimizing IP for IoT, Profile and Compliances, Application protocols for IoT, The Transport Layer, IoT application Transport Methods.</p>			
MODULE-4		8 Hours	
<p>Data and Analysis for IoT: An Introduction to data Analytic for IoT, Machine Learning, Big Data Analytic Tools and Technology, edge streaming analytics ,Network analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT security practices and systems vary, Formal risk.</p>			
MODULE-5		8 Hours	
<p>IoT Physical Devices and Endpoints: Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino programming, IoT Physical Devices and endpoints.</p>			

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

Sl.NO	Experiments
1	Select any one development board (Eg., Arduino or Raspberry Pi) and control LED using the board.
2	Using the same board as in (1), read data from a sensor. Experiment with both analog and digital sensors.
3	Control any two actuators connected to the development board using Bluetooth.
4	Read data from sensor and send it to a requesting client. (using socket communication) Note: The client and server should be connected to same local area network.
5	Create any cloud platform account, explore IoT services and register a thing on the platform.
6	Push sensor data to cloud.
7	Control an actuator through cloud.
8	Access the data pushed from sensor to cloud and apply any data analytics or visualization services.
9	Create a mobile app to control an actuator.
10	Identify a problem in your local area or college which can be solved by integrating the things you learned so far and create a prototype to solve it
11	
12	

Course outcomes (Course Skill Set):

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

- Interpret the impact and challenges posed by IoT networks leading to new architectural models.
- Compare and Contrast the deployment of smart objects and the technologies to connect them to network.
- Appraise the role of IoT protocols for efficient network communication.
- Elaborate the need for Data Analytics and security in IoT.
- Illustrate different sensor technologies for sensing real world entities and identify the applications of IoT in 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) 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**)

- 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 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

- Adrian McEwen, Hakim Cassimally - Designing the Internet of Thing Wiley Publications, 2012.
- ArshdeepBahga, Vijay Madiseti - Internet of Things: A Hands-On Approach, Universities Press, 2014.
- Pethuru Raj, Anupama C. Raman, The Internet of Things, Enabling technologies and usecases –CRC Press 2017.

Web links and Video Lectures (e-Resources):

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

Production and Operation Management		Semester	VI
Course Code	BMM602	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	52 hrs	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory		
Course objectives: <ul style="list-style-type: none"> To make the students understand the functions of production, planning and controls, generating new products, issues in production To provide the knowledge of principles of forecasting, forecasting methods, types and its accuracy. To provide the knowledge on facilities location, lean management, Six Sigma and Quality Control. 			
Teaching-Learning Process (General Instructions) These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes. <ul style="list-style-type: none"> Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. Chalk and Talk method for Problem Solving. Adopt flipped classroom teaching method. Adopt collaborative (Group Learning) learning in the class. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
MODULE-1		10 Hours	
Functions of Production Planning controls operations and productivity, productivity measurement, design of goods and services: selection, generating new products, product development, issues in product design.			
MODULE-2		10 Hours	
Forecasting- Importance of forecasting- types of forecasting and their uses- General principles of forecasting- forecasting techniques- qualitative methods and quantitative methods- accuracy of forecasting methods.			
MODULE-3		10 Hours	
Factors affecting facilities location , mathematical models for facilities, location, types of facilities- layout: product layout, process layout, group technology layout, assembly line balancing, computerized layout: ALDEP, CRAFT, CORELAP			
MODULE-4		10 Hours	
Lean Management , philosophy and creation of lean enterprise, JIT concepts - Kanban Systems- Elements of Total Quality Management, Six Sigma Quality Control, MRP, Lot sizing techniques in MRP.			
MODULE-5		10 Hours	
Scheduling Policies- techniques , flow shop and job shop scheduling techniques. Inventory Management- Functions of Inventories- relevant inventory costs-ABC analysis- VED analysis- EOQ model.			
Course outcomes (Course Skill Set): At the end of the course the student will be able to: <ul style="list-style-type: none"> Understand the importance of forecasting, Uses of long term and short-term forecasting, and Application of qualitative and quantitative methods for finding the future demands. 			

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**).

- 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

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Modern Production, Operations Management	Baffa and Rakesh Sarin	Wiley	8 th Edition, 2016
2	Operation Management	B Mahadevan	Pearson Edu.	2018
Reference Books				
1	Production Control A Quantitative Approach	John E Biegel		
2	Production and Operations Management	S N Chary	Mc Graw Hill Edu	6 th Edition, 2019

Web links and Video Lectures (e-Resources):

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

Control Engineering		Semester	VI
Course Code	BMM613A	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		
<p>Course objectives:</p> <ul style="list-style-type: none"> • Understand the basic concepts & mathematical modelling of systems. • Modelling of mechanical, hydraulic, pneumatic and electrical systems. • Representation of system elements by blocks and its reduction. • Transient and steady state response analysis of a system. • Frequency response analysis using polar plot. • Frequency response analysis using bode plot. • Analysis of system using root locus plots. 			
<p>Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none"> • Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. • Chalk and Talk method for Problem Solving. • Adopt flipped classroom teaching method. • Adopt collaborative (Group Learning) learning in the class. • Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1			8 Hours
<p>Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers-Proportional, Integral, Differential, Proportional & Integral, Proportional Differential and Proportional Integral Differential controllers.</p>			
Module-2			8 Hours
<p>Modelling of Physical Systems: Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic and Pneumatic Systems.</p> <p>Analogous Systems: Direct and inverse analogues for mechanical, thermal and fluid systems.</p> <p>Block diagram Algebra: General representation of a feedback control system, transfer functions, rules of block diagram algebra, reduction of block diagram to obtain closed loop transfer function. Signal flow graphs, Mason's gain formula.</p>			
Module-3			8 Hours
<p>Steady state operation: Steady state analysis for general block diagram for a control system, steady state characteristics, equilibrium in a system.</p> <p>Time Response of feedback 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. Routh's stability criterion for a control system.</p>			
Module-4			8 Hours
<p>Root Locus Plots: Root locus method: Significance of Root locus, angle and magnitude conditions, breakaway points, angles of departure and arrival, construction of Root locus using general rules and steps, Lead and Lag compensation</p>			
Module-5			8 Hours

Frequency Domain Analysis: Relationship between time and frequency response, Polar plot, Bode Plot, Nyquist plot and Nyquist stability criterion, Relative Stability, Phase and Gain Margins

Course outcome (Course Skill Set)

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

1. Recognize control system and its types, control actions.
2. Determine the system governing equations for physical models (Electrical, Thermal, Mechanical, Electromechanical).
3. Calculate the gain of the system using block diagram and signal flow graph.
4. Illustrate the response of 1st and 2nd order systems.
5. Determine the stability of transfer functions in complex domain and frequency domain.

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**).

- 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

- J Nagrath and M Gopal, 'Control Systems Engineering', New Age International(P) Limited, Publishers, Fifth edition, 2005, ISBN: 81 - 224 - 2008-7.

Reference Books:

- K Ogata, 'Modern Control Engineering', Pearson Education Asia/ PHI, 4th Edition, 2002. ISBN 978 - 81 - 203 - 4010 - 7.
- Benjamin C. Kuo, 'Automatic Control Systems', John Wiley India Pvt. Ltd., 8th Edition, 2008.
- Joseph J Distefano III et al., 'Feedback and Control System', Schaum's Outline series, TMH, 2nd Edition, 2007.

Web links and Video Lectures (e-Resources):

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

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Non-Destructive Testing		Semester	VI
Course Code	BMM613B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		
Course objectives: <ul style="list-style-type: none"> To introduce the basic principles, techniques, equipment, applications and limitations of Non-Destructive Testing(NDT) methods such as Visual, Penetrant Testing, Magnetic Particle Testing, Ultrasonic Testing, Radiography, Eddy Current. To enable selection of appropriate NDT methods. To identify advantages and limitations of NDT methods To make aware the developments and future trends in NDT. 			
Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. <ul style="list-style-type: none"> Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. Chalk and Talk method for Problem Solving. Adopt flipped classroom teaching method. Adopt collaborative (Group Learning) learning in the class. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1		8 Hours	
OVERVIEW OF NDT: NDT Versus Mechanical testing, Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT. Visual inspection – Unaided and aided.			
Module-2		8 Hours	
SURFACE NDT METHODS: Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials, magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.			
Module-3		8 Hours	
THERMOGRAPHY AND EDDY CURRENT TESTING (ET): Thermography- Principles, Contact and non -contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.			
Module-4		8 Hours	
ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE): Ultrasonic Testing-Principle, Transducers,transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique –Principle, AE parameters, Applications.			
Module-5		8 Hours	

RADIOGRAPHY (RT): Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films – graininess, density, speed, contrast, characteristic curves, Penetrometers, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero- Radiography, Computed Radiography, Computed Tomography.

Course outcome (Course Skill Set)

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

CO1: Classify various Non-destructive testing methods.

CO2: Check different metals and alloys by visual inspection method.

CO3: Explain and perform non-destructive tests like: Liquid penetrant test, Magnetic particle test, Ultrasonic test, X- ray and Gamma ray radiography, Leak Test, Eddy current test.

CO4: Identify defects using relevant NDT methods.

CO5: Differentiate various defect types and select the appropriate NDT methods for better evaluation.

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**).

- 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**

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Practical Non-Destructive Testing	Baldev Raj, T.Jayakumar,	Narosa Publishing House	2009
2	Non-Destructive Testing Techniques	Ravi Prakash	New Age International Publishers	1st revised edition 2010

Reference Books:

1	ASM Metals Handbook,"Non_Destructive	American Society of	Metals Park, Ohio, USA,	2000
2	Introduction to Nondestructivetesting: a training guide	Paul E Mix,	Wiley	2nd Edition New Jersey, 2005
3	Handbook of Nondestructiveevaluation	Charles, J. Hellie	McGraw Hill, New York	2001
ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic				

Web links and Video Lectures (e-Resources):

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

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Geometric Modelling for CAD & Computer Graphics		Semester	VI
Course Code	BMM613C	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		
<p>Course objectives:</p> <ul style="list-style-type: none"> • Know the overview of how computers can assist in mechanical component design • Understand the meaning of Geometric Modelling & Computer Graphics and its application in design of components • Use 2D & 3D transformations for effective viewing • Mathematically represent curves, surfaces & solids • Understand various drawing algorithms • Understand how realistic image can be formed 			
<p>Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none"> • Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. • Chalk and Talk method for Problem Solving. • Adopt flipped classroom teaching method. • Adopt collaborative (Group Learning) learning in the class. • Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1			8 Hours
<p>Geometric Modelling: Introduction and scope; Computer Graphics: Introduction & scope Transformations: Representation of points, Transformations: Rotation, Reflection, Scaling, Shearing, Combined Transformations, Translations and Homogeneous Coordinates, A geometric interpretation of homogeneous coordinates, Over all scaling, Points at infinity, Rotation about an arbitrary point, Reflection through an arbitrary line, Rotation about an axis parallel to coordinate axis, Rotation about an arbitrary axis in space, Reflection through an arbitrary plane.</p>			
Module-2			8 Hours
<p>Types and Mathematical Representation of Curves: Curve representation, Explicit, Implicit and parametric representation. Nonparametric and parametric representation of Lines, Circles, Ellipse, Parabola, Hyperbola, Conics. Parametric representation of synthetic curve, Hermite cubic splines, Bezier curves: Blending function, Properties, generation, B-spline curves- Cox-deBoor recursive formula, Properties, Open uniform basis functions, Non-uniform basis functions, Periodic B-spline curve.</p>			
Module-3			8 Hours
<p>Types and Mathematical Representation Solids: Solid entities: Block, Cylinder, Cone, Sphere, Wedge, Torus, Solid representation, Fundamentals of solid modeling, Set theory, Regularized set operations, Set membership classification, Half spaces, Basic elements, Building operations, Boundary representation and Constructive solid geometry, Basic elements, Building operations.</p> <p>Scan Conversion and Clipping: Representation of points, lines, Drawing Algorithms: DD algorithm, Bresenham's integer line algorithm, Bresenham's circle algorithm, Polygon filling algorithms: Scan conversion, Seed filling, Scan line algorithm. Viewing transformation, Clipping - Points, lines, Text, Polygon, Cohen-Sutherland line clipping, Sutherland-Hodgmen algorithm.</p>			

Module-4	8 Hours
<p>Visual Realism: Introduction, Hidden line removal, Visibility of object views, Visibility techniques: Minimax test, Containment test, Surface test, Silhouettes, Homogeneity test, Sorting, Coherence, Hidden surface removal- Z- buffer algorithm, Warnock's algorithm, Hidden solid removal - ray tracing algorithm, Shading, Shading models, Diffuse reflection, Specular reflection, Ambient light, Shading of surfaces: Constant shading, Gourand shading, Phong shading, Shading enhancements, Shading Solids, Ray tracing for CSG, Z-buffer algorithm for B-rep and CSG</p>	
Module-5	8 Hours
<p>Applications: Colouring- RGB, CMY, HSV, HSL colour models, Data Exchange: Evolution of Data exchange, IGES, PDES, Animation: Conventional animation-key frame, In between, Line testing, Painting, Filming, Computer animation, Entertainment and Engineering Animation, Animation system hardware, Software architecture, Animation types, Frame buffer, Colour table, Zoom- pan-scroll, Cross bar, Real time play back, Animation techniques- key frame, Skelton. Path of motion and p-curves.</p>	
<p>Course outcome (Course Skill Set) At the end of the course the student will be able to :</p> <ul style="list-style-type: none"> • Design free form surfaces for the given application • Develop solid model of any given component • Recognize how a visual image can be an effective means of communication • Acquire and develop the skills needed to creatively solve visual communication problems. • Understand, develop and employ visual hierarchy using images and text. 	
<p>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.</p> <p>Continuous Internal Evaluation:</p> <ul style="list-style-type: none"> • 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. <p>Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.</p> <p>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).</p> <ol style="list-style-type: none"> 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:

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	CAD/CAM-Theory and Practice	Ibrahim Zeid	McGraw Hill,	2006
2	Mathematical Elements for Computer Graphics	David Rogers & Alan Adams	Tata McGraw Hill	2002
Reference Books				
1	Computer Graphics- Schaum's Outline	Xiang Z, Plastock, R. A	McGraw Hill	2007
2	Computer Graphics- Principles and Practice-	Foley, van Dam, Feiner and	Addison Wesley	1996
3	Computer Graphics	Sinha A N., Uday A D	Tata McGraw Hill	2008
4	Computer Graphics with OpenGL Version	Donald Hearn & Pauline Baker	Pearson Education	3 rd /4 th Edition, 2011
5	Interactive Computer Graphics- A Top Down approach with OpenGL	Edward Angel	Pearson Education	5 th Edition, 2008

Web links and Video Lectures (e-Resources):

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

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Composite Materials		Semester	VI
Course Code	BMM613D	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		
<p>Course objectives:</p> <ul style="list-style-type: none"> To know the behaviour of constituents in the composite materials To Enlighten the students in different types of reinforcement To Enlighten the students in different types of matrices To develop the student's skills in understanding the different manufacturing methods available for compositematerial. To understand the various characterization techniques To illuminate the knowledge and analysis skills in applying basic laws in mechanics to the composite materials. 			
<p>Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none"> Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. Chalk and Talk method for Problem Solving. Adopt flipped classroom teaching method. Adopt collaborative (Group Learning) learning in the class. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1		8 Hours	
<p>Introduction to Composite Materials: Definition, classification & brief history of composite materials. Constituent of composite materials: Reinforcements, Matrix, Coupling agents, coatings & fillers. Reinforcements: Introduction, Glass Fibers, Boron Fibers, Carbon Fibers, Organic Fibers, Ceramic Fibers, Whiskers, Other Non-oxide Reinforcements, Comparison of Fibers Matrix Materials: Polymers, Metals and Ceramic Matrix Materials.</p>			
Module-2		8 Hours	
<p>Polymer Matrix Composites (PMC): Processing of PMC's; Processing of Thermoset Matrix Composites, Thermoplastic Matrix Composites, Sheet Moulding Compound and carbon reinforced polymer composites. Interfaces in PMC's, Structure & Properties of PMC's, applications Metal Matrix Composites: Types of metal matrix composites, Important Metallic Matrices, Processing, Interfaces in Metal Matrix Composites, Properties & Applications.</p>			
Module-3		8 Hours	
<p>Ceramic Matrix Composites (CMC): Processing of CMC's; Cold Pressing & Sintering, Hot Pressing, Reaction Bonding Processes, Infiltration, Directed Oxidation, In Situ Chemical Reaction Technique, Sol-Gel, Polymer Infiltration & Pyrolysis, Electrophoretic Deposition, Self-Propagating High Temperature Synthesis. Interfaces, properties and applications of CMC's. Carbon Fiber/Carbon Matrix Composites: Processing of Carbon/Carbon Composites, Oxidation protection of Carbon/Carbon Composites, Properties of Carbon/Carbon Composites, and application of Carbon/Carbon Composites.</p>			
Module-4		8 Hours	
<p>Non-conventional Composites: Introduction, Nano composites; Polymer clay nanocomposites, self-healing composites, self-reinforced composites. Bio-composites, Laminates; Ceramic Laminates, Hybrid Composites.</p>			

Performance/Characterization of Composites: Static Mechanical Properties; Tensile Properties, Compressive Properties, Flexural Properties, In-Plane Shear Properties, Interlaminar Shear Strength.

Module-5

8 Hours

Micromechanics of Composites: Density, Mechanical Properties; Prediction of Elastic Constants, Micromechanical Approaches, Halpin-Tsai Equations, Transverse Stresses, Thermal properties. Numerical Problems.

Course outcome (Course Skill Set)

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

CO1: Use different types of manufacturing processes in the preparation of composite materials

CO2: Analyze the problems on macro mechanical behavior of composites

CO3: Analyze the problems on micromechanical behavior of Composites
CO4: Determine stresses and strains relation in composites materials.

CO5: Understand and effective use of properties in design of composite structures

CO6: Perform literature search on a selected advanced material topic.

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 220B2.4, 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:**

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Composite Material Science and Engineering	Krishan K. Chawla	Springer	Third Edition First Indian Reprint 2015
2	Fibre-Reinforced Composites, Materials, Manufacturing, and Design	P.K. Mallick	CRC Press, Taylor & Francis Group	Third Edition
3	Mechanics of Composite Materials & Structures	MadhijitMukhopadhay	Universities Press	2004
Reference Books				
1	Mechanics of Composite materials	Autar K. Kaw	CRC Taylor & Francis	2nd Ed, 2005
2	Stress analysis of fiber Reinforced Composites Materials	Michael W, Hyer	Mc-Graw Hill International	2009
3	Mechanics of Composite Materials	.Robert M. Jones	Taylor & Francis	1999

Web links and Video Lectures (e-Resources):

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

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Operation Management		Semester	VI
Course Code	BMM654A	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		
<p>Course objectives:</p> <ul style="list-style-type: none"> To know the behaviour of constituents in the composite materials To Enlighten the students in different types of reinforcement To Enlighten the students in different types of matrices To develop the student's skills in understanding the different manufacturing methods available for compositematerial. To understand the various characterization techniques To illuminate the knowledge and analysis skills in applying basic laws in mechanics to the composite materials. 			
<p>Teaching-Learning Process (General Instructions)</p> <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none"> Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. Chalk and Talk method for Problem Solving. Adopt flipped classroom teaching method. Adopt collaborative (Group Learning) learning in the class Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1		8 Hours	
Introduction, Production of Goods Versus Providing Services, the operation management function, The Scope of Operations Management, Types and Characteristics of Manufacturing and Service Systems, Productivity, its improvement and factors affecting productivity and topic related numerical.			
Module-2		8 Hours	
Product and Service Design: Introduction, Sources of Ideas for New or Redesigned Products and Services, Legal, Ethical, and Environmental Issues, Designing for Manufacturing, and services.			
Module-3		8 Hours	
Master Scheduling: The Master Scheduling Process, Planning Horizons, Master Scheduling Format, Available-to-Promise Quantities and related numerical			
Module-4		8 Hours	
MRP and ERP: Introduction, MRP Inputs, processing, outputs, MRP in Services, Benefits and Requirements of MRP, numerical, Capacity Requirements Planning, MRP II and ERP.			
Module-5		8 Hours	
Purchasing and Supply Chain Management (SCM): Introduction, Importance of purchasing and SCM, the procurement process, Concept of tenders, Approaches to SCM, Vendor development.			
<p>Course outcome (Course Skill Set)</p> <p>At the end of the course the student will be able to :</p> <ul style="list-style-type: none"> Analyse the aggregate plan and master production schedule for an organization, given its periodic demand. Apply MRP, purchasing and SCM techniques into practice. 			

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:

- William J Stevenson, Production and Operations management Tata McGraw Hill. 13th edition, 2018.
- Joseph G. Monks, Operations Management Tata McGraw Hill. 2nd Edition, 2020
- B. Mahadevan, Operations Management: Theory and Practice Pearson 3rd Edition, 2015

Web links and Video Lectures (e-Resources):

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

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Air Conditioning Systems		Semester	VI
Course Code	BMM654B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		
Course objectives:			
<ul style="list-style-type: none"> • Study the working of air conditioning systems and their applications. • Identify the performance parameters and their relations of an air conditioning system. 			
Teaching-Learning Process (General Instructions)			
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.			
<ul style="list-style-type: none"> • Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. • Chalk and Talk method for Problem Solving. • Adopt flipped classroom teaching method. • Adopt collaborative (Group Learning) learning in the class. • Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1		8 Hours	
Introduction to Refrigeration –Basic Definitions, ASHRAE Nomenclature, Air Refrigeration Cycles-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and demerits and applications			
Module-2		8 Hours	
Industrial Refrigeration-Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain.			
Module-3		8 Hours	
Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.			
Module-4		8 Hours	
Air-Conditioning: Introduction to Air-Conditioning, Basic Definition, Classification, power rating, Mathematical Analysis of Air-Conditioning Loads, Related Aspects, Different Air-Conditioning Systems-Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air-Conditioner and Packaged Air-Conditioner, Components related to Air-Conditioning Systems.			
Module-5		8 Hours	
Transport air conditioning Systems: Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains, Air conditioning systems for ships			
Course outcome (Course Skill Set)			
At the end of the course the student will be able to:			
<ul style="list-style-type: none"> • Estimate the performance of air-conditioning systems using the principles of psychrometry. • Compute and Interpret cooling and heating loads in an air-conditioning system. • Identify suitable refrigerant for various refrigerating systems. 			

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

- 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:

- Refrigeration and Air conditioning Arora C.P Tata Mc Graw -Hill, New Delhi 2ndEdition, 2001
- Principles of Refrigeration Roy J. Dossat Wiley Limited
- Refrigeration and Airconditioning Stoecker W.F., and Jones J.W., Mc Graw - Hill, New Delhi 2nd edition, 1982.

Reference Books

- Heating, Ventilation and Air Conditioning McQuiston Wiley Students edition 5th edition2000.
- Air conditioning PITA Pearson 4th edition 2005
- Refrigeration and Air- Conditioning S C Arora& S Domkundwar Dhanpat Rai Publication

Web links and Video Lectures (e-Resources):

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

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Operation Research		Semester	VI
Course Code	BMM654B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination nature (SEE)	Theory		
<p>Course objectives: To enable the student to understand and analyse managerial and engineering problems to equip him to use the resources such as capitals, materials, productions, controlling, directing, staffing, and machines more effectively.</p>			
<p>Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none"> • Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. • Chalk and Talk method for Problem Solving. • Adopt flipped classroom teaching method. • Adopt collaborative (Group Learning) learning in the class. • Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1		8 Hours	
<p>Introduction: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).</p>			
Module-2		8 Hours	
<p>LPP: Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method</p>			
Module-3		8 Hours	
<p>Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method.</p>			
Module-4		8 Hours	
<p>Network analysis: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks</p>			
Module-5		8 Hours	
<p>Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games</p>			
<p>Course outcome (Course Skill Set) At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Optimize the allocation of resources, • Plan transportation networks, and • Develop policies to promote economic growth. 			

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:

- Operations Research P K Gupta and D S Hira S. Chand and Company LTD. Publications, New Delhi 2007
- Operations Research, An Introduction Hamdy A. Taha PHI Private Limited Seventh Edition, 2006

Reference Books

- Operations Research, Theory and Applications J K Sharma Trinity Press, Laxmi Publications Pvt.Ltd. Sixth Edition, 2016
- Operations Research Paneerselvan PHI
- Operations Research A M Natarajan, P Balasubramani Pearson Education, 2005

Web links and Video Lectures (e-Resources):

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

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Smart Manufacturing Lab-2		Semester	VI
Course Code	BMML606	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	100
Examination nature (SEE)	Practical		
Course objectives:			
The objective of this course is to impart students to the fundamentals of various 3D Printing Techniques for application to various industrial needs.			
Sl.NO	Experiments		
1	Modeling of Metal Parts in CAD Software.		
2	Body/head scanning using Sense 3D Scanner.		
3	Object Scanning using EinScan 3D Scanner.		
4	Slicing of corrected STL files in SLM RP Tools Software.		
5	Process Parameters (laser power, scan speed, hatch width, hatch space, etc.,) Optimization in PSW Software for fabrication on SLM RP Machine.		
6	Laser path generation in DMDCAM Software for fabrication on LENS Machine.		
7	Laser path generation in UG CAM Software for fabrication on Micro stereolithography (MSL) RP machine.		
8	Fabrication of Metal parts on SLM RP Machine.		
Demonstration Experiments (For CIE)			
1	Fabrication of Metal parts on LENS RP Machine.		
2	Building and testing a low-cost desktop 3D printer.		
3	Post-processing of Fabricated metal parts by Wire EDM.		
4	Post-processing of Fabricated metal parts by Shot-peening, polishing, etc., to improve the surface quality of the produced parts.		
Course outcomes (Course Skill Set):			
At the end of the course the student will be able to:			
<ul style="list-style-type: none"> • Model complex geometry of engineering components. • Make use of point cloud data to reconstruct industrial and medical components. • Evaluate the process parameters of SLM and LENS metal AM machines to improve the quality of the parts produced. • Improve surface finish of fabricated components by post-processing techniques. • Construct low cost desktop 3D Printer and test for performance 			
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 .			
<ul style="list-style-type: none"> • 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 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 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:

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Introduction to Cloud Computing		Semester	VI
Course Code	BMM657A	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	25	Total Marks	100
Credits	01	Exam Hours	3
Examination nature (SEE)	Theory		
<p>Course objectives:</p> <ul style="list-style-type: none"> • Explain the fundamentals of cloud computing • Illustrate the cloud application programming and aneka platform • Contrast different cloud platforms used in industry 			
<p>Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none"> • Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. • Chalk and Talk method for Problem Solving. • Adopt flipped classroom teaching method. • Adopt collaborative (Group Learning) learning in the class. • Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1		5 Hours	
<p>Introduction, Cloud Infrastructure: Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock- in, Energy use and ecological impact, Service level agreements, User experience and software licensing. Exercises and problems.</p>			
Module-2		5 Hours	
<p>Cloud Computing: Application Paradigms.: Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model.</p>			
Module-3		5 Hours	
<p>Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization</p>			
Module-4		5 Hours	
<p>Cloud Resource Management and Scheduling: Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources.</p>			
Module-5		5 Hours	
<p>Cloud Security, Cloud Application Development: Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor.</p>			

Course outcome (Course Skill Set)

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

- Compare the strengths and limitations of cloud computing
- Identify the architecture, infrastructure and delivery models of cloud computing
- Apply suitable virtualization concept.
- Choose the appropriate cloud player
- Address the core issues of cloud computing such as security, privacy and interoperability
- Design Cloud Services
- Set a private cloud

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. Cloud Computing Theory and Practice, Dan C Marinescu, Elsevier(MK), 2013
2. Rajkumar Buyya , James Broberg, Andrzej Goscinski, Computing Principles and Paradigms, Willey 2014
3. Cloud Computing Implementation, Management and Security, John W Rittinghouse, James F Ransome, CRC Press, 2013

Web links and Video Lectures (e-Resources):

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

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Cyber Security		Semester	VI
Course Code	BMM657B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	25	Total Marks	100
Credits	01	Exam Hours	3
Examination nature (SEE)	Theory		
Course objectives: <ul style="list-style-type: none"> • Explain the fundamentals of cloud computing • Illustrate the cloud application programming and aneka platform • Contrast different cloud platforms used in industry 			
Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. <ul style="list-style-type: none"> • Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations. • Chalk and Talk method for Problem Solving. • Adopt flipped classroom teaching method. • Adopt collaborative (Group Learning) learning in the class. • Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information. 			
Module-1		5 Hours	
Introduction, Cloud Infrastructure: Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock- in, Energy use and ecological impact, Service level agreements, User experience and software licensing. Exercises and problems.			
Module-2		5 Hours	
Cloud Computing: Application Paradigms.: Challenges of cloud computing, Architectural styles of cloud computing , Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model.			
Module-3		5 Hours	
Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization			
Module-4		5 Hours	
Cloud Resource Management and Scheduling: Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources.			
Module-5		5 Hours	
Cloud Security, Cloud Application Development: Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor.			

Course outcome (Course Skill Set)

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

- Compare the strengths and limitations of cloud computing
- Identify the architecture, infrastructure and delivery models of cloud computing
- Apply suitable virtualization concept.
- Choose the appropriate cloud player
- Address the core issues of cloud computing such as security, privacy and interoperability
- Design Cloud Services
- Set a private cloud

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.
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- 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. Cloud Computing Theory and Practice, Dan C Marinescu, Elsevier(MK), 2013
2. Rajkumar Buyya , JamesBroberg, Andrzej Goscinski, Computing Principles and Paradigms, Willey 2014
3. Cloud Computing Implementation, Management and Security, John W Rittinghouse, James F Ransome, CRC Press, 2013

Web links and Video Lectures (e-Resources):

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