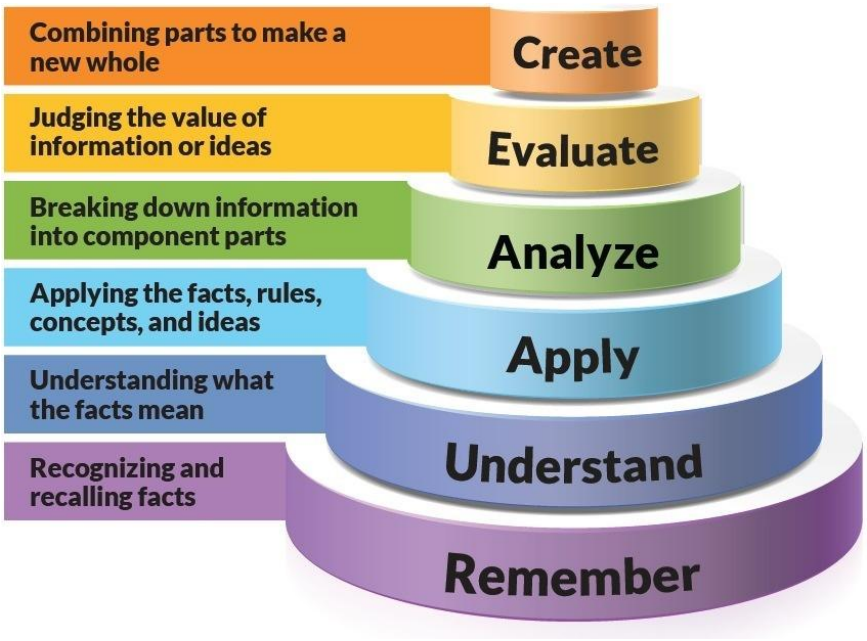
COURSE DESCRIPTOR BOOKLET

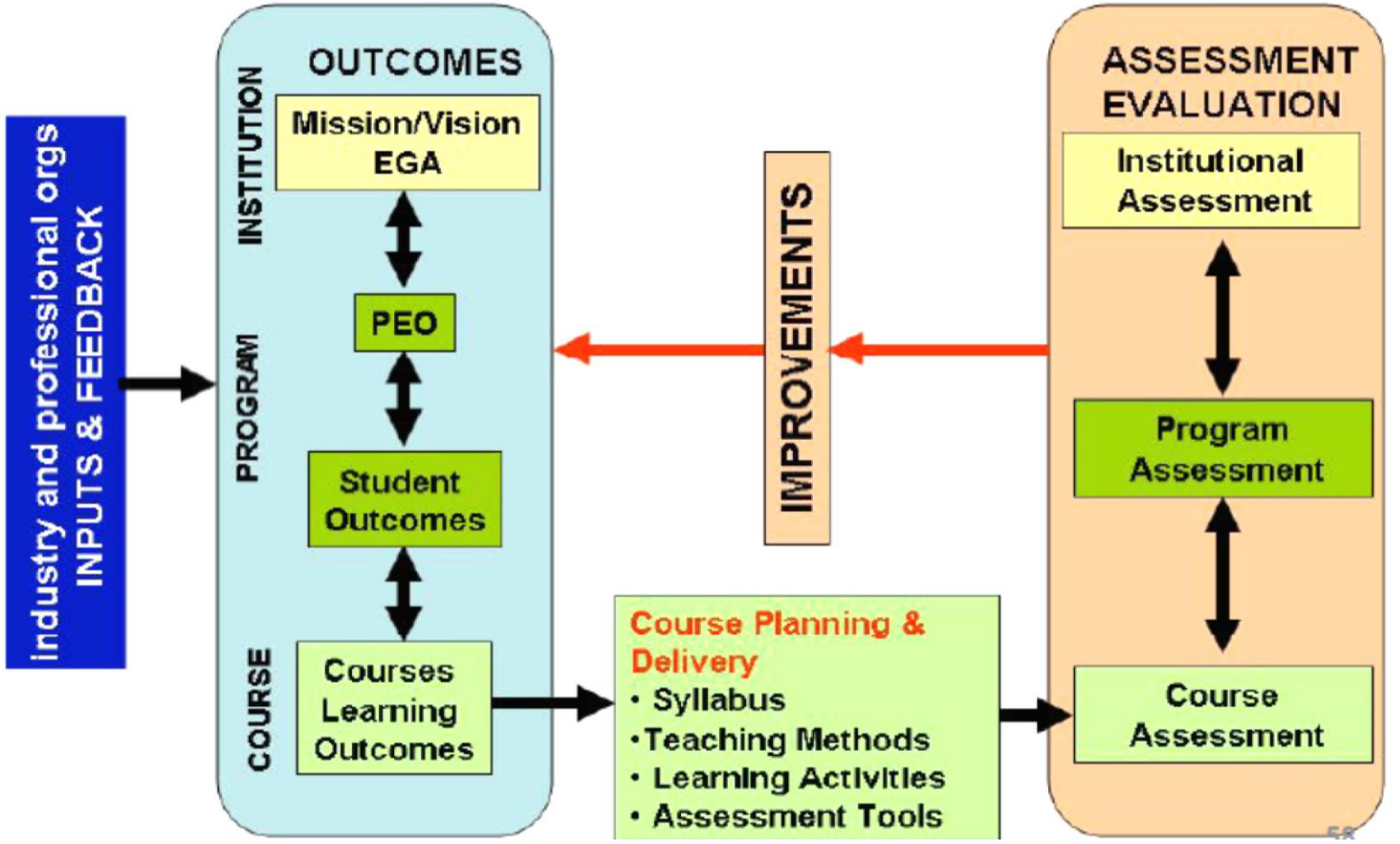
M.Tech CAD/CAM
Mechanical Engineering

For the batch of students admitted during
2016 – 2017 & 2017-2018 Academic Year



INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Approved by AICTE; Affiliated to JNTUH and Accredited by NAAC with 'A' Grade
Dundigal, Hyderabad – 500 043

The OBE Framework



Vision

The Department of Mechanical Engineering envisions value based education, research and development in the areas of Manufacturing and Computer Aided Engineering as an advanced center for Mechanical Engineering, producing graduates of world-class competence to face the challenges of global market with confidence, creating effective interface with various organizations.

Mission

The mission of the Mechanical Engineering Department is to prepare effective and responsible engineers for global requirements by providing quality education and to improve pedagogical methods employed in delivering the academic programs to the needs of the industry and changing world by conducting basic and applied research and to generate intellectual property.

Part – I

I. Program Educational Objectives and Assessment Criteria:

Program Educational Objectives, Program Outcomes and Assessment Criteria (Approved by DAC MECH on 30/01/2016):

Mechanical Engineering Department Advisory Council: The Mechanical Engineering Department Advisory Council (MECHDAC) includes a diverse group of experts from academic and industry, as well as alumni representation. The Advisory Board meets annually, or as needed, for a comprehensive review of the Mechanical Engineering Department strategic planning and programs. The Advisory Council meets with administration, faculty and students and prepares a report, which is presented to principal. In each visit, the Department of Mechanical Engineering responds to the report indicating improvements and amendments to the program.

Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.
Outcomes — Program outcomes are narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program.

II. Program Educational Objectives (PEO'S)

A graduate of Institute of Aeronautical Engineering College, Mechanical Engineering should enjoy a successful career in Mechanical Engineering or a related field after graduation. The program aims to:

Program Educational Objective 1

Impart essential knowledge in the latest technological topics on computer aided engineering and to prepare them for taking up further **research** in the areas

Program Educational Objective 2

Create congenial environment that promotes learning, growth and imparts ability to work with **inter-disciplinary** groups

Program Educational Objective 3

Broaden and deepen the capabilities in **analytical and experimental methods**, analysis of data, and draw relevant conclusions for scholarly writing and presentation

These Program Educational Objectives are broad by intention, permitting the Mechanical Engineering CAD/CAM post graduates to seek further research or work in diverse areas. To make these objectives meaningful, they may be demonstrated by performance, actions, or achievements.

1. To impart essential knowledge in the latest technological topics on computer aided engineering and to prepare them for taking up further research in the areas:
   - Impart knowledge of various computerized tools for performing geometry and dimensional tolerance in different technical drawings.

- Impart knowledge of software for modeling and analysis of various systems and sub systems.
- Develop the knowledge of using multi physics tools to gain research knowledge and develop further mathematical and experimental models in engineering

2. To create congenial environment that promotes learning, growth and imparts ability to work with inter-disciplinary groups:
   - Knowledge of robotic systems and subsystems to work with electronic engineers in development of new products and assembly lines.
   - Knowledge of research methodology to work in any of the inter-disciplinary group to develop standard research.
   - Factual reporting in engineering journals which may further lead to publishing inter-departmental white papers for technology transfer.
3. To broaden and deepen the capabilities in analytical and experimental methods, analysis of data and draw relevant conclusions for scholarly writing and presentations:
   - Broad spectrum of project work included in two phases encompasses the importance of raw data collection from previous scholarly articles, conversion of raw data to scientific data by numerical, mathematical and experimental analysis.
   - Specified subjects for writing technical reports and publishing research and scholarly articles in renowned journals.
   - Encouragement to publish scholarly articles in journals in hand with the faculty and mentoring for overall improvement.

III. Program Outcomes (PO'S):

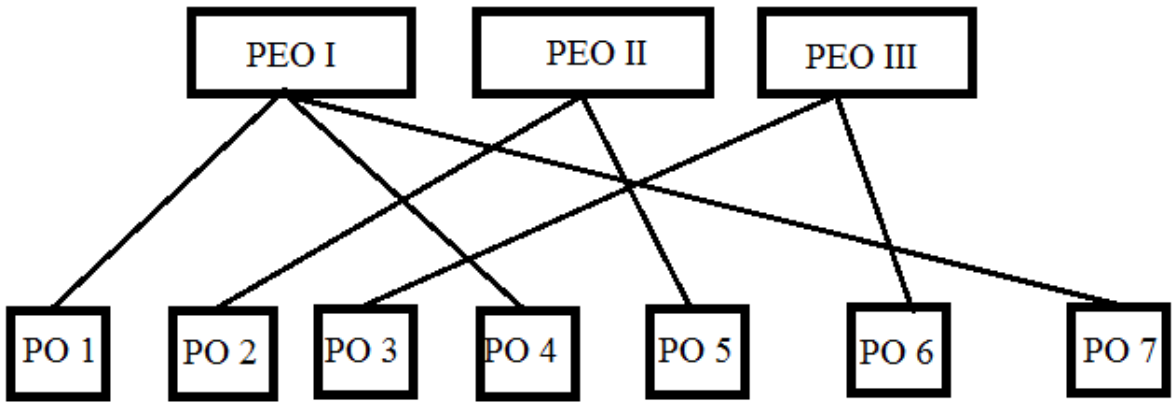
1. **Engineering Knowledge:** Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.
2. **Develop Novel Designs:** Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.
3. **Analyze Complex Systems:** Conduct experimental and analytical study and analyzing results with scientific methods and use of software tools.
4. **Development of Solutions:** Independently carry out research / investigation and development work to solve practical problems.
5. **Teamwork and Project Management:** Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.
6. **Technical Presentation Skills:** Write and present a substantial technical report / document.
7. **Lifelong Learning:** Design and validate technological solutions to improve the defined problems and engage in lifelong learning through continuing education.

IV. PEO's Vs PO's

S. No	Program Educational Objectives	Program Outcomes
PEO - I	To impart essential knowledge in the latest technological topics on computer aided engineering and to prepare them for taking up further research in the areas.	1. Apply advanced knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues 4. Independently carry out research / investigation and development work to solve practical problems

		7. Design and validate technological solutions to improve the defined problems and engage in lifelong learning through continuing education
PEO - II	To create congenial environment that promotes learning, growth and imparts ability to work with inter-disciplinary groups.	2. Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields. 5. Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team
PEO - III	To broaden and deepen the capabilities in analytical and experimental methods, analysis of data and draw relevant conclusions for scholarly writing and presentations.	3. Conduct experimental and analytical study and analyzing results with scientific methods and use of software tools. 6. Write and present a substantial technical report / document.

V. Mapping of Program Outcomes to Program Educational Objectives



VI. MAPPING OF PO's Vs PEO's

Program Outcomes	PEO-I	PEO-II	PEO-III
1. **Engineering Knowledge:** Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	✔		
2. **Develop Novel Designs:** Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.		✔	
3. **Analyze Complex Systems:** Conduct experimental and analytical study and analyzing results with scientific methods and use of software tools.			✔
4. **Development of Solutions:** Independently carry out research / investigation and development work to solve practical problems.	✔		
5. **Teamwork and Project Management:** Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team..		✔	
6. **Technical Presentation Skills:** Write and present a substantial technical report / document			✔
7. **Lifelong Learning:** Design and validate technological solutions to improve the defined problems and engage in lifelong learning through continuing education.	✔		

Note:

- The assessment process can be direct or indirect.
- The direct assessment will be through interim assessment by the faculty or by industry / technology experts.
- The indirect assessment on the other hand could be by students through course outcomes, lab evaluation, department associations, exit interviews, engineering services, GATE examination etc.
- Frequency of assessment can be once in a semester and justified by the programme coordinator.

VII. Table-1 Relation between the Program Educational Objectives and Program Outcomes:

A broad relation between the program objective and the outcomes is given in the following table:

	(PEO-I) Research	**(PEO-II) Inter-disciplinary groups**	**(PEO-III) Analytical and Research Skills**
1.**Engineering Knowledge:** Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	3	2	3
2. **Develop Novel Designs:** Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	3	3	3
3. **Analyze Complex Systems:** Conduct experimental and analytical study and analyzing results with scientific methods and use of software tools.	3	3	3
4. **Development of Solutions:** Independently carry out research / investigation and development work to solve practical problems.	3	2	2
5. **Teamwork and Project Management:** Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team..	2	3	3
6. **Technical Presentation Skills:** Write and present a substantial technical report / document	2	2	2
7. **Lifelong Learning:** Design and validate technological solutions to improve the defined problems and engage in lifelong learning through continuing education.	2	2	2

Table - Relationships between program objectives and program outcomes
Key: 3 = Strong relationship; 2 = Moderate relationship

Note:

- The assessment process can be direct or indirect.
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I SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

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Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**ADVANCED CAD**				
Course Code	BCCB01				
Programme	M.Tech				
Semester	I	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. A Venuprasad, Assistant Professor, ME				
Course Faculty	Mr. A Venuprasad, Assistant Professor, ME				

I. COURSE OVERVIEW:

Advanced CAD encompasses the concepts and principles of computer graphics, CAD tools, surface modelling, parametric representation of synthetic surfaces and 3D geometric modelling. The principles of computer graphics include the detailed concepts from graphic primitives to the transformations both in 2D and 3D. The fundamentals of CAD tools cover the concepts from CAD/CAM system evaluation criteria to the geometric modelling techniques like types of mathematical representations and rational curves. The mathematical representation of surfaces and their parametric representations are covered in detail with surface modelling. Parametric representation of synthetic surfaces and corresponding transformations both in 3D and 2D are discussed consequently. 3D geometric modelling along with solid and boundary representation techniques, STEP architecture and collaborative engineering concepts are discussed to complete the course.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	A70328	VII	CAD/CAM	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Advanced CAD	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	3	Presentation on Real-world problems
PO2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	1	Assignments
PO3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	2	Seminar
PO4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	1	Assignments
PO5	Write and present a substantial technical report / document.	2	Presentation on Real-world problems
PO6	Independently carry out research / investigation and development work to solve practical problems	3	Presentation on Real-world problems
PO7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	2	Assignments

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand of basic trends in design and modeling applicable to CAD/CAM.
II	Applying the CAD tools for designing.
III	Create surface and geometric models.

VIII. COURSE OUTCOMES (COs):

CO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
CO1	Understand the principles of computer graphics, coordinate systems and geometrical transformations in graphics	PO 1, PO 2	3
CO2	Prepare parametric geometric models for synthetic curves.	PO 1, PO 2	2
CO3	Represent parametrically various curves and splines	PO 1, PO 2, PO 3	2
CO4	Represent various synthetic and geometric modelling technics	PO 2	1
CO5	Describe various design applications, collaborative engineering and CAD/CAM exchange formats	PO 3, PO 6	3

3 = High; 2 = Medium; 1 = Low

IX. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CLO 1	3											

CLO 2	3						1					
CLO 3	3	3										
CLO 4	3	2										
CLO 5		2					2					
CLO 6	2	2	2									
CLO 7		1										
CLO 8		1	1									
CLO 9		2										
CLO 10	2	2					3					
CLO 12			3			3						

3 = High; 2 = Medium; 1 = Low

X. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1,PO2 PO3,PO6	SEE Exams	PO1,PO2, PO3,PO6	Assignments	PO 2	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 3						

XI. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XII. SYLLABUS

UNIT-I	**PRINCIPLES OF COMPUTER GRAPHICS**
Principles of computer graphics : Introduction, graphic primitives, point plotting, lines, Bresenham's circle algorithm, ellipse, transformation in graphics, coordinate systems, view port, 2D and 3D transformation, hidden surface removal, reflection, shading and generation of character.	
UNIT-II	**CAD TOOLS**
Definition of CAD Tools, Types of system, CAD/CAM system evaluation criteria, brief treatment of input and output devices. Graphics standard, functional areas of CAD, Modeling and viewing, software documentation, efficient use of CAD software; Geometric modeling: Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves hermite cubic splines Bezier curves Bezier splines rational curves.	
UNIT-III	**SURFACE MODELING**
Mathematical representation surfaces, surface model, surface entities surface representation. Parametric representation of surfaces, plane surface, rule surface, surface of revolution, tabulated cylinder.	

UNIT-IV	PARAMETRIC REPRESENTATION OF SYNTHETIC SURFACES
Parametric representation of synthetic surfaces: : Hermite Bicubic surface, Bezier surface, Bezier Spline surface, COONs surface, Blending surface Sculptured surface, Surface manipulation; Displaying, Segmentation, Trimming, Intersection, Transformations (both 2D and 3D).	
UNIT-V	**GEOMETRIC MODELING – 3D**
Geometricmodelling-3D: Solid modeling, solid representation, boundary representation (13-rep), Constructive solid geometry (CSG). CAD/CAM exchange: Evaluation of data, exchange format, IGES data representations and structure, STEP Architecture, implementation, ACIS and DXF; Design applications: Mechanical tolerances, mass property calculations, finite element modeling and analysis and mechanical assembly; Collaborative engineering: Collaborative design, principles, approaches, tools, design systems.	
Text Books:	
1. Ibrhim Zeid, "Mastering CAD/CAM", Tata McGraw Hill, 2nd Edition, 2013. 2. P. N. Rao, "CAD/CAM Principles and Applications", Tata McGraw Hill, 3 rd Edition, 2010. 3. M. P. Groover, E. Zimmers, "CAD/ CAM Computer- Aided Design and Manufacturing", Pearson, 1st Edition, 2003. 4. R. Alavala Chennakesava, "CAD/ CAM Concepts and Applications", PHI, 1st Edition, 2013.	
Reference Books:	
1. Farid Amirouche, "Principles of Computer-Aided Design and Manufacturing, Pearson, 2nd Edition, 2004. 2. P. Radha Krishnan, "CAD/ CAM/ CIM", New Age International, 4th Edition, 2016. 3. Warren. S. Seames, "Computer Numerical Control Concepts and Programming", Delmar Cengage Learning, 4 th Edition, 2013	
E-Text Books:	
1. http://sbmpme.blogspot.in/2011/01/cad-cam-cim-p-radhakrishnan.html 2.https://www.scribd.com/doc/228624725/cad-cam-text-book-by-P-N-RAO	

XIV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	**Classify** principles of computer graphics	CLO 1	T1:28.7 R1:2.6
3	**Explain** graphic primitives, plotting lines	CLO 1	T1:27.5 R1:2.7
4-5	**Explain** the Bresenham's circle algorithm, ellipse	CLO 1	T1:29.6 R1:2.6
6-7	**Compare** transformations in graphics, coordinate systems, view port, 2D and 3D transformations	CLO 1, 2	T1:29.7 R1:2.7
7	**Illustrate** hidden surface removal, reflection	CLO 2	T1:29.8 R1:4.4
8-9	**Illustrate** shading and generation of character.	CLO 2	T1:29.7 R1:2.7
10-11	**Describe** the CAD tools, types of system, CAD/CAM evaluation criteria, i/p and o/p devises	CLO 3	T1:30.7 R1:4.10
12-13	**Explain** Graphics standard, functional areas of CAD, modelling and viewing, software documentation	CLO 3	T1:29.8 R1:4.4
14-15	**Compare** geometric modeling and mathematical representation of curves, wire frame models and entities	CLO 4	T1:30.7 R1:4.10
16	**Explain** the parametric representation of synthetic curves	CLO 5	T2:33.9 R1:7.5
17-18	**Categorize** hermite cubic xplines, Bezier curves and splines rational curves	CLO 5	T2:35.10 R3:8.1

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
19-20	**Explain** mathematical representation of surfaces	CLO 6	T2:34.10 R2:7.5
20	**Explain** mathematical representation of surface model	CLO 6	T2:35.12 R1:9.2
21-22	**Explain** mathematical representation of surface entities and representation	CLO 6	T2:36.1 R2:9.4
23-24	**Describe** parametric representation of surfaces, plane surface	LO 7	T2:37.1 R2:9.9
25-26	**Explain** parametric representation of surfaces, rule surface, surface of revolution	LO 7	T2:37.1 R2:9.9
27	**Explain** parametric representation of surfaces, tabulated cylinder	CLO 7	T2:27.12 R1:11.9
28	**Explain** the Hermite bicubic surface	LO 8	T2:27.12 R1:11.9
29	**Explain** beizer surface	CLO 8	T2:27.5 R1:10.2
30	**Explain** beizer spline surface	LO 8	T2:27.5 R1:10.2
31-32	**Explain** COONs surface, Blending, sculptured surfaces	CLO 8	T2:27.7 R1:11.3
33	**Explain** Surface manipulation, displaying, segmentation	CLO 9	T2:27.8 R1:11.6
34-35	**Explain** trimming, intersection	CLO 9	T2:27.12 R1:11.7
36-37	**Illustrate** transformations – both 2D and 3D, solid modeling and representation and boundary representation	CLO 9, 10	T2:27.12 R1:11.8
38	**Illustrate** CSG, evaluation of data, exchange format	CLO 10	T2:27.12 R1:11.8
39-40	**Compare** IGES data representations and structure, STEP architecture, implementation ACIS, DXF	CLO 10	T2:27.12 R1:11.10
41-42	**Explain** Design applications, mechanical tolerances, mass property calculations	CLO 11	T2:27.12 R1:11.10
43	**Distinguish** FEM analysis and mechanical assembly	CLO 11	T3:27.14 R1:12.3
44	**Explain** collaborative design, principles and approaches	LO 12	T2:27.12 R1:11.10
45	**Explain** the collaborative tools and design systems	CLO 12	T2:27.14 R1:12.3

XIII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs
3	Encourage students to solve real time applications of CAD	Industrial Visits	PO 2,PO 6

Prepared by:
Mr. A Venuprasad, Assistant Professor, ME

HOD, ME

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS				
Course Code	BCC002				
Programme	M.Tech				
Semester	I	CAD/CAM			
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3		
Course Coordinator	Ms. V Subba Laxmi , Assistant Professor				
Course Faculty	Ms. V Subba Laxmi , Assistant Professor				

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of manufacturing technology with the help of various processes widely employed in industries. This *course* is designed to provide students with an *overview* of a wide variety of *manufacturing processes*. The fundamental principles behind the *processes* will be discussed with the intent of providing a working knowledge of a broad range of *manufacturing processes*.

II. COURSE PRE-REQUISITES:

Level	Credits	Periods	Prerequisite	Level
PG	3	3	Numerical methods for solving linear equations,Taylor's series expansion.	PG

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Numerical methods for partial differential equations	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✘	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

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VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	2	Presentation on real-world problems
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	1	Seminar
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	3	Presentation on real-world problems
PO 4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	1	Seminar
PO 5	Write and present a substantial technical report / document.	1	Seminar
PO 6	Independently carry out research / investigation and development work to solve practical problems.	2	Assignments
PO 7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	2	Assignments

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Analyze finite difference approximation.
II	Determine partial differential equations.
III	Apply partial differential equations with approximation.

VIII. COURSE LEARNING OUTCOMES (COs):

CO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
CO 1	Classify the partial differential equations and apply finite difference methods. Solve parabolic equations by Crank-Nicholson method and using explicit formula.	PO 3 PO6,PO7	3 1
CO 2	Understand the concepts of convergence stability, consistency, Lax equation theorem. stability analysis by matrix, eigen, Von Neumann methods.	PO 3 PO6,PO7	3 1
CO 3	Solve first order quasi linear equation by analytic method and Lax Wendroff explicit method, apply method of characteristics.	PO 3 PO6,PO7	3 1
CO 4	Analyze elliptic equations and study the finite difference in polar coordinates. Study CFI condition, propagation of discontinuities	PO 3 PO6,PO7	3 1
CO 5	Apply systematic methods for large linear systems namely stones implicit method. Apply finite element method,Galerkin Formulation.	PO 3 PO6,PO7	3 1

3 = High; 2 = Medium; 1 = Low

IX.MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

(COs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1			3			1	1
CO 2			3			1	1
CO 3			3			1	1
CO 4			3			1	1
CO 5			3			1	1

3 = High; 2 = Medium; 1 = Low

IX. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2, PO 3, PO 4, PO 5, PO 6, PO 7	SEE Exams	PO 1, PO 2, PO 3, PO 4, PO 5, PO 6, PO 7	Assignments	PO 3, PO 6, PO 7	Seminars	PO 2, PO 4, PO 5
Laboratory Practices		Student Viva		Mini Project	-	Certification	-

X. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
	Assessment of Mini Projects by Experts		

XI. SYLLABUS

UNIT-I	PARABOLIC EQUATIONS	Classes:09
Introduction to finite difference formula**;** Parabolic equations: Introduction, explicit finite difference approximation to one dimensional equation, Crank-Nicholson implicit method, derivation for boundary conditions.		
UNIT-II	**CONVERGENCE STABILITY AND CONSISTENCY**	**Classes: 09**
ADI: Alternate direction implicit (ADI) method, finite difference in cylindrical and spherical polar coordinates; Convergence stability and consistency: Definitions of local truncation error and consistency convergence analysis, stability analysis by matrix method, eigen value, Von Newman stability methods, global rounding error, local truncation error Lax`s equation theorem		
UNIT-III	**HYPERBOLIC EQUATIONS**	**Classes: 09**
Analytical solution of first order quasi linear equation, numerical integration along a characteristic laxwenderoff explicit method. CFI condition Wenderoff`s implicit approximation, propagation of discontinuties, numerical solution by the method of characteristics.		

UNIT-IV	ELLIPTIC EQUATIONS	Classes: 09
Introduction, finite differences in polar co-ordinates, formulas for derivative near a curved boundary analysis of the discretization error of the five point approximation to Polman`s equation over a rectangle.		
UNIT-V	**SYSTEMATIC ITERATIVE METHODS**	**Classes: 09**
Systematic iterative methods for large linear systems, necessary and sufficient condition for convergence of iterative methods, stones implicit methods, finite element method: Weighted residual method variations methods, division of the region into elements linear element, Galerkin formulation.		

Text Books:

1. G. D. Smith, "Numerical Solution of partial differential equations, finite Differences methods", Brunel University, Clarandon Press Oxford, 3rd Edition, 1985.
2. Joe D. Hoffman, "Numerical Methods for Engineers and scientists", Tata McGraw Hill, 2nd Edition, 2001

Reference Books:

1. A. R. Mitchel and D. F. Griffiths, "The Finite Difference Methods in Partial Differential equation", John Wiley, 1st Edition, 1980.
2. Larry J. Segerlind, "Applied Finite Element Analysis", John Wiley, 2nd Edition, 1984.

XII.COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Classify partial differential equations	CO 1	T-1, T-2
2-4	Apply Finite difference formula.	CO 1	T-1, T-2
5-10	Apply Crank-Nicholson implicit method to solve Partial differential equation.	CO 1	T-1, T-2
11-13	Solve derivation for boundary conditions	CO 2	T-1
14-18	Explain alternate direction implicit (ADI) method	CO 2	T-1
19-22	Explain finite difference in cylindrical and spherical polar coordinates	CO 3	T-1
23-25	Understand the concepts of convergence stability, consistency, Lax equation theorem.	CO 3	T-1
25-30	Understand stability analysis by matrix, eigen, Von Neumann methods.	CO 3	T-1
31-35	Solve first order quasi linear elliptic equation.	CO 3	T-1
36-38	Study CFI condition, propagation of discontinuities	CO 4	T-1
39-41	Analyze of the discretization error of the five point approximation to Polman`s equation over a rectangle.	CO 4	T-1
42-44	Analyze elliptic equations and study the finite difference in polar coordinates.	CO 4	T-1
45-48	Apply systematic methods for large linear systems namely stones implicit method.	CO 5	T-2,R1:4.6
48-50	Apply finite element method,Galerkin Formulation.	CO 5	T-2,R1

XII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed Actions	Relevance with POs
1	To improve standards and analyze the concepts.	Seminars / Guest Lectures / NPTEL	PO 3
2	Encourage students to solve real time applications and prepare towards competitive examinations.	Assignments	PO 3

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MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**RAPID PROTOTYPE TECHNOLOGIES**				
Course Code	BCC003				
Programme	M.Tech				
Semester	I I				
Course Type	Core				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Course Faculty	Dr.G.V.R.Seshagiri Rao, Professor, ME				

I. COURSE OVERVIEW:

This course bridges gap between idea and production. Rapid prototyping is a group of methods used to rapidly manufacture a scale model of a physical part or assembly using three-dimensional computer aided design (CAD), Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) data. Construction of the part or assembly is usually done using 3D printing technology. Rapid prototyping techniques are often referred to solid free; computer automated manufacturing, form fabrication. This course covers the knowledge of rapid prototyping systems.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME510	VI	Additive Manufacturing techniques	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Rapid prototype technologies	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	Seminars	✔	Videos	✔	MOOCs
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into fiveunits and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	3	Presentation on Real-world problems
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	2	Projects
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	2	Assignments
PO 4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	1	Seminars
PO5	Write and present a substantial technical report / document.	3	Projects
PO6	Independently carry out research / investigation and development work to solve practical problems	2	projects
PO7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	1	Seminars

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications
II	Identify The process photopolymers, photo polymerization, layering technology, laser and laser scanning
III	Applying of measurement and scaling technique for prototype manufacturing.

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO1	Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications.	CLO 1	Identify and understand of basic concepts of Rapid prototyping technologies
		CLO 2	Understand and Apply concepts of Rapid prototyping
		CLO 3	Understand and Apply concepts of Rapid prototyping
CO2	Identify The process photopolymers, photo polymerization, layering technology, laser and laser scanning	CLO 4	Apply the concepts of prototyping technology
		CLO 5	Apply the concepts of prototyping technology
		CLO6	Understand the selection of manufacturing method

CO3	Applying of measurement and scaling technique for prototype manufacturing.	CLO 7	Identify the Layering Technology, Applications.
		CLO 8	Understand the different models and specifications
		CLO 9	Understand the different models and specifications
CO4	Identify the Rapid Prototyping Data Formats	CLO 10	Identify the Rapid Prototyping Data Formats
		CLO 11	Identify the Rapid Prototyping Data Formats
		CLO 12	Identify the Rapid Prototyping Data Formats
CO5	Application for powder based rapid prototyping systems	CLO 13	Application for powder based rapid prototyping systems
		CLO 14	Application for powder based rapid prototyping systems
		CLO 15	Application for powder based rapid prototyping systems

3 = High; 2 = Medium; 1 = Low

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BCCB13.01	CLO 1	To Study the Various Experimental Techniques.	PO 1	3
BCCB13.02	CLO 2	Involved forMeasuringDisplacements,Stresses, Strains in Structural Components	PO 1	3
BCCB13.03	CLO 3	Understand the shear force and bending moment diagrams of symmetrical beams	PO 1,PO 2	3
BCCB13.04	CLO 4	To Study the Various Experimental Techniques.	PO 1,PO 2	2
BCCB13.05	CLO 5	Involved forMeasuringDisplacements,Stresses, Strains in Structural Components	PO 2	2
BCCB13.06	CLO 6	To Study the Various ExperimentalTechniques.	PO 1,PO 2,PO 3	2
BCCB13.07	CLO 7	Involved for Measuring Displacements, Stresses, Strains in Structural Components	PO 2	1
BCCB13.08	CLO 8	Distinguish bending and shear stresses developed in beams of various sections	PO 2, PO 3	1
BCCB13.09	CLO 9	Involved forMeasuringDisplacements,Stresses, Strains in Structural Components	PO 2	2
BCCB13.10	CLO 10	Understand the shear force and bending moment diagrams of symmetrical beams	PO 1,PO 2	2
BCCB13.11	CLO 11	To Study the Various Experimental Techniques.	PO 1,PO 2,PO 3	3
BCCB13.12	CLO 12	Distinguish bending and shear stresses developed in beams of various sections	PO 3, PO 6	3
BCCB13.13	CLO 13	Distinguish bending and shear stresses developed in beams of various sections	PO 2, PO 6	3
BCCB13.14	CLO 14	To Study the Various Experimental Techniques	PO 3,PO 2	3
BCCB13.15	CLO 15	Distinguish bending and shear stresses developed in beams of various sections	PO 3, PO 6	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(COs)	Course Outcomes						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3						
CO 2	3		2	3		3	
CO 3	3	3	2	3		3	
CO 4	3	2	1	3	3	3	3
CO 5		2			2	3	2

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 1	3						
CLO 2	3						
CLO 3	3	3					
CLO 4	3	2					
CLO 5		2					
CLO 6	2	2	2				
CLO 7		1					
CLO 8		1	1				
CLO 9		2					
CLO 10	2	2					
CLO 11			3			2	
CLO 12			3			3	
CLO 13		3				3	
CLO 14		3	3				
CLO 15			1			1	

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1,PO3, PO5	SEE Exams	PO1,PO3, PO5	Seminar and Term Paper	PO1,PO2,PO3, PO5
Viva	-	Mini Project	-	Laboratory Practices	-

XIII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIV. SYLLABUS

UNIT-I	**INTRODUCTION TO RAPID PROTOTYPING**
Introduction: Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes, Process Chain.	
UNIT-II	**TYPES OF PROTOTYPING SYSTEMS**
Liquid-based Rapid Prototyping Systems: Stereo lithography Apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. solid ground curing (SGC): models and specifications, process, working principle, applications, advantages and disadvantages, case studies; solid-based Rapid Prototyping Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.	
UNIT-III	**POWDER BASED RAPID PROTOTYPING SYSTEMS AND TOOLING**
Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs. RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.	
UNIT-IV	**RAPID PROTOTYPING DATA FORMAT**
Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software"s: Features of various RP software"s like Magic"s, Mimics, Solid View, ViewExpert, 3 D View, Velocity 2 , Rhino, STL View 3 Data Expert and 3 D doctor.	
UNIT-V	**RAPID PROTOTYPING APPLICATIONS**
RP Applications: Application, Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.	
Text Books:	
Chua C.K., Leong K.F, LIM C.S, "Rapid prototyping: Principles and Applications",World Scientific publication Edition, 2010.	

Reference Books:
1. D.T Pham, S. S. Dony, "Rapid Manufacturing", Springer, 1st Edition, 2001. 2. Paul F Jacobs, "Rapid Prototyping & Manufacturing", Wohlers Associates, 2000 ASME Press, 1st Edition, 1996

XIV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
1-3	Identify and understand of basic concepts of Rapid prototyping technologies	Introduction To Rapid Prototyping, Prototyping fundamentals, Historical Development	T1, R1
4-7	Understand and Apply concepts of Rapid prototyping	Advantages And Limitations Of Rapid Prototyping, Commonly Used Terms Classification Of RP Process, Rapid Prototyping Process Chain	T1
8-11	Apply the concepts of prototyping technology	Fundamental Automated Processes, Process Chain, Types Of Prototyping Systems, Liquid-Based Rapid PrototypingSystems	T1, R2, R1
12-16	Understand the selection of manufacturingmethod	Stereo Lithography Apparatus (Sla): Models And Specifications, Process Working Principle, Photopolymers, Photo polymerization	T1
17-20	Identify the Layering Technology, Applications.	Layering Technology, Laser And Laser Scanning, Applications, Advantages And Disadvantages, Case Studies, Solid Ground Curing (Sgc)	T1,R2
21-25	Understand the different models and specifications	Models And Specifications, Process, Working Principle, Applications, Solid-Based Rapid Prototyping Systems	T1, R1
26-29	Understand and apply the Laminated Object Manufacturing	Laminated Object Manufacturing (Lom), Models And Specifications Process, Working Principle, Applications, Advantages And Disadvantages, Case Studies.	T1, R1
30-33	Understand and apply the Fused Deposition Modeling	Fused Deposition Modeling (Fdm) Models And Specifications, Process, Working Principle, Applications, Advantages And Disadvantages, Case Studies.	T1, R1

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with Pos
1	To improve standards and analyze the concepts.	Seminars	PO 1
2	Concepts related to Additive Manufacturing	Seminars / NPTEL	PO 2,PO 3
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2,PO 6,PO7

Prepared by:
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MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**PRECISION ENGINEERING**				
Course Code	**BCC201**				
Programme	M.Tech				
Semester	I	CAD/CAM			
Course Type	Elective				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	**Dr. G. Naveen Kumar, Associate Professor, ME**				

I. COURSE OVERVIEW:

The course is aimed at students from all engineering majors. Precision Engineering Design & Measurement covers the fundamental practices common to all engineering majors in making and reporting basic engineering measurements and their use in designing high precision items. Precision Engineering Design & Measurement covers the fundamental practices common to all engineering majors in making and reporting basic engineering measurements and using these measurements to design high-precision items. Students will learn about the engineering design process and commonly used engineering measurement tools as well as statistical analysis and standard uncertainty analysis methods.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME010	IV	**Machine Tools and Metrology**	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Precision Engineering	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	Seminars	✔	Videos	✔	MOOCs
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into fiveunits and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
30 %	To test the analytical skill of the concept.
20 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	3	Presentation on real-world problems
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	2	Seminar
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	2	Assignments
PO 4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	2	Seminar
PO 5	Write and present a substantial technical report / document.	1	Seminar
PO 6	Independently carry out research/investigation and development work to solve practical problems	2	Assignments
PO 7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	1	Assignments

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Comprehensive understanding of different manufacturing processes for product development.
II	Apply casting, metal joining and forming processes for various industries.
III	Select process parameters, equipment for material processing

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand various manufacturing processes used in various industries and their design principles in casting, welding forging, extrusion processes.	CLO 1	Understand various manufacturing processes used in various industries.
		CLO 2	Explain the steps involved in casting processes
		CLO 3	Use design principles to incorporate sprue,runner,gates, and risers in foundry practice.
CO 2	Understand and application of various tolerancing systems and reference datums	CLO 4	Evaluate properties of sand for use in sand casting.
		CLO 5	Solve problems and find methods to rectify casting defects.
		CLO 6	Demonstrate the preparation of moulds for various casting processes
CO 3	Explaining tolerance analysis including Cp, Cpk, kurtosis and skewness and other algebraic	CLO 7	Describe applications of various casting processes

	statistical methods.	CLO 8	Explain principles of welding, brazing and soldering processes.
		CLO 9	Demonstrate use of welding equipment for various industrial applications.
CO 4	Application of geometrical dimensional tolerancing and development of tolerancing test charts	CLO 10	Demonstrate use of Brazing and soldering equipment for various industrial applications.
		CLO 11	Explain design of welded joints, residual stresses, distortion and control.
		CLO 12	Explain causes and remedies of welding defects.
CO 5	Measurement of critical components using machines like CMM and lazer alignment and testing	CLO 13	Compare destructive and non-destructive testing techniques.
		CLO 14	Understand the effect of heat input in welds.
		CLO 15	Understand the importance of sheet metal forming, bending, and deep drawing.

IX. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BCC201.01	CLO 1	Understand various manufacturing processes used in various industries.	PO 1	3
BCC201.02	CLO 2	Explain the steps involved in casting processes	PO 1	3
BCC201.03	CLO 3	Use design principles to incorporate sprue,runner,gates, and risers in foundry practice.	PO 1	3
BCC201.04	CLO 4	Evaluate properties of sand for use in sand casting.	PO 2	2
BCC201.05	CLO 5	Solve problems and find methods to rectify casting defects.	PO 2	2
BCC201.06	CLO 6	Demonstrate the preparation of moulds for various casting processes	PO 2	2
BCC201.07	CLO 7	Describe applications of various casting processes	PO 4	1
BCC201.08	CLO 8	Explain principles of welding, brazing and soldering processes.	PO 4	1
BCC201.09	CLO 9	Demonstrate use of welding equipment for various industrial applications.	PO 5	2
BCC201.10	CLO 10	Demonstrate use of Brazing and soldering equipment for various industrial applications.	PO 5	2
BCC201.11	CLO 11	Explain design of welded joints, residual stresses, distortion and control.	PO 6	3
BCC201.12	CLO 12	Explain causes and remedies of welding defects.	PO 6	3
BCC201.13	CLO 13	Compare destructive and non-destructive testing techniques.	PO 3	3
BCC201.14	CLO 14	Understand the effect of heat input in welds.	PO 1, PO 5	3
BCC201.15	CLO 15	Understand the importance of sheet metal forming, bending, and deep drawing.	PO 7	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OFPROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(COs)	Program Outcomes (POs)			
	PO1	PO2	PO3	PO5
CO 1	1	2		
CO 2	1	2		
CO 3		3	2	
CO 4			2	2
CO 5		1	3	

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Learning Outcomes (CLOs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7
CLO 1	3	2				
CLO 2	3	2				
CLO 3		3	2			
CLO 4			2		2	
CLO 5		1	3			
CLO 6		1			2	
CLO 7			3	2		
CLO 8	3		3	2	3	
CLO 9		3				
CLO 10	3			3		
CLO 11	2	2				3
CLO 12	3				2	3
CLO 13	3		3	3		
CLO 14				3	2	
CLO 15	3		3	3		

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2, PO 3, PO 4, PO 5, PO 6, PO 7	SEE Exams	PO 1, PO 2, PO 3, PO 4, PO 5, PO 6, PO 7	Assignments	PO 3, PO 6, PO 7	Seminars	PO 2, PO 4, PO 5
Laboratory Practices	PO 3	Student Viva	PO 3	Mini Project	-	Certification	-

XIII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIV. SYLLABUS

UNIT-I	CONCEPT OF ACCURACYAND TOLERANCE ZONE CONVERSION	Classes:09
Concepts of accuracy: Introduction, concept of accuracy of machine tools,spindle and displacement accuracies, accuracy of numerical control systems, errors due to numerical interpolation displacement measurement system and velocity lags; geometric dimensioning and tolerancing: Tolerance zone conversions, surfaces, features, features of size, datum features, datum Oddly configured and curved surfaces as datum features, equalizing datums datum feature of representation; form controls, orientation controls logical approach to tolerancing		
UNIT-II	**DATUMS**	**Classes: 09**
Datum systems: Design of freedom, grouped datum systems, different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped datum system with spigot and recess pair and tongue, slot pair, computation of transnational and rotational accuracy, geometric analysis and application		
UNIT-III	**TOLERANCE ANALYSIS**	**Classes: 09**
Tolerance analysis: Process capability, mean, variance, skewness, Kurtosis, process capability metrics, Cp, Cpk, Cost aspects, feature tolerances. Geometric tolerances; surface finish, review of relationship between attainable tolerance grades and different machining process, cumulative effect of tolerances sure fit law, normal law and truncated normal law		
UNIT-IV	**TOLERANCE CHARTING TECHNIQUES**	**Classes: 09**
Tolerance charting techniques: Operation sequence for typical shaft type of components, preparation of process drawings for different operations, tolerance worksheets and centrally analysis, examples, design features to facilitate machining; datum features, functional and manufacturing components design, machining considerations, redesign for manufactured.		
UNIT-V	**MEASURING SYSTEM PROCESSING**	**Classes: 09**
In Processing or In-Situ measurement of position of processing, point-post process and on machine measurement of dimensional features and surface-mechanical and optical measuring systems; working systems of CMM; Laser alignment and testing.		
Text Books:		
1. R. L. Murthy, “Precision Engineering in Manufacturing”, New Age International limited, 1st Edition, 1996. 2. James D. Meadows, “Geometric Dimensioning and Tolerancing”, Marcel Dekker, 1st Edition, 1995.		

3. Norio Taniguchi, "Nano Technology", Oxford University Press, 1st Edition, 1996. 4. Matousek, "Engineering Design–A systematic Approach",Blackie& Son Ltd., London.
Reference Books:
1. Preumont, A., "Vibration Control of Active Structures", Kluwer Academic Publishers, 2002. 2. F. Y. Cheng, H. Jiang, K. Lou, "Smart Structures: Innovative Systems for Seismic Response Control", CRC Press, 2008.

XV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Outcomes (COs)	Reference
1-4	What are the concept of accuracy of machine tools?	CO 1	T1:3.1 R1:3.1
5-7	What is spindle and displacement accuracies, accuracy of numerical control systems?	CO 1	T1:3.2.5 R1:3.3.4
8-10	What are the errors due to numerical interpolation displacement measurement system?	CO 1	T1:3.1.5 R1:3.1.3
11-14	write about theTolerance zone conversions, surfaces, features, features of size?	CO 2	T1:9.1 R1:5.1
15-16	What is the geometric dimensioning and tolerancing?	CO 2	T1:9.2.1 R1:5.2.3
17-20	What datum features, datum Oddly configured and curved surfaces as datum features?	CO 2	T1:9.4.2 R1:5.3
21-23	What are the advantages of using equalizing datums datum feature of representation?	CO 2	R2:9.16 R2:27.5
24-26	What are the advantages of using orientation controls logical approach to tolerancing?	CO 2	R2:9.16.12 R2:27.1
27-28	Write about Design of freedom, grouped datum systems?	CO 2	R2:9.64 R2:30.2
29-30	What are the necessary conditions for the two and three mutually perpendicular grouped datum planes?	CO 3	R2:9.55 R1:29.3
31-32	What are the Grouped datum system with spigot and recess?	CO 3	T1:7.1.1 R1:4.6
33-34	Write about Grouped datum system with spigot and recess pair and tongue?	CO 3	T1:7.1 R1:3.6.1
35	What is the computation of transnational and rotational accuracy, geometric analysis and application.?	CO 3	T1:7.1.1 R1:4.6
36-37	How the Process capability, mean, variance, skewness performed?	CO 4	T1:7.2 R1:4.2
38	What is the review of relationship between attainable tolerance grades and different machining process?	CO 4	T1:8.3 R2:6.5
39	What is the cumulative effect of tolerances sure fit law, normal law and truncated normal?	CO 4	T1:8.7 R1:4.8.12
40-41	What is the Operation sequence for typical shaft type of components, preparation of process drawings for different operations?	CO 4	T1:8.4 R1:4.5
42	What is tolerance worksheets and centrally analysis?	CO 4	T1:8.9 R1:4.8.15
43-44	What is design features to facilitate machining?	CO 4	T1:8.6 R1:4.8.15
45-47	What is datum features, functional and manufacturing components design?	CO 5	T1:8.1 R1:4.8.6
48-49	Write process machining considerations, redesign for manufactured?	CO 5	T1:7.4 R1:4.4

Lecture No	Topics to be covered	Course Outcomes (COs)	Reference
50-52	Write process In Processing or In-Situ measurement of position of processing?	CO 5	T1:7.4.2 R1:4.4.1
53-55	What is point-post process and on machine measurement of dimensional features and surface-mechanical and optical measuring systems?	CO 5	T1:7.4.4 R1:4.4.2
56-57	Write about working systems of CMM?	CO 5	T1:7.3 R1:4.3

XVI. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed Actions	Relevance with POs
1	Advances in manufacturing processes	Seminars / Guest Lectures / NPTEL	PO 1, PO 2, PO 3
2	Interaction of materials and manufacturing processes	Seminars / Guest Lectures / NPTEL	PO 2, PO 5
3	Recommended practices in casting, welding, and forming	Assignments / Laboratory Practices	PO 1, PO 3, PO 4, PO 6, PO 7

Prepared by:
Dr. G. Naveen Kumar, Associate Professor

HOD, ME

INSTITUTE OF AERONAUTICAL ENGINEERING

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Dundigal, Hyderabad -500 043

Mechanical Engineering

COURSE DESCRIPTOR

Course Title	ADVANCED MECHANICS OF SOLIDS			
Course Code	**BCC206**			
Programme	**M.Tech**			
Semester	**II**			
Course Type	**Core**			
Regulation	**R16**			
Course Structure	**Theory**		**Practical**	
	Lectures	**Tutorials**	**Practical**	**Credits**
	3	**-**	**-**	**3**
Course Faculty	**Mr. U.S.P Rao , Associate Professor, ME**			

I. COURSE OVERVIEW:

Theoretical and computational concepts and techniques in continuum mechanics of deformable solids and its application to the mechanical response of machine and structural elements. Elasticity, plasticity, viscoelasticity. Finite element method. Elastic stress and analysis, plane stress and plane strain, stress concentrations. Principle of virtual work and variational theorems.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME004	III	Mechanics of Solids	4

III. MARKSDISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Advanced Mechanics Of Solids	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	Seminars	✔	Videos	✔	MOOCs
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each module carries equal weight age in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
30 %	To test the analytical skill of the concept.
20 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Technical Seminar and Term Paper.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	**CIE Exam**	**Technical Seminar and Term Paper**	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 9th and 17th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:
Two seminar presentations and the term paper with overview of topic are conducted during II semester. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		**Strength**	**Proficiency assessed by**
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	1	Term paper
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	1	Term paper and Guest Lectures
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	1	Seminar and Guest Lectures

PO 4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	2	Guest Lecturers
PO 5	Write and present a substantial technical report / document.	1	NPTEL Videos and Guest Lecturers
PO 6	Independently carry out research / investigation and development work to solve practical problems	2	MOOCs and Guest Lecturers
PO7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	1	Guest Lecturers

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES:

The course should enable the students to:

I	Understand the theory of elasticity including stress, strain, displacement and Hooke's law and strain energy Relationships.
II	Understand the shear force and bending moment diagrams of symmetrical beams
III	Distinguish bending and shear stresses developed in beams of various sections.
IV	Compare stresses in a shaft under torsion and in thin cylindrical members.
V	Compare the stress and strain relations of isotropic rectangular plates.

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	understand bending action and shear centre of symmetrical and unsymmetrical sections.	CLO 1	Outline the history of elasticity.
		CLO 2	Identify the elastic bodies and understand the behaviour of ductile and brittle materials.
		CLO 3	Understand the different coordinate systems and applications.
CO 2	pute the circumference stress and radial stress of curved beams.	CLO 4	Understand the contact stresses between plane and curved bodies.
		CLO 5	Distinguish between contact stress and normal stresses of various bodies.
CO 3	lyse torsion of hollow and solid circular cross section.	CLO 6	Understand the terminology of simple harmonic motion, natural frequency, time period and circular frequency.
		CLO 7	Understand the types of vibrations.
		CLO 8	Ability to present the natural frequency and equation of motions of rotor systems.
CO 4	pute the stress and strain relations of isotropic rectangular plates.	CLO 9	Ability to present the mathematical modelling of single degree of freedom systems and multi degree of freedom systems.
		CLO 10	Examine the mathematical modeling of lumped mass system and distributed parameter systems and understand the working principle of

			vibration absorber.
CO 5	pute the contact stresses between various bodies.	CLO 11	Understand the natural frequencies of multi degree of freedom systems.
		CLO 12	Demonstrate the mode shapes of MDOF systems.
		CLO 13	Examine the mode shapes of continuous systems and observe in ANSYS and MATLAB.

IX. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to	PO's Mapped	Strength of Mapping
BCC206.01	CLO 1	Outline the history of elasticity.	PO 1	1
BCC206.02	CLO 2	Identify the elastic bodies and understand the behavior of ductile and brittle materials.	PO 2, PO 6	1
BCC206.03	CLO 3	Understand the different coordinate systems and applications.	PO 1, PO 3	2
BCC206.04	CLO 4	Understand the contact stresses between plane and curved bodies.	PO 2, PO 6	2
BCC206.05	CLO 5	Distinguish between contact stress and normal stresses of various bodies.	PO 3	1
BCC206.06	CLO 6	Understand the terminology of simple harmonic motion, natural frequency, time period and circular frequency.	PO 1	1
BCC206.07	CLO 7	Understand the types of vibrations.	PO 1, PO 3	2
BCC206.08	CLO 8	Ability to present the natural frequency and equation of motions of rotor systems.	PO 1, PO 3	1
BCC206.09	CLO 9	Ability to present the mathematical modelling of single degree of freedom systems and multi degree of freedom systems.	PO 5, PO 6	2
BCC206.10	CLO 10	Examine the mathematical modeling of lumped mass system and distributed parameter systems and understand the working principle of vibration absorber.	PO 1, PO 6	1
BCC206.11	CLO 11	Understand the natural frequencies of multi degree of freedom systems.	PO 6, PO 7	1
BCC206.12	CLO 12	Demonstrate the mode shapes of MDOF systems.	PO 5, PO 7	2
BCC206.13	CLO 13	Examine the mode shapes of continuous systems and observe in ANSYS and MATLAB.	PO 5, PO 7	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7
CO 1	2	1	1		1	
CO 2		1	1		1	
CO 3	2		2			

CO 4	1			2	2	
CO 5				2	1	2

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Learning Outcomes (CLOs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7
CLO 1	1					
CLO 2		1			1	
CLO 3	2		1			
CLO 4		1			2	
CLO 5			1			
CLO 6	1					
CLO 7	1		2			
CLO 8	1		1			
CLO 9				2	2	
CLO 10	1				1	
CLO 11					1	1
CLO 12				2		2
CLO 13				2		2

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO1,PO3, PO5	SEE Exams	PO1,PO3, PO5	Seminar and Term Paper	PO1,PO2,PO3, PO5
Viva	-	Mini Project	-	Laboratory Practices	-

XIII. ASSESSMENT METHODOLOGIES -INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIV. SYLLABUS:

UNIT I SHEAR CENTRE
Two dimensional elasticity theory in Cartesian coordinates, plane stress problem in polar coordinates, Thick cylinders, Rotating discs, stress concentration.

UNIT II CURVED BEAM THEORY
Torsion of non-circular prismatic sections, rectangular and axi-symmetric, circular plates, introduction to Shell theory, contact stresses.
UNIT III TORSION
Single degree freedom, two degree freedom system without and with damping. Free and forced vibrations, transient vibrations.
UNIT IV THEORY OF PLATES
Transient vibrations of single and two degree freedom systems, multi-degree of freedom systems, applications of matrix methods, continuous systems.
UNIT V CONTACT STRESSES
Free and forced vibrations of strings bars and beams, principle of orthogonality, classical and energy methods.
TEXT BOOKS:
1.Arthur P. Boresi , Richard, J. Schmidt, "Advanced Mechanics of materials" wiley international, 6th Edition, 2003.
2. J. P. Den Hortog, "Advanced strength of materials", Dover Publications, 1st Edition, 2012.
3.Timoshenko, "Theory of Plates", Tata McGraw Hill, 1st Edition, 2013.
REFERENCES:
1.Stephen P. Timoshenko, S. WoinowskyKriger, "Theory of Plates and Shells", Tata McGraw Hill, 2nd Edition, 2013.
2.James. O. Seely, Smith, B. Fred, "Advanced Mechanics of materials, John Willey, 1st Edition 1967.

XV. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
1-3	Understand the basic concepts of elasticity	Two dimensional elasticity theory in Cartesian coordinate system.	T1:1.1, 1.2
4-6	Describeoverall architecture of theory of elasticity.	Plane stress problem in polar coordinates.	T1:2.1
7-9	Understand the basic concepts of contact stresses	Hertzian contact stress theory basics	T2:2.2, 2.3
10-13	Compute the contact stresses of plane and circular bodies	Contact stress calculation by using Hertzian contact stress theory.	T1:4.1, 4.2, 4.3
14-16	Understand the fundamentals of vibrations	Fundamentals of vibrations, types of vibrations, natural frequency and time period.	T1:4.2, 4.4
17-20	Understand the concepts of distributed mass and lumped mass	Calculation of natural frequencies of single degree of freedom systems such as spring mass system, simple pendulum.	T2: 5.1, 5.2
21-22	Develop mathematical models of mechanical systems	Calculate the natural frequencies of single degree of freedom and multi degree of freedom systems.	T2:6.1, 6.2, 6.4

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
23-27	Understand the working principle of vibration absorber.	Dynamic vibration absorber, calculation of vibration absorption,Resonance principle.	T2:7.2, 7.3, 7.4
28-36	Analyze the mode shapes of lumped and distributed mass parameter systems.	Mode shapes of multi degree of freedom systems.	T2:8.1, 8.3
37-40	Compute the simulations of various bodies under excitation.	Simulation of damped and undamped processes of motion of vibrations under various excitations.	T1:5.3
41-45	Understand the infinite degree of freedom systems	Free and forced vibrations of strings bars and beams	T1:5.5, 5.6, 5.7

XVI. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs
1	Modal Analysis	Seminars / Guest Lectures / NPTEL	PO 1, PO 6, PO 7
2	Vibration energy harvesting	Work Shops/ Guest Lectures / NPTEL	PO 5, PO 6

Prepared By:
Mr. U. S. P. Rao, Associate Professor

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Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**INTRODUCTION TO AEROSPACE ENGINEERING**				
Course Code	BAE701				
Programme	M. Tech				
Semester	I	ME			
Course Type	Open Elective - I				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. Vijay Kumar Madura, Assistant professor				
Course Faculty	Mr. Vijay Kumar Madura, Assistant Professor				

I. COURSE OVERVIEW:

Introduction to Aerospace engineering covers the fundamental concepts, and approaches of aerospace engineering, and are highlighted through lectures on aeronautics, astronautics, and design. Active learning aerospace modules make use of information technology. Student teams are immersed in a hands-on, lighter-than-air (LTA) vehicle design project, where they design, LTA vehicles. The connections between theory and practice are realized in the design exercises. The performance, weight, and principal characteristics of the LTA vehicles are estimated and illustrated using physics, mathematics, and chemistry known to freshmen, the emphasis being on the application of this knowledge to aerospace engineering and design rather than on exposure to new science and mathematics.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS008	II	Modern Physics	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Introduction to aerospace engineering	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	ICT / PPT	✔	Quiz	✔	Assignments	✘	MOOCs
✘	Chalk & Talk	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	Independently carry out research / investigation and development work to solve practical problems	1	Assignments
PO2	Write and present a substantial technical report/ document.	2	Assignments
PO3	Abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	2	Presentation on Real-world problems
PO4	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	-	-
PO5	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	-	-
PO6	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	-	-
PO7	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	-	-

3 = High; 2 = Medium; 1 = Low

VII. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BAE701.01	CLO 1	Understand, Identify, Study and comprehend processes that lead to solutions to a particular problem.	PO1	1
BAE701.02	CLO 2	Develop one- self to gain knowledge about current technical term which helps to extend the outputs of research.	PO2	2
BAE701.03	CLO 3	Outline performance of the output of research, development, or design.	PO2	2
BAE701.04	CLO 4	Identify, solve new problems and gain new knowledge.	PO1	1
BAE701.05	CLO 5	Understand about the performance parameters, performance in steady flight, cruise, climb, range, endurance, accelerated flight symmetric maneuvers, turns, sideslips, takeoff and landing.	PO1	1
BAE701.06	CLO 6	Getting knowledge about the theory to produce a safe, effective, economic production of aircraft.	PO3	2
BAE701.07	CLO 7	Understand the theoretical knowledge behind the design and development of aircrafts.	PO1	1
BAE701.08	CLO 8	Gain knowledge about the basic Aerodynamics, Flight mechanics and aircraft structures which are the foundation stones for knowledge based exams.	PO1	1

BAE701.09	CLO 9	Discuss the principle constituents of the transportation system involved in civil and commercial aircrafts and understanding the working of space propulsion systems.	PO3	2
BAE701.10	CLO 10	Extend the outputs of earlier research and discover good ideas for new products or improving current products.	PO3	2
BAE701.11	CLO 11	Memorize procedure and steps to keep the products working effectively.	PO3	2
BAE701.12	CLO 12	Gain knowledge about the anatomy of aircraft, helicopters, satellites and other air vehicles, and about the working importance of each component in an air vehicle.	PO1	1
BAE701.13	CLO 13	Ability to summarize the efficiency of the design in achieving the mission goal and safety of flight.	PO3	2
BAE701.14	CLO 14	Understand the impact of radiations in the outer space on the spacecrafts and satellites and safety precautions to be followed.	PO1	1
BAE701.15	CLO 15	Choose a concept or idea of technical real time problems to form solutions for the same.	PO1	1

3 = High; 2 = Medium; 1 = Low

VIII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes(CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 1	1						
CLO 2		2					
CLO 3		2					
CLO 4	1						
CLO 5	1						
CLO 6			2				
CLO 7	1						
CLO 8	1						
CLO 9			2				
CLO 10			2				
CLO 11			2				
CLO 12	1						
CLO 13			2				
CLO 14	1						
CLO 15	1						

3 = High; 2 = Medium; 1 = Low

IX. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO2, PO3	SEE Exams	PO 1, PO 2, PO 3	Assignments	PO 1, PO 2	Seminars	PO 3
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

X. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XI. SYLLABUS

UNIT-I	INTRODUCTION TO AERONAUTICS AND ASTRONAUTICS
Historical perspective of aeronautics and astronautics, anatomy of the airplane, anatomy of a space vehicle, aerodynamic forces; Parameters affecting aerodynamic forces: Dimensional analysis; Theory and experiment, wind tunnels; Atmosphere: Properties of U.S. standard atmosphere, definitions of altitude.	
UNIT-II	**ONE DIMENSIONAL FLOW IN INCOMPRESSIBLE AND COMPRESSIBLE FLUIDS, TWO DIMENSIONAL FLOW AND FINITE WING**
Continuity equation, Bernoulli's equation; Application of Bernoulli's equation: Airspeed indicators and wind tunnels, one dimensional compressible flow concepts, speed of sound, compressible flow equations in a variable-area stream tube, application to airspeed measurement, applications to channels and wind tunnels; Two dimensional flow and finite wing: Limitations of one dimensional flow equations; Theory of lift: circulation, Airfoil pressure distribution, Helmholtz vortex theorems, Simulating the wing with a vortex Line, downwash, elliptic lift distribution; Lift and drag: Momentum and energy, Slope of finite wing lift curve, verification of Prandtl wing theory, additional effects of wing vortices, search for reduced induced drag.	
UNIT-III	**VISCOUS EFFECTS, DRAG DETERMINATION, AIRFOILS, WINGS AND HIGH- LIFT SYSTEMS**
Boundary layer, boundary layer on bluff bodies, creation of circulation, laminar and turbulent boundary layers: skin friction, nature of Reynolds number, effect of turbulent boundary layer on separation; Total Incompressible drag: Parasite drag, drag due to lift, importance of aspect ratio; Compressibility drag: Prediction of drag divergence Mach number, sweptback wings, total drag. Supersonic flow: Shock waves and Mach waves, supersonic wing lift and drag, area rule, supersonic aircraft, airfoils; Wings: early airfoil development, modern airfoils, supersonic airfoils, airfoil pitching moments, effects of sweepback on lift, airfoil characteristics, airfoil selection and wing design; High-lift Devices: Airfoil maximum lift coefficient, leading and trailing edge devices, effect of sweepback, deep stall, effect of Reynolds number, propulsive lift.	
UNIT-IV	**AIRPLANE PERFORMANCE, STABILITY AND CONTROL, AEROSPACE PROPULSION**
Level flight performance, climb performance, range, endurance, energy-state approach to airplane performance, takeoff performance, landing performance; Static longitudinal stability; Dynamic longitudinal stability; Dynamic lateral stability; Control and maneuverability: Turning performance, control systems, active controls; Aerospace propulsion: Piston engines, gas turbines; Speed limitations of gas turbines: Ramjets, propellers, overall propulsion efficiency, rocket engines, rocket motor performance, propulsion- airframe integration.	

UNIT-V	AIRCRAFT STRUCTURES, HYPERSONIC FLOWS, ROCKET TRAJECTORIES AND ORBITS
Aircraft structures: Importance of structural weight and integrity, development of aircraft structures, importance of fatigue, materials, loads, weight estimation; Hypersonic flows: temperature effects, Newtonian theory; rocket trajectories, multistage rockets, escape velocity, circular orbital or satellite velocity, elliptical orbits, orbital maneuvers.	
Text Books:	
1. Newman D, "Interactive Aerospace Engineering and Design", McGraw-Hill, 1st Edition, 2002. 2. Anderson J. D, "Introduction To Flight", McGraw-Hill Education, 5th Edition,2002	
Reference Books:	
1. Kermode. A. C, "Flight without Formulae", McGraw Hill, 4th Edition, 1997. 2. Barnard R.H and Philpot. D.R, "Aircraft Flight", Pearson, 3rd Edition,2004. 3. SwattonP.J, "Flight Planning", Blackwell Publisher, 6th Edition, 2002.	

XII. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Balloons and dirigibles, heavier than air aircraft, commercial air transport.	CL01	T3 - 1.1
2	Introduction of jet aircraft, helicopters, missiles.	CL01	T3 - 1.2
3	Conquest of space, commercial use of pace, exploring solar system and beyond, a permanent presence of humans in space.	CL02	T3- 1.3
4	Earth's atmosphere, standard atmosphere, temperature extremes of space.	CL02	T1-1.6
5	Laws of gravitation, low earth orbit, microgravity, benefits of microgravity.	CL03	T1-1.8.1
6	The near earth radioactive environment. The magnetosphere. Environmental impact on spacecraft.	CL02	T1-1.8.2 R1:2.3
7	Meteoroids and micrometeoroids, space debris. Planetary environments.	CL02	T1-1.8.4
8	Anatomy of the airplane, helicopter, launch vehicles and missiles, space vehicles.	CL012	T3-1.9
9-10	Static forces and moments on the vehicle.	CL07	T2-2.1
11	Understanding engineering models aerodynamic forces on a wing, force coefficients. Generating lift.	CL010	T3-2.2
12	Moment coefficients, center of pressure, aerodynamic of wings. Sources of drag.	CL08	T2-2.4
13-14	Thrust for flight, the propeller and the jet engine, governing equations, rocket engines.	CL07	T2-3.1
15-16	Performance parameters, performance in steady flight.	CL05	T2-3.5
17-19	Cruise, climb, range, endurance, accelerated flight symmetric maneuvers, turns, sideslips, takeoff and landing.	CL05	T2-3.7.1
20-22	Flight vehicle Stability, static stability, dynamic stability. Longitudinal and lateral stability, handling qualities of the airplanes.	CL08	T2-3.73 R2:3.8
23-24	General types of construction, monocoque, semi-monocoque.	CL08	T1-3.8
25	Typical wing and fuselage structure.	CL08	T1-3.8.4
26	Metallic & non-metallic materials.	CL010	T1-3.8.5
27-28	Use of aluminum alloy, titanium, stainless steel.	CL010	T1-4.2
29-30	Use of composite materials.	CL010	T1-4.4

31-32	Basic ideas about engines, use of propeller and jets for thrust production.	CL011	T1-4.5
33	Principles of operation of rocket, types of rockets.	CL09	T1-4.6
34-35	Satellite missions, an operational satellite system, elements of satellite, satellite bus subsystems.	CL013	T1-4.7.1
36	Satellite structures, mechanisms and materials.	CL014	T1-4.9
37-39	Propulsion and station keeping. Space missions. Mission objectives. Case studies.	CL011	T1-5.1.1
40-41	Communication and telemetry. Thermal control. Attitude determination and control.	CL015	T1-5.2
42	Goals of human space flight missions. Historical background. The Soviet and US missions.	CL02	T1-5.3
43-44	The Mercury, Gemini, Apollo (manned flight to the moon), Skylab, Apollo-Soyuz, Space Shuttle. International Space Station, extravehicular activity.	CL02	T1-5.6 R2:6.5
45	The space suit. The US and Russian designs. Life support systems. Flight safety.	CL02	T1-5.7

XIII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs
1	Gain information about lift augmentation devices and control surfaces	Seminars / Guest Lectures / NPTEL	PO 1, PO 3

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**RENEWABLE ENERGY SYSTEMS**				
Course Code	**BPE701**				
Programme	M.Tech				
Semester	I	**CAD / CAM**			
Course Type	**Open Elective**				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	3
Course Faculty	Mr. G. Sarat Raju, Assistant Professor , ME				

I. COURSEOVERVIEW:

Renewable resources include solar energy, wind, falling water, the heat of the earth (geothermal), plant materials (biomass), waves, ocean currents, temperature differences in the oceans and the energy of the tides. Renewable energy technologies produce power, heat or mechanical energy by converting those resources either to electricity or to motive power. The policy maker concerned with development of the national grid system will focus on those resources that have established themselves commercially and are cost effective for on-grid applications.

II. .COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
PG	**BPE701**	I	Engineering Physics, theromdynamics	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Personality development through life enlightenment skills	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✔	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATIONMETHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weight age in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1)

Component	**Theory**	**Total Marks**
Type of Assessment	CIE Exam	
CIA Marks	30	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8thand 16thweek of the semester respectively. The CIE exam is conducted for 30 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

VI. HOW PROGRAM OUTCOMES AREASSESSED:

Program Outcomes (POs)		**Strength**	**Proficiency assessed by**
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	1	Assignments

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	1	Seminar
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	2	Assignments
PO 4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	1	Seminar
PO 5	Write and present a substantial technical report / document.	1	Seminar
PO 6	Independently carry out research/investigation and development work to solve practical problems	2	Assignments
PO 7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	1	Assignments

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES :

The course should enable the students to:	
I	Illustrate the concept of photo voltaic power generation.
II	Discuss the Magneto hydrodynamic (MHD) and wind energy power conversion systems.
III	Explain tidal and wave energy.
IV	Design energy conversion systems with low impact on environment.
V	Understand the technology of fuel cells.

VIII. COURSE OUTCOMES(COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	To understand different ways for photovoltaic power generation .	CLO 1	To study the photovoltaic power generation methods
		CLO 2	To understand the solar cell performance
		CLO 3	To study applications of super conducting materials in electrical equipment system
CO 2	To understand the principle of MHD generation.	CLO 4	To understand the Principles of MHD power generation
		CLO 5	Distinguish different types of wind turbines

CO 3	Explain different ways of TIDAL and WAVE energy.	CLO 6	To study turbines and generators for tidal Power generation.
		CLO 7	To understand the power generation by waves
		CLO 8	To understand the ocean thermal energy conversion systems
CO 4	To understand the different environmental effects.	CLO 9	To study thermo electric energy conversion.
		CLO 10	To study about the environmental effects.
CO 5	Identify different types of fuel cells	CLO 11	Distinguish between different fuel cells
		CLO 12	To understand the description of batteries

IX. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BPE701.01	CLO 1	To study the photovoltaic power generation methods	PO4	2
BPE701.02	CLO 2	To understand the solar cell performance	PO5	1
BPE701.03	CLO 3	To study applications of super conducting materials in electrical equipment system	PO6	1
BPE701.04	CLO 4	To understand the Principles of MHD power generation	PO4	1
BPE701.05	CLO 5	Distinguish different types of wind turbines	PO5, PO6	1
BPE701.06	CLO 6	To study turbines and generators for tidal Power generation.	PO4, PO5	2
BPE701.07	CLO 7	To understand the power generation by waves	PO6, PO7	1
BPE701.08	CLO 8	To understand the ocean thermal energy conversion systems	PO7,PO5	2
BPE701.09	CLO 9	To study thermo electric energy conversion.	PO4	1
BPE701.10	CLO 10	To study about the environmental effects.	PO7	1
BPE701.11	CLO 11	Distinguish between different fuel cells	PO5	1
BPE701.12	CLO 12	To understand the description of batteries	PO6	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Learning Outcomes (CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1				2		1	
CO 2	1				2	1	
CO 3					1		1

CO 4			2		1	1	
CO 5							1

XI. MAPPING COURSE LEARING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUT COMES

Course Learning Outcomes (CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 1				2			
CLO 2					1		
CLO 3						1	
CLO 4				1			
CLO 5					1	1	
CLO 6				2	2		
CLO 7						1	1
CLO 8					2		2
CLO 9				1			
CLO 10							1
CLO 11					1		
CLO 12						2	

XII. ASSESSMENT METHODOLOGIES -DIRECT

CIE Exams	PO1 PO2 PO 3	SEE Exams	PO1 PO2 PO 3	Assignments	-	Seminars	PO3, PO4
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIII. ASSESSMENT METHODOLOGIES -INDIRECT

✔	Assessment of course outcomes (by feedback, once)	✔	Student feedback on faculty (twice)
✘	Assessment of mini projects by experts		

XIV. SYLLABUS:

UNIT-I	PHOTOVOLTAIC POWER GENERATION SYSTEMS	Classes: 09
Photo voltaic power generation: spectral distribution of energy in solar radiation, solar cell configurations, voltage developed by solar cell, photo current and load current, practical solar cell performance, commercial photo voltaic systems, test specifications for PV systems, applications of super conducting materials in electrical equipment systems.		

UNIT-II	**MHD WIND ENERGY CONVERSION AND WIND POWER GENERATION**	**Classes:10**
Principles of MHD power generation, ideal MHD generator performance, practical MHD generator, MHD technology; Wind Energy conversion: Power from wind, properties of air and wind, types of wind turbines, operating characteristics.		
UNIT-III	**TIDAL AND WAVE ENERGY CONVERSION**	**Classes:08**
Tides and tidal power stations, modes of operation, tidal project examples, turbines and generators for tidal power generation. Wave energy conversion: Properties of waves, power content, vertex motion of waves, device applications, types of ocean thermal energy conversion systems application of OTEC systems examples.		
UNIT-IV	**ENERGY CONVERSION SYSTEMS AND ENVIRONMENTAL EFFECTS**	**Classes:09**
Miscellaneous energy conversion systems: coal gasification and liquefaction, biomass conversion, geothermal energy, thermo electric energy conversion, principles of EMF generation, co generation and energy storage, combined cycle co generation, energy storage; Global energy position and environmental effects: energy units, global energy position.		
UNIT-V	**FUEL CELLS**	**Classes:09**
Fuel cells: Types of fuel cells, H_2O_2 Fuel cells, application of fuel cells, batteries, description of batteries, battery application for large power, environmental effects of energy conversion systems.		

Text Books:

1. Ashok Desai V, Non-Conventional Energy, Wiley Eastern Ltd, 1990.
2. Rakosh das Begamudre, "Energy conversion systems", New age International publishers, New Delhi - 2000.
3. Freris L.L. Prentice Hall1, "Wind energy Conversion Systems", 1990.
4. Spera D.A., "Wind Turbine Technology: Fundamental concepts of wind turbine technology", ASME Press, NY, 1994.

Reference Books:

1. Mittal K.M, Non-Conventional Energy Systems, Wheeler Publishing Co. Ltd, 1997.
2. Ramesh R, Kurnar K.U, Renewable Energy Technologies, Narosa Publishing House, New Delhi, 1997.
3. John Twidell, Tony Weir "Renewable Energy Resources", 2nd edition.
4. Kreith, Kreider, "Solar Energy Handbook", McGrawHill

Web References:

1. http://www.nrel.gov/docs/fy13osti/54909.pdf
2. http://www.gisday.com/resources/ebooks/renewable-energy.pdf
3. http://www.geni.org/globalenergy/library/energytrends/currentusage/renewable/Renewable-Energy- Potential-for-India.pdf
4. http://www.cerien.upc.edu/jornades/jiie2005/ponencies/power%20converters%20and%20control%20of%2 0renewable%20energy%20systems%20paper.pdf
5. https://www.irena.org/DocumentDownloads/Publications/RE_Technologies_Cost_ Analysis- SOLAR_PV.pdf

E-Text Books:

1. http://maxwell.sze.hu/~marcsa/MegujuloEnergiaforrasok/Books/renewable%20energy%20resources.pdf
2. http://lab.fs.uni-lj.si/kes/erasmus/Renewable%20Energy%20Conversion,%20Transmission,%20and%20Storage.pdf
3. http://www.landartgenerator.org/LAGI-FieldGuideRenewableEnergy-ed1.pdf

XV. COURSEPLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No.	Topics to be covered	Reference
1-2	Photo voltaic power generation	T1:ch1:19-20 verses
3-4	spectral distribution of energy in solar radiation, solar cell configurations	T1:ch1:21-22 verses
5-6	voltage developed by solar cell	T1:ch1:23-25 verses
7-8	photo current and load current	T1:ch1:29-32 verses
9-10	practical solar cell performance, commercial photo voltaic systems	T1:ch1:26-28
10-11	test specifications for PV systems	T1:ch1: 63-65 verses
12-13	Applications of super conducting materials in electrical equipment systems.	T1:ch1:52-55 verses
14-15	Principles of MHD power generation	T1:ch1:56-59 verses

15-16	ideal MHD generator performance	T1:ch1:60-63verses
17-18	practical MHD generator	T1:ch1:52-59 verses
19-20	MHD technology; Wind Energy conversion	T1:ch1:71-78 verses
21-22	Power from wind, properties of air and wind	T1:ch2:41-44
23-24	types of wind turbines,	T1:ch2:45-48
25-26	Operating characteristics.	T1:ch3:13 verses
27-28	Tides and tidal power stations	T1:ch3:21,27 verses
29-30	modes of operation, tidal project examples	T1:ch3:35 verses
31-40	Turbines and generators for tidal power generation.	T1:ch6: 5verses
41-42	Wave energy conversion	T1:ch6: 13verses
43-44	Properties of waves, power content	T1:ch6: 17verses
45-46	vertex motion of waves, device applications	T1:ch6: 23 verses
47-48	Types of ocean thermal energy conversion systems application OTEC systems examples.	T1:ch6: 35verses
49-50	Miscellaneous energy conversion systems	T1:ch7: 30verses
51-52	coal gasification and liquefaction, biomass conversion	T1:ch7: 32verses
52-53	Geothermal energy, thermo electric energy conversion	T1:ch18:45 verses
54-55	principles of EMF generation, co generation and energy storage	T1:ch18:48 verses
56-57	combined cycle co generation, energy storage	T1:ch19:40 verses
58-59	Fuel cells: Types of fuel cells, H2O2 Fuel cells	T1:ch19:42 verses
60-61	application of fuel cells, batteries, description of batteries	T1:ch20:21 verses
62-63	battery application for large power	T1:ch20:26 verses
64-65	environmental effects of energy conversion systems	T1:ch20:45 verses

XIII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSIONREQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs
1	To improve standards and analyze the concepts	Seminars / NPTEL	PO 4
2	Encourage students to solve real time problems	Seminars / NPTEL	PO 5, PO 6

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPUTER AIDED DESIGN LABORATORY**			
Course Code	BCCB09			
Programme	M.Tech (CAD/CAM)			
Semester	I	ME		
Course Type	Core			
Regulation	IARE - R16			
	Lectures	**Tutorials**	**Practical**	**Credits**
	-	-	3	2
Course Faculty	Dr. K CH APPARAO, Associate Professor			

I. COURSE OVERVIEW:

The course is aimed at giving exposure to and enhancing the knowledge and skills of fresh graduate engineers and engineers involved in the operational use of CNC machines. CAD helps the user to design and build simple or complex products, assemblies, and plants. At first they were very expensive and hard to learn. Nowadays, with the advent of fast personal computers, user friendly GUI interfaces, and much more efficient calculation algorithms, CAD/CAM has become a household name in the engineering and manufacturing field. In fact, because of these tools, an engineer has become a designer, eliminating the need for a full time drafter.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
PG	BCCB09	I	Computer Aided Design Laboratory	2

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Computer Aided Design Laboratory	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	CHALK & TALK	✔	VIVA	✘	ASSIGNMENTS	✘	Moocs
✔	LCD / PPT	✘	SEMINARS	✘	MINI PROJECT	✘	VIDEOS
✘	OPEN ENDED EXPERIMENTS						

V. EVALUATION METHODOLOGY:

Continuous internal assessment (CIA):

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, with 20 marks for day to day evaluation and 10 marks for Internal Examination (CIE).

Semester End Examination (SEE):

The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the this courses is contains 12 experiments. The question paper pattern is as follows: Two full questions with 'either' 'or' choice will be drawn from each set. Each set contains 4 questions.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 10 marks for Continuous Internal Examination (CIE), 20 marks for Day to Day Evaluation.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Day to Day Evaluation	
CIA Marks	10	20	30

Continuous Internal Examination (CIE):

Two CIE exam shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration consisting of two sets.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		**Strength**	**Proficiency assessed by**
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	3	Lab related Exercises
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	3	Lab related Exercises
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	3	Lab related Exercises
PO 6	Independently carry out research/investigation and development work to solve practical problems	2	Lab related Exercises

3= High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Understanding the basic modern trends in design and manufacturing using CAD/CAM.
II	Learn Computer application in various manufacturing process and use of computer in manufacturing.
III	Advanced aspects of enabling computer aided technologies used in design.
IV	Solve design problem of mechanical part or components
V	Understanding and application of thermal analysis software for different parts

VIII. COURSE OUTCOMES (COs):

CO Code	CO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BCCB09.01	CO 1	Draw complex geometries of machine components in sketcher mode.	PO1	3
BCCB09.02	CO 2	Write programs to generate analytical and synthetic curves used in engineering practice.	PO1 PO2	3
BCCB09.03	CO 3	Generate Freeform shapes in party mode to visualize components.	PO1 PO3	3
BCCB09.04	CO 4	Create complex engineering assemblies using appropriate assembly constraints.	PO6	2
BCCB09.05	CO 5	Understanding and application of thermal analysis software for different parts	PO1 PO3	3

3= High; 2 = Medium; 1 = Low

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes (COs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3						
CO 2	3	3					
CO 3	3		3				
CO 4						2	
CO 5	3		3				

3= High; 2 = Medium; 1 = Low

X. ASSESSMENT METHODOLOGIES–DIRECT:

CIE Exams	PO 1, PO 2, PO 3	SEE Exams	PO 1, PO 2, PO 3	Assignments	-	Seminars	-
Laboratory Practices	PO 1, PO 2, PO 3	Student Viva	PO 1, PO 2, PO 3, PO 6	Mini Project	-	Certification	-
Term Paper	-						

XI. ASSESSMENT METHODOLOGIES–INDIRECT:

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XII. SYLLABUS:

S No.	Experiment
1	PART AND ASSEMBLY MODELING OF PIPEVICE Construct the Drawing of VICE BODY
2	Construct the Drawing of SCREW ROD
3	Construct the Drawing of CUP
4	Construct the Drawing of SET SCREW
5	Construct the Drawing of Movable JAW and ROD
6	Construct the Drawing of Movable ROD
7	Assembly modeling of PIPEVICE
8	Static Analysis of Thick Cylinder
9	Stress Analysis of Rotating disc
10	Buckling Analysis of Pates
11	Large Deflection Analysis of Circular plate
12	Analysis of a Composite Plate

XIII. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No.	Learning Objectives	Topics to be covered
1-3	Overview of Computer Aided Design	Creation of working drawing, creating geometry, constraining the profile.
4-6	Understanding and applying the different types of CAD tools.	Extracting a part using tools, creating pattern of holes, translating rotating, mirroring, managing the specification tree.
7-9	Describe and identify the parts, to choose the functions and operations of a CAD system and draw up specifications	Creating sheets and views, creating text and dimensions.
10-12	Understand the keypad structure and Identify the type of materials of parts	Creating an assembly, moving components, assembling existing components, creating bill of materials,
13-15	Understand the shape design and use of sweep tools	Creating wire frame and surface geometry using generative shape design and sweep tools.
16-18	Understand the types of patches	Generation of Ferguson"s cubic surface patches, Bezier surface patches. Coons patch, import and export of drawing from other software.
19-21	Understanding the application of software , import and export of drawing	Coons patch, import and export of drawing from other software

Lecture No.	Learning Objectives	Topics to be covered
22-24	Understanding and applying the different analytical modes	Linear static analysis, automatic calculation of rigid body modes, uses specified eigen value shift, lumped and consistent mass matrices.
25-27	Understand the concepts of analytical techniques.	Buckling analysis, jacobi inverse iteration techniques, steady state harmonic response, mode superposition method, overall structural and damping.
28-30	Understand the concept of different dynamic and heat transfer analysis	Linear dynamic analysis, non linear static analysis, non-linear dynamic analysis. Steady state heat transfer analysis problems.
31-33	Understand the concept thermal analysis.	Transient heat transfer analysis, Familiarity with element library.
34-36	Understand and applying the thermal analysis software for result analysis.	Defining Boundary conditions, multipoint constraint familiarity with different types of loads. Results and analysis. Design optimization.
37-39	Internal Lab Exam	CIE-I

Prepared by:
Dr. K. CH Apparao, Professor

HOD, ME

II SEMESTER

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

Mechanical Engineering

COURSE DESCRIPTOR

Course Title	**COMPUTER AIDED PROCESS PLANNING**			
Course Code	**BCC208**			
Programme	**M. Tech (CAD/CAM)**			
Semester	**II**			
Course Type	**Core**			
Regulation	**R16**			
Course Structure	**Theory**		**Practical**	
	Lectures	**Tutorials**	**Practicals**	**Credits**
	3	**-**	**-**	**3**
Course Faculty	**Mr. M. Sunil Kumar, Assistant Professor**			

I. COURSE OVERVIEW:

Process planning translates design information into the process steps and instructions to efficiently and effectively manufacture products. As the design process is supported by many computer-aided tools, computer-aided process planning (CAPP) has evolved to simplify and improve process planning and achieve more effective use of manufacturing resources.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
PG	BCC001	I	Advanced CAD	3

III. MARKS DISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Computer Aided Process Planning	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	Seminars	✔	Videos	✔	MOOCs
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each module carries equal weight age in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
30 %	To test the analytical skill of the concept.
20 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Technical Seminar and Term Paper.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	**CIE Exam**	**Technical Seminar and Term Paper**	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 9th and 17th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:
Two seminar presentations and the term paper with overview of topic are conducted during II semester. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		**Strength**	**Proficiency assessed by**
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues	1	Term paper
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields	1	Term paper and Guest Lectures
PO 5	Write and present a substantial technical report / document	2	Guest Lecturers

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES:

The course should enable the students to:

Understanding the basic concepts of Computer Aided Process Planning
Applying the Computer Aided Process Planning in automation
Understanding the fundamental theories and technologies in Computer Aided Process Planning

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Generate the structure of automated process planning system and uses the principle of generative and retrieval CAPP systems for automation	CLO 1	Generate the structure of automated process planning system
		CLO 2	Uses the principle of generative
		CLO 3	Retrieval CAPP systems for automation
CO 2	Select the manufacturing sequence and explains the reduction of total set up cost for a particular sequence	CLO 4	Select the manufacturing sequence
		CLO 5	Reduction of total set up cost for a particular sequence
CO 3	Predict the effect of machining parameters on production rate, cost and surface quality and determines the manufacturing tolerances	CLO 6	Production rate of machining parameters
		CLO 7	Surface quality determination
		CLO 8	Determines the manufacturing tolerances
CO 4	Explain the generation of tool path and solve optimization models of machining processes	CLO 9	The generation of tool path
		CLO 10	Solve optimization models of machining processes
CO 5	Create awareness about the implementation techniques for CAPP	CLO 11	Implementation techniques for CAPP: MIPLAN system, Computer programming languages for CAPP
		CLO 12	Criteria for selecting a CAPP system and benefits of CAPP
		CLO 13	**Criteria** for selecting of capacity planning system

IX. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to	PO's Mapped	Strength of Mapping
BCS005.01	CLO 1	Generate the structure of automated process planning system	PO 1	1
BCS005.02	CLO 2	Uses the principle of generative	PO 2	1
BCS005.03	CLO 3	Retrieval CAPP systems for automation	PO 1	2
BCS005.04	CLO 4	Select the manufacturing sequence	PO 2	2

BCS005.05	CLO 5	Reduction of total set up cost for a particular sequence	PO2	1
BCS005.06	CLO 6	Production rate of machining parameters	PO 1	1
BCS005.07	CLO 7	Surface quality determination	PO 1	2
BCS005.08	CLO 8	Determines the manufacturing tolerances	PO 1	1
BCS005.09	CLO 9	The generation of tool path	PO 5	2
BCS005.10	CLO 10	Solve optimization models of machining processes	PO 1	1
BCS005.11	CLO 11	Implementation techniques for CAPP: MIPLAN system, Computer programming languages for CAPP	PO 1, PO 5	1
BCS005.12	CLO 12	Criteria for selecting a CAPP system and benefits of CAPP	PO 5	2
BCS005.13	CLO 13	**Criteria** for selecting of capacity planning system	PO 5	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7
CO 1	2	1				
CO 2		1				
CO 3	2					
CO 4	1			2		
CO 5				2		

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Learning Outcomes (CLOs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7
CLO 1	1					
CLO 2		1				
CLO 3	2					
CLO 4		2				
CLO 5		1				

CLO 6		1				
CLO 7	2					
CLO 8	1					
CLO 9				2		
CLO 10	1					
CLO 11	1			1		
CLO 12				2		
CLO 13				2		

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO1, PO2, PO5	SEE Exams	PO1, PO2, PO5	Seminar and Term Paper	PO1, PO2, PO5
Viva	-	Mini Project	-	Laboratory Practices	-

XIII. ASSESSMENT METHODOLOGIES -INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIV. SYLLABUS:

UNIT I INTRODUCTION TO CAPP
Information requirement for process planning system, role of process planning, advantages of conventional process planning over CAPP, structure of automated process planning system, feature recognition, methods; Generative CAPP system: Importance, principle of generative CAPP system, automation of logical decisions, knowledge based systems, inference engine, implementation, benefits.
UNIT II RETRIEVAL CAPP SYSTEM AND SELECTION OF MANUFACTURING SEQUENCE
Significance, group technology, structure, relative advantages, implementation, and applications: Selection of manufacturing sequence: Significance, alternative manufacturing processes, reduction of total set up cost for a particular sequence, quantitative methods for optimal selection.
UNIT III DETERMINATION OF MACHINING PARAMETERS
Reasons for optimal selection of machining parameters, effect of parameters on production i-ate, cost and surface quality. Different approaches, advantages of mathematical approach over conventional approach, solving optimization models of machining processes.
UNIT IV DETERMINATION OF MANUFACTURING TOLERANCES
Design tolerances, manufacturing tolerances, methods of tolerance allocation, sequential approach, integration of design and manufacturing tolerances, advantages of integrated approach over sequential approach.
UNIT V GENERATION OF TOOL PATH AND IMPLEMENTATION TECHNIQUE FOR CAPP
Simulation of machining processes, NC tool path generation, graphical implementation, determination of optimal index positions for executing fixed sequence, quantitative method; Implementation techniques for CAPP: MIPLAN system, computer programming languages tbr CAPP, criteria for selecting a CAPP system and benefits of CAPP, computer integrated planning systems, and capacity planning system.

TEXT BOOKS:
1. Mikell P. Groover "Automation Production systems and Computer Integrated Manufacturing System", 3 rd Edition, 2013.
2. Sadhu Singh, "Computer Design and Manufacturing", S.K. Kataria & Sons, 1st Edition, 2013.
REFERENCES:
1. Chang, T. C, Wysk, R. A, "An Introduction to Automated Process Planning", Prentice, 1st Edition, 1985.
2. Gallagher, C. C, Knight, W. A., "Group Technology: Production Method in Manufacturing", Ellis Horewood, 1st Edition, 1986
3. Nilsson, N. J., "Principles of Artificial Intelligence", Springer, 1st Edition, 1982.
4. Cornelius, L.T, "Computer Aided and Integrated Manufacturing Systems: Manufacturing Processes" World scientific, 1st Edition, 2003.

XV. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
1-3	Understand the requirement for process planning system, role of process planning, advantages of conventional process planning over CAPP	Information requirement for process planning system, role of process planning, advantages of conventional process planning over CAPP	T1:1.1, 1.2
4-6	**Describe** overall process planning system, feature recognition, methods; Generative CAPP system	Introduction to Views structure of automated process planning system, feature recognition, methods; Generative CAPP system	T1:2.1
7-9	Understand the principle of generative CAPP system, automation of logical decisions, knowledge based systems, inference engine, implementation, benefits.	Importance, principle of generative CAPP system, automation of logical decisions, knowledge based systems, inference engine, implementation, benefits.	T2:2.2, 2.3
10-13	Understand the basic concepts of group technology, structure, relative advantages, implementation, and applications	Introduction to Significance, group technology, structure, relative advantages, implementation, and applications	T1:4.1, 4.2, 4.3
14-16	Implementing the concept of Selection of manufacturing sequence: Significance, alternative manufacturing processes	Selection of manufacturing sequence: Significance, alternative manufacturing processes	T1:4.2, 4.4
17-20	Understand the concepts of total set up cost for a particular sequence, quantitative methods for optimal selection..	Reduction of total set up cost for a particular sequence, quantitative methods for optimal selection.	T2: 5.1, 5.2
21-22	Understand the concepts of optimal selection of machining parameters, effect of parameters on production i-ate, cost and surface quality..	Reasons for optimal selection of machining parameters, effect of parameters on production i-ate, cost and surface quality.	T2:6.1, 6.2, 6.4
23-27	Develop and execute solutions to solve real-time applications using optimization models of machining processes	Different approaches, advantages of mathematical approach over conventional approach, solving optimization models of machining processes.	T2:7.2, 7.3, 7.4

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
28-36	Evaluate manufacturing tolerances, methods of tolerance allocation, sequential approach	Design tolerances, manufacturing tolerances, methods of tolerance allocation, sequential approach	T2:8.1, 8.3
37-40	Understand the Integration of design and manufacturing tolerances, advantages of integrated approach over sequential approach.	Integration of design and manufacturing tolerances, advantages of integrated approach over sequential approach.	T1:5.3
41-45	Understanding the concept of NC tool path generation, graphical implementation, determination of optimal index positions for executing fixed sequence, quantitative method	Simulation of machining processes, NC tool path generation, graphical implementation, determination of optimal index positions for executing fixed sequence, quantitative method	T1:5.5, 5.6, 5.7
46-49	Understanding the concept of MIPLAN system, computer programming languages tbr CAPP, criteria for selecting a CAPP system and benefits of CAPP, computer integrated planning systems, and capacity planning system	CAPP: MIPLAN system, computer programming languages tbr CAPP, criteria for selecting a CAPP system and benefits of CAPP, computer integrated planning systems, and capacity planning system.	T1:5.5, 5.6, 5.7

XVI. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs
1	Graphical implementation, determination of optimal index positions for executing fixed sequence	Revised version	PO 1, PO 6, PO 7
2	optimal selection of machining parameters in detail	Revised version	PO 5, PO 6

Prepared By:
Mr. M. Sunil Kumar, Assistant Professor

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INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	Design of Hydraulic and Pneumatic System				
Course Code	BCC004				
Programme	M.Tech				
Semester	II	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. Vijay Kumar Madura, Assistant professor				
Course Faculty	Mr. Vijay Kumar Madura, Assistant professor				

I. COURSEOVERVIEW:

This course provides students with an introduction to principal concepts and methods of fluid mechanics. Topics covered in the course include pressure, hydrostatics, and buoyancy; open systems and control volume analysis; mass conservation and momentum conservation for moving fluids; viscous fluid flows, flow through pipes; dimensional analysis; boundary layers, and lift and drag on objects. Students will work to formulate the models necessary to study, analyze, and design fluid systems through the application of these concepts, and to develop the problem solving skills essential to good engineering practice of fluid mechanics in practical applications

II. COURSEPRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	BCC004	IV	Mechanics of fluids and hydraulic machines	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Design of Hydraulic and Pneumatic System	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONALMETHODOLOGIES:

✔	ICT / PPT	✔	Quiz	✔	Assignments	✘	MOOCs
✘	Chalk & Talk	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATIONMETHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8thand 16thweek of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES AREASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	1	Assignments
PO2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	2	Assignments
PO3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	3	Seminars
PO4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	2	Presentation on Real-world problems
PO5	Write and present a substantial technical report / document.	-	-
PO6	Independently carry out research / investigation and development work to solve practical problems	-	-
PO7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	-	-

3 = High; 2 = Medium; 1 = Low

VII. COURSE OUTCOMES(COs):

CLO Code	CO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BCC004.01	CO 1	Define fluid kinematics and classification of flows, concepts of stream function and velocity potential function which provides solution for velocity and acceleration of fluid flow in real time applications.	PO 1	1
BCC004.02	CO 2	Explain one dimensional, two dimensional flows in wind tunnel with classification of both compressible and in compressible flows in continuity equation.	PO 1, PO 3	2
BCC004.03	CO 3	Design of hydraulic power packs and circuit diagrams long with the hydraulic elements and circuits	PO 1, PO 3	2
BCC004.04	CO 4	Development of hydraulic and pneumatic circuits with applications for low cost automations and industrial applications	PO 1, PO 2, PO 4	3
BCC004.05	CO 5	Integration of hydraulic and pneumatic circuits with program logic circuit automations and trouble shooting	PO 1, PO 3	2

3 = High; 2 = Medium; 1 = Low

VIII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFICOUTCOMES:

Course Learning Outcomes(CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 1	1						
CLO 2	2		2				
CLO 3	2		2				
CLO 4	3	3		3			
CLO 5	2		2				

IX. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO 1, PO2 PO 3, PO4	SEE Exams	PO 1, PO2 PO 3, PO 4	Assignments	PO 1, PO2	Seminars	PO 3
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-

X. ASSESSMENT METHODOLOGIES -INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XI. SYLLABUS

UNIT-I	OIL AND HYDRAULIC SYSTEMS
Introduction, history of fluid power, Pascal's law, Bramah's Press, Bernoulli's principle, Toricelli principle, fluid principle, fluid properties, viscosity, effect of temperature, dust and decay of oils, basic systems of hydraulic, physical units of fluid power, units of measurement, types of hydraulic fluid and selection criteria, properties of hydraulic fluid, physical characteristic, maintenance of hydraulic oils, oil hydraulic element and their representation in the circuits, comparison of mechanical, electrical, hydraulic and pneumatic systems for force and motion, analysis in automation.	
UNIT-II	**HYDRAULIC PUMPS**
Classification of pumps, gear pump, types of gear pumps, screw pump, vane pump, types of vane pumps, piston pump, bent axis in line piston pump, internal and external gear pumps, selection and sizing specification of pumps, specification of pumps, pump and pressure pulsation, flow rate and power of hydraulic pump, power and pump efficiencies, pressure, flow efficiencies, oil compatibility, size, noise, pump ripple, checklist; Actuators, design of linear actuator, cushioning, seals, mounting details, piston rod diameter and its effect on the pressure, servo controlled valves, hydraulic balanced circuits, sequencing and synchronizing circuits, rotary actuators.	
UNIT-III	**HYDRAULIC POWER PACK**
Element of power pack, design of hydraulic power pack, line pressure, discharge and motor. Selection, power pack size and capacity, importance of pressure relief valve and safety systems, heating and cooling systems for hydraulic power pack.	

UNIT-IV	HYDRAULIC CIRCUITS AND ACCUMULATOR
Hydaulic circuits, manual or automatic hydraulic system, regenerative circuit, use of check valves in hydraulic circuit, selection of pump, standard in circuit circuit diagram representation, sequencing and synchronizing circuits; accumulator, low cost automation; meter-in circuit, meter-out circuit, bleed-off circuit, direction control valves, solenoid valves, flow control and pressure control valves, pressure compensation, accumulator.	
UNIT-V	**AUTOMATION**
Hydraulic and pneumatic equipment in automation, low cost automation, relay circuit, programmable logic circuit, automation, micro controller; maintenance and troubleshooting of hydraulic and pneumatic circuit.	
Text Books:	
1. S. R. Majumdar, "Oil Hydraulic Systems", Tata McGraw Hill, 1st Edition,2013. 2. S. R. Majumdar, "Pneumatic Systems, Principles &maintaianance", Tata McGraw Hill, 1stEdition,2013.	
Reference Books:	
1. Andrew Parr, "Hydraulic & Pneumatic", Butterworth-Heinemann Ltd, 2nd Edition,2013. 2. Antony Esponssito, "Fluid Power with applications", Prentice Hall, 5th Edition,2015.	

XII. COURSEPLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Outline of various units	CLO 1	T1:1.4 R1:1.2
2-5	Explain the fluid properties	CLO 1	T1:1.5 R1:2.4
6-7	Distinguish various pressures	CLO 1	T1:2.5 R1:2.5
8-10	Determine the pressure with different instruments	CLO 1	T1:2.5 R1:2.6
11-12	Differentiate various flow lines	CLO 4	T1:22.7
13-14	Classify and describe various flows	CLO 6	T1:6.3 R1:5.3
15-16	Formulate continuity equation for 1 and 3-d flow	CLO 7	T1:6.6 R1:5.3.6
18	List various forces	CLO 7	R1:6.2
19-20	Formulate Euler's and Bernoulli's equations	CLO 7	T1:7.5 R1:6.3
21-22	Apply momentum equation for a pipe bend	CLO 7	T1:8.5 R1:6.8
23	Define boundary layer	CLO 7	T1:12.2 R1:13.1
24-25	Distinguish boundary layer of laminar, turbulent and transition	CLO 9	T1:12.3 R1:13.2
26-27	Explain separation of boundary layer	CLO 10	T1:12.10 R1:13.7
28	Demonstrate Reynolds's experiment	CLO 11	T1:11.2 R1:10.2
29-30	Formulate the Darcy's equation	CLO 12	T1:11.5 R1:10.3
31-32	Discuss the series and parallel connections of pipes	CLO 12	T1:11.12 R1:11.9

33-35	Construct total energy and hydraulic gradient lines	CLO 12	T1:11.8 R1:11.5
36-38	Measurement the discharge	CLO 12	T1:9.9
39-41	Discuss the effect of hydrodynamic force on flat vanes	CLO 18	T1:20.3 R1:17.2
42-44	Draw the velocity triangles for curved vanes	CLO 19	T1:20.4 R1:17.4.4
45	Classify the turbines	CLO 20	T1:21.4 R1:18.5
46-48	Evaluate the performance of turbines	CLO 21	T1:22 R1:18.6.1
49	Describe the functions of draft tube	CLO 21	T1:21.12 R1:18.10
50-51	Define unit quantities and Draw characteristic curves	CLO 20	T1:22.5 R1:18.13
52	Illustrate the governing of turbines	CLO 21	T1:21.21 R1:18.14
54-55	Explain Cavitations, water hammer, surge tank	CLO 21	T1:21.23
56-57	Classify and Explain the working of centrifugal pump	CLO 14	T1:24.3 R1:19.2
58-59	Compare the characteristic curves of centrifugal pump	CLO 16	T1:24.16 R1:19.10
60	Describe and Evaluate the performance of reciprocating pumps	CLO 17	T1:23.4 R2:20.2

XIII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSIONREQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1, PO 4	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 4, PO3	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

Prepared by:
Mr. M. Vijay Kumar, Assistant Professor

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INSTITUTE OF AERONAUTICAL ENGINEERING

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MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**FLEXIBLE MANUFACTURING SYSTEM**				
Course Code	**BCC006**				
Programme	M.Tech				
Semester	II	CAD/CAM			
Course Type	Core				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	**Dr. G. Naveen Kumar, Associate Professor, ME**				
Course Faculty	**Dr. G. Naveen Kumar, Associate Professor, ME**				

I. COURSE OVERVIEW:

Flexible Manufacturing is a sub discipline of mechanical engineering, and optical engineering concerned with designing machines, fixtures, and other structures that have exceptionally low tolerances, are repeatable, and are stable over time. These approaches have applications in machine tools. allowed a different approach to engine design. The reduced cost of machining has made possible integrated structural configurations, with more functions assigned to the same piece of metal.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME006	IV	**Production Technology**	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Flexible manufacturing system	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	Seminars	✔	Videos	✔	MOOCs
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into fiveunits and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
30 %	To test the analytical skill of the concept.
20 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	3	Assignments
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	2	Seminar
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	2	Assignments
PO 4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	2	Seminar
PO 5	Write and present a substantial technical report / document.	1	Seminar
PO 6	Independently carry out research/investigation and development work to solve practical problems	1	Assignments
PO 7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	-	Assignments

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Understanding of modern trends in design and manufacturing using CAD/CAM
II	Apply performance analysis techniques.
III	Understand preventive maintenance procedures in manufacturing

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	To expose the student to the different types of manufacturing available today such as the Special Manufacturing System, the Manufacturing Cell, and the Flexible Manufacturing System	CLO 1	Understand the basic concepts of FMS
		CLO 2	Apply the concept of system design procedures to different levels of production.
		CLO 3	Identify the system modeling issues and control them
CO 2	To learn the fundamentals of computer assisted numerical control	CLO 4	Apply the concept of scheduling

	programming and programming languages	CLO 5	Understand and Apply system modeling techniques
		CLO 6	Distinguish between continuous and discrete modeling techniques
CO 3	Understanding the modelling, design and simulation of complex systems	CLO 7	Design models of manufacturing systems
		CLO 8	Analysis of performance of manufacturing system
		CLO 9	Understand the preventative maintenance
CO 4	The common CAD/CAM data base organized to serve both design and manufacturing	CLO 10	Understand the basic concepts of FMS
		CLO 11	Apply the concept of system design procedures to different levels of production.
		CLO 12	Identify the system modeling issues and control them
CO 5	To practice the PLC control devices and CNC operation skills.	CLO 13	Understand and Apply system modeling techniques
		CLO 14	Distinguish between continuous and discrete modeling techniques
		CLO 15	Design models of manufacturing systems

IX. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BCC006.01	CLO 1	Understand the basic concepts of FMS	PO 1	1
BCC006.02	CLO 2	Apply the concept of system design procedures to different levels of production.	PO 1	1
BCC006.03	CLO 3	Identify the system modeling issues and control them	PO 1	1
BCC006.04	CLO 4	Apply the concept of scheduling	PO 2	2
BCC006.05	CLO 5	Understand and Apply system modeling techniques	PO 2	2
BCC006.06	CLO 6	Distinguish between continuous and discrete modeling techniques	PO 2	2
BCC006.07	CLO 7	Design models of manufacturing systems	PO 3	1
BCC006.08	CLO 8	Analysis of performance of manufacturing system	PO 4	1
BCC006.09	CLO 9	Understand the preventative maintenance	PO 5	2
BCC006.10	CLO 10	Understand the basic concepts of FMS	PO 5	2
BCC006.11	CLO 11	Apply the concept of system design procedures to different levels of production.	PO 6	3
BCC006.12	CLO 12	Identify the system modeling issues and control them	PO 6	3
BCC006.13	CLO 13	Understand and Apply system modeling techniques	PO 3	3
BCC006.14	CLO 14	Distinguish between continuous and discrete modeling techniques	PO 5	3
BCC006.15	CLO 15	Design models of manufacturing systems	PO 7	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OFPROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(COs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1						
CO 2		2					
CO 3		1	3				
CO 4				2			
CO 5					2	2	

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Learning Outcomes (CLOs)	Program Outcomes (PO)						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CLO 1	1						
CLO 2	1						
CLO 3	1						
CLO 4		2					
CLO 5		2					
CLO 6		2					
CLO 7			1				
CLO 8							
CLO 9					2		
CLO 10				1	2		
CLO 11						3	
CLO 12				1		3	
CLO 13			3				
CLO 14					3		
CLO 15							2

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 2, PO 3, PO 4, PO 5, PO 6, PO 7	SEE Exams	PO 1, PO 2, PO 3, PO 4, PO 5, PO 6, PO 7	Assignments	PO 3, PO 6, PO 7	Seminars	PO 2, PO 4, PO 5
Laboratory Practices	PO 3	Student Viva	PO 3	Mini Project	-	Certification	-

XIII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIV. SYLLABUS

UNIT-I	**FLEXIBLE MANUFACTURING SYSTEM**	**Classes:09**
Introduction: Definitions of manufacturing with input-output model, definition of system, basic problems concerning systems and system design procedure, modes of manufacturing – job/batch/flow and multi- product, small batch manufacturing.		
UNIT-II	**SYSTEM MODELLING ISSUES**	**Classes: 09**
System modeling issues: Centralized versus distributed control; Real-time vs discrete event control; Forward vs. backward scheduling approaches with finite/infinite capacity loading; Modeling of absorbing states and deadlocks; Conflicts; Concurrency, and synchronization.		
UNIT-III	**SYSTEM MODELLING TOOLS AND TECHNIQUES**	**Classes: 09**
System Modeling Tools and Techniques: Introduction to mathematical modeling, optimization, and simulation; issues related with deterministic and stochastic models. Continuous and discrete mathematical modeling methods -discrete event, monte carlo method; Basic concepts of Markov chains and processes; The M/M/1 and M/M/m queue; Models of manufacturing systems including transfer lines and flexible manufacturing systems, introduction to Petri nets		
UNIT-IV	**PERFORMANCE ANALYSIS**	**Classes: 09**
Performance Analysis: Transient analysis of manufacturing systems, analysis.		
UNIT-V	**PREVENTATIVE MATAINANCE**	**Classes: 09**
Preventive maintenance, Karban system, implementation issues.		
Text Books:		
5. N. K. Jha, "Hand Book of Flexible Manufacturing Systems", Academic Press, 1st Edition, 2013. 6. Talichi Ohno, "Production System beyond Large Scale Production", Toyota Productivity Press India Pvt. Ltd, 1st Edition, 2010. 7. H K Shivanand, "Flexible Manufacturing Systems", New Age International, 1stEdition, 2006.		

Reference Books:
3. Farid Amirouche, "Principles of Computer-Aided Design and Manufacturing, 2nd Edition, 2004.
4. P. Radha Krishnan, "CAD/ CAM/ CIM", New Age International, 4th Edition, 2016.

XV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No.	Course learning outcomes	Topics to be covered	Reference
1 – 3	**Understand** the basic concepts of FMS	Introduction: Definitions of manufacturing with input-output model, definition of system, basic problems concerning systems.	T1,T2, R1
4 – 6	**Apply** the concept of system design procedures to different levels of production.	system design procedure, modes of manufacturing– job/batch/flow and multi-product, small batch manufacturing	T1,T2
7 – 9	**Identify** the system modeling issues and control them	System modeling issues: Centralized versus distributed control; Real-time vs discrete event control.	T2,T3
10 – 13	**Apply** the concept of scheduling	Forward vs. backward scheduling approaches with finite/infinite capacity loading; Modeling of absorbing states and deadlocks; Conflicts; Concurrency, and synchronization.	T1,T2
14 – 16	**Understand and Apply** system modeling techniques	System Modeling Tools and Techniques: Introduction to mathematical modeling, optimization, and simulation; issues related with deterministic and stochastic models.	T1, R1
17 – 20	**Distinguish** between continuous and discrete modeling techniques	Continuous and discrete mathematical modeling methods -discrete event, monte carlo method; Basic concepts of Markov chains and processes; The M/M/1 and M/M/m queue.	T1
21 – 22	**Design** models of manufacturing systems	Models of manufacturing systems including transfer lines and flexible manufacturing systems, introduction to Petri nets.	T1
23 – 25	**Analysis** of performance of manufacturing system	Performance Analysis: Transient analysis of manufacturing systems, analysis.	T1,T2

29 – 35	Understand the preventative maintenance	Preventive maintenance, Karban system, implementation issues.	T1,T2

XVI. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed Actions	Relevance with POs
1	Advances in manufacturing processes	Seminars / Guest Lectures / NPTEL	PO 1, PO 2, PO 3
2	Interaction of materials and manufacturing processes	Seminars / Guest Lectures / NPTEL	PO 2, PO 5
3	Recommended practices incasting, welding, and forming	Assignments / Laboratory Practices	PO 1, PO 3, PO 4, PO 6, PO 7

Prepared by:
Dr. G. Naveen Kumar, Associate Professor **HOD, ME**

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Mechanical Engineering

COURSE DESCRIPTOR

Course Title	**COMPUTER AIDED MANUFACTURING**			
Course Code	**BCC005**			
Programme	**M.Tech**			
Semester	**II**			
Course Type	**Core**			
Regulation	**R16**			
Course Structure	**Theory**		**Practical**	
	Lectures	**Tutorials**	**Practicals**	**Credits**
	3	**-**	**-**	**3**
Course Faculty	**Mr. M V Aditya Nag, Assistant Professor**			

I. COURSE OVERVIEW:

Computer Aided Manufacturing is highly demanded area now a day. Computer Aided Manufacturing deals with Design of components to manufacturing and also includes Planning and controlling the processes. Industries widely use CNC, FMS and Robotics technology now a day. Students will be familiar with its hardware and software and also able to write programs for machining.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	A70328	VII	CAD/CAM	4

III. MARKS DISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Computer Aided Manufacturing	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	eminars	✔	Videos	✔	MOOCs
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each module carries equal weight age in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
30 %	To test the analytical skill of the concept.
20 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Technical Seminar and Term Paper.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	**CIE Exam**	**Technical Seminar and Term Paper**	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 9th and 17th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:
Two seminar presentations and the term paper with overview of topic are conducted during II semester. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		**Strength**	**Proficiency assessed by**
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	1	Term paper
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	1	Term paper and Guest Lectures
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	1	Seminar and Guest Lectures
PO 5	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team	2	Assignments
PO 6	Write and present a substantial technical report / document.	1	NPTEL Videos and Seminar
PO 7	Independently carry out research / investigation and development work to solve practical problems	2	Presentation on Real-world problems

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES:

The course should enable the students to:

I	To build concrete foundation for their core branch as a thinker, inter disciplinary thoughts
II	To create strong skills of writing CNC programs, PLC programs.
III	To educate students to understand different advances in manufacturing system like: GT, CAPP and FMS
IV	To educate students by covering robotics and different material handling system required in manufacturing shop floor.
V	To educate students by covering different Integrated production management system.

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	To Understand the fundamentals of computer assisted numerical control programming and relates skills.	CLO 1	Describe basic concepts of CAM application
		CLO 2	Apply CNC programs for manufacturing of different geometries on milling and lathe machines.
CO 2	Describe about various Toolings for CNC Machines	CLO 3	Describe about various Toolings for CNC Machines
CO 3	Understand about Post Processors for CNC Systems	CLO 4	Understand about Post Processors for CNC Systems
CO 4	Understand about usage of Microcontrollers & PLC in CAM systems	CLO 5	Understand about Microcontrollers & PLC
CO 5	Identify scope of Implementation of CAQC , CAPP, Artificial Neural Networks, Artificial Intelligence and Expert system to CAM systems for preliminary industrial applications	CLO 6	Classify different components using different techniques of group technology
		CLO 7	Apply Process planning for different components
		CLO 8	Describe CAQC methodologies for preliminary industrial applications
		CLO 9	Identify applications Artificial Neural Networks, Artificial Intelligence and Expert system to CAM systems

IX. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to	PO's Mapped	Strength of Mapping
BCC005.01	CLO 1	Describe basic concepts of CAM application	PO 1	3
BCC005.02	CLO 2	Apply CNC programs for manufacturing of different geometries on milling and lathe machines.	PO 1	3
BCC005.03	CLO 3	Describe about various Toolings for CNC Machines	PO 1,PO 2	3
BCC005.04	CLO 4	Understand about Post Processors for CNC Systems	PO 1,PO 2	2
BCC005.05	CLO 5	Understand about Microcontrollers & PLC	PO 2	2
BCC005.06	CLO 6	Classify different components using different techniques of group technology	PO 1,PO 2,PO 3	2

BCC005.07	CLO 7	Apply Process planning for different components	PO 2	1
BCC005.08	CLO 8	Describe CAQC methodologies for preliminary industrial applications	PO 2, PO 3	1
BCC005.09	CLO 9	Identify applications Artificial Neural Networks, Artificial Intelligence and Expert system to CAM systems	PO 2, PO 3	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (PO)						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2						
CO 2	1	2	1		1	3	1
CO 3		2			2		
CO 4	3		1		3	1	1
CO 5		1					

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Learning Outcomes (CLOs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7
CLO 1	2					
CLO 2	2					
CLO 3	1	2	1		1	3
CLO 4		2			2	
CLO 5	3		1		3	1
CLO 6		1				
CLO 7		1				
CLO 8		1				
CLO 9		1				

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO1, PO3, PO5	SEE Exams	PO1, PO3, PO5	Seminar and Term Paper	PO1, PO2, PO3, PO5
Viva	-	Mini Project	-	Laboratory Practices	-

XIII. ASSESSMENT METHODOLOGIES -INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIV. SYLLABUS:

UNIT-I	**COMPUTER AIDED PROGRAMMING**
General information, APT programming, examples Apt programming problems (2D machining only), NC programming on CAD/CAM systems, the design and implementation of post processors; Introduction to CAD/CAM software, automatic tool path generation.	
UNIT-II	**TOOLING FOR CNC MACHINES**
Interchangeable tooling system, preset and qualified tools, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers; DNC systems and adaptive control: Introduction, type of DNC systems, advantages and disadvantages of DNC, adaptive control with optimization, adaptive control with constrains, adaptive control of machining processes like turning, grinding.	
UNIT-III	**POST PROCESSORS FOR CNC**
Introduction to post processors: The necessity of a post processor, the general structure of a post processor, the functions of a post processor, DAPP based post processor. Communication channels and major variables in the DAPP based post processor; the creation of a DAPP based post processor.	
UNIT-IV	**MICRO CONTROLLERS**
Introduction to microcontrollers: Hardware components, I/O pins, ports, external memory: counters, timers and serial data I/O interrupts, selection of micro controllers embedded controllers, applications and programming of micro controllers; Programming logic controllers: Introduction, hardware components of PLC, System, basic structure, principle of operations, programming mnemonics timers, internal relays and counters, applications of PLC's in CNC Machines.	
UNIT-V	**COMPUTER AIDED PROCESS PLANNING**
Hybrid CAAP system, computer aided inspection and quality control, coordinate measuring machine, limitations of CMM, computer aided testing, optical inspection methods, artificial intelligence and expert system: Artificial neural networks, artificial intelligence in CAD, experts systems and its structures	
Text Books:	
1. Yoram Koren,"Computer Control of Manufacturing System", Tata Mcgraw Hill, 1stEdition, 1983. 2. K. Lalit Narayan, K. Mallikarjuna Rao, "Computer Aided Manufacturing", 1stEdition, 2008.	
Reference Books:	
1. Mikell. P. Grover, Emory W. Zimmer, "CAD/CAM", PHI, 1stEdition, 2010	

XV. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
1-2	**Explain** General information, APT programming	General information, APT programming, examples Apt programming problems (2D machining only)	T1:28.7 R1:2.6
3	**Apply** NC programming on CAD/CAM systems	NC programming on CAD/CAM systems, the design and implementation of post processors; Introduction to CAD/CAM software, automatic tool path generation	T1:27.5 R1:2.7
4-5	**Explain** working principle of NC,CNC,DNC	DNC systems and adaptive control: Introduction, type of DNC systems, advantages and disadvantages of DNC	T1:29.6 R1:2.6
6-7	**Discuss** functions of NC, CNC,DNC	Adaptive control with optimization, adaptive control with constrains, adaptive control of machining processes like turning, grinding	T1:29.7 R1:2.7
7	**Illustrate** Tooling For CNC Machines	Interchangeable tooling system, preset and qualified tools, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers	T1:29.8 R1:4.4
8-9	**Illustrate** post processors for CNC Machines	Introduction to post processors: The necessity of a post processor, the general structure of a post processor, the functions of a post processor	T1:29.7 R1:2.7
10-11	**Describe** DAPP based post processor	DAPP based post processor. Communication channels and major variables in the DAPP based post processor; the creation of a DAPP based post processor.	T1:30.7 R1:4.10
12-13	**Explain** microcontroller	Introduction to microcontrollers: Hardware components, I/O pins, ports, external memory: counters, timers and serial data I/O interrupts.	T1:29.8 R1:4.4
14-15	**Discuss** programming of micro controllers	Selection of micro controllers embedded controllers, applications and programming of micro controllers	T1:30.7 R1:4.10
16	**Explain** Programming logic controllers	Programming logic controllers: Introduction, hardware components of PLC, System, basic structure, principle of operations	T2:33.9 R1:7.5
17-18	**Categorize** hardware components of PLC	Programming mnemonics timers, internal relays and counters	T2:35.10 R3:8.1
19-20	**Explain** applications of PLC's in CNC Machines	Applications of PLC's in CNC Machines	T2:34.10 R2:7.5
20	**Discuss** Computer Aided Process Planning	Hybrid CAPP system	T2:35.12 R1:9.2
21-22	**Discuss** Part families, Part classification and coding	Hybrid CAPP system	T2:36.1 R2:9.4
23-24	**Explain** Group Technology	Hybrid CAPP system	T2:37.1 R2:9.9
25-26	**Explain** Hybrid CAPP system	Hybrid CAPP system	T2:37.1 R2:9.9
27	**Illustrate** Process Planning function, CAPP - Methods of CAPP	Hybrid CAPP system	T2:27.12 R1:11.9
28	**Explain** Opitz parts classification system	Hybrid CAPP system	T2:27.12 R1:11.9
29	**Explain** MICLASS parts classification system	Hybrid CAPP system	T2:27.5 R1:10.2
30	**Discuss** computer aided inspection and quality control	Computer aided inspection and quality control	T2:27.5 R1:10.2

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
31-32	**Explain** objectives of CAQC	Computer aided inspection and quality control	T2:27.7 R1:11.3
33-34	**Explain** integration of CAQC with CIM	Computer aided testing	T2:27.8 R1:11.6
35-36	**Distinguish** contact and non-contact inspection methods	Computer aided testing, optical inspection methods	T2:27.12 R1:11.7
37-38	**Explain** coordinate measuring machine	Coordinate measuring machine, limitations of CMM	T2:27.12 R1:11.8
39-40	**Discuss** artificial intelligence and expert system	Artificial intelligence and expert system	T2:27.12 R1:11.8
41-42	**Explain** Artificial neural networks	Artificial neural networks	T2:27.12 R1:11.10
43-44	**Discuss** artificial intelligence in CAD/CAM	Artificial intelligence in CAD	T2:27.12 R1:11.10
45	**Explain** experts systems and its structures	Experts systems and its structures	T3:27.14 R1:12.3

XVI. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs
1	Encourage students to get exposed with real time CAM environment.	Industrial Visits	PO 2,PO 6

Prepared By:
Mr. M V Aditya Nag, Assistant Professor

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Dundigal, Hyderabad -500 043

Mechanical Engineering

COURSE DESCRIPTOR

Course Title	**DESIGN FOR MANUFACTURING AND ASSEMBLY**			
Course Code	**BCC202**			
Programme	**M.Tech**			
Semester	**II**			
Course Type	**Elective**			
Regulation	**R16**			
Course Structure	**Theory**		**Practical**	
	Lectures	**Tutorials**	**Practical**	**Credits**
	3	**-**	**-**	**3**
Course Faculty	**Dr K .Viswanath Allamraju, Professor , ME**			

I. COURSE OVERVIEW:

This course bridges gap between design and manufacturing, it introduces the principles of design for developing the product, which includes design considerations in casting, forging, metal forming and in welding.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME004	III	Mechanics of Solids	4

III. MARKS DISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Design for manufacturing and assembly	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	Seminars	✔	Videos	✔	MOOCs
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each module carries equal weight age in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
30 %	To test the analytical skill of the concept.
20 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Technical Seminar and Term Paper.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	**CIE Exam**	**Technical Seminar and Term Paper**	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 9^{th} and 17^{th} week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:

Two seminar presentations and the term paper with overview of topic are conducted during II semester. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		**Strength**	**Proficiency assessed by**
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	1	Term paper
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	1	Term paper and Guest Lectures
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	1	Seminar and Guest Lectures
PO 4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	2	Guest Lecturers

PO 5	Write and present a substantial technical report / document.	1	NPTEL Videos and Guest Lecturers
PO 6	Independently carry out research / investigation and development work to solve practical problems	2	MOOCs and Guest Lecturers
PO7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	1	Guest Lecturers

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES:

The course should enable the students to:

I	Understanding of basic design rules for manufacturing and material selection.
II	Applying the production processes for ease of manufacturing.
III	Apply the concepts of design for manufacturing and assembly for product manufacturing.
IV	Understand the assembly transfer systems.
V	Understand the design for manual assembly.

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Describe the properties of materials for various design components.	CLO 1	Outline the history of DFMA.
		CLO 2	Identify the general rules for manufacturability.
		CLO 3	Understand the different designs.
CO 2	Determine the various machining processes related to metal casting.	CLO 4	Understand the metal casting.
		CLO 5	Identify the various machining processes.
CO 3	Understand the design guide lines of metal joining processes.	CLO 6	Appraisal of various welding processes.
		CLO 7	Understand the effects of thermal stresses in weld joints.
		CLO 8	Ability to present design guidelines for extruded sections.
CO 4	Develop the assembly processes for various components in manufacturing.	CLO 9	Ability to present the development of the assemble process
		CLO 10	Understand the assembly advantages.
CO 5	Develop a design for manual assembly of various mechanical assemblies in production for maintaining quality of products.	CLO 11	Understand the design for assembly fits in the design process.
		CLO 12	Demonstrate the DFMA of cotter joint.
		CLO 13	Demonstrate the DFMA of internal combustion engine assembly.

IX. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to	PO's Mapped	Strength of Mapping
BCC202.01	CLO 1	Outline the history of DFMA.	PO 1	1
BCC202.02	CLO 2	Identify the general rules for manufacturability.	PO 2, PO 6	1
BCC202.03	CLO 3	Understand the different designs.	PO 1, PO 3	2
BCC202.04	CLO 4	Understand the metal casting.	PO 2, PO 6	2
BCC202.05	CLO 5	Identify the various machining processes.	PO 3	1
BCC202.06	CLO 6	Appraisal of various welding processes.	PO 1	1
BCC202.07	CLO 7	Understand the effects of thermal stresses in weld joints.	PO 1, PO 3	2
BCC202.08	CLO 8	Ability to present design guidelines for extruded sections.	PO 1, PO 3	1
BCC202.09	CLO 9	Ability to present the development of the assemble process	PO 5, PO 6	2
BCC202.10	CLO 10	Understand the assembly advantages.	PO 1, PO 6	1
BCC202.11	CLO 11	Understand the design for assembly fits in the design process.	PO 6, PO 7	1
BCC202.12	CLO 12	Demonstrate the DFMA of cotter joint.	PO 5, PO 7	2
BCC202.13	CLO 13	Demonstrate the DFMA of internal combustion engine assembly.	PO 5, PO 7	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7
CO 1	2	1	1		1	
CO 2		1	1		1	
CO 3	2		2			
CO 4	1			2	2	
CO 5				2	1	2

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Learning Outcomes (CLOs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7
CLO 1	1					
CLO 2		1			1	
CLO 3	2		1			
CLO 4		1			2	
CLO 5			1			
CLO 6	1					
CLO 7	1		2			
CLO 8	1		1			
CLO 9				2	2	
CLO 10	1				1	
CLO 11					1	1
CLO 12				2		2
CLO 13				2		2

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO1, PO3, PO5	SEE Exams	PO1, PO3, PO5	Seminar and Term Paper	PO1, PO2, PO3, PO5
Viva	-	Mini Project	-	Laboratory Practices	-

XIII. ASSESSMENT METHODOLOGIES -INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIV. SYLLABUS:

UNIT I INTRODUCTION OF DESIGN
Introduction: Design philosophy steps in design process, general design rules for manufacturability, basic principles of design Ling for economical production, creativity in design; Materials selection of materials for design developments in material technology, criteria for material selection, material selection interrelationship with process selection process selection charts.
UNIT II MACHINING PROCESSES
Machining process: Overview of various machining processes, general design rules for machining, dimensional tolerance and surface roughness, design for machining, ease of redesigning of components for machining ease with suitable examples. General design recommendations for machined parts; Metal casting: Appraisal of various casting processes, selection of casting process, general design considerations for casting, casting tolerances, use of solidification simulation in casting design, product design rules for sand casting.

UNIT III METAL JOINING
Metal joining: Appraisal of various welding processes, factors in design of weldments, general design guidelines, pre and post treatment of welds, effects of thermal stresses in weld joints, design of brazed joints; Forging, design factors for forging, closed dies forging design, parting lines of die drop forging die design general design recommendations. Extrusion and sheet metal work: Design guidelines for extruded sections, design principles for punching, blanking, bending, deep drawing, Keeler Goodman forming line diagram, component design for blanking.
UNIT IV ASSEMBLY ADVANTAGES
Assembly advantages: Development of the assemble process, choice of assemble method assemble advantages social effects of automation, automatic assembly transfer systems: Continuous transfer, intermittent transfer, indexing mechanisms, and operator, paced free, transfer machine
UNIT V DESIGN FOR MANUAL ASSEMBLY
Design of manual assembly: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.
TEXT BOOKS:
1. GeoffreyBoothroyd, "Assembly Automation and Product Design", CRC Press, 2nd Edition, 2013
2. George E. Deiter, "Engineering Design - Material & Processing Approach", Tata McGraw Hill, 2nd Edition, 2000.
REFERENCES:
1. A Delbainbre, "Computer Aided Assembly"1992
2. Geoffrey Boothroyd, Peter Dewhurst, Winston. A. Knight, "Product Design for Manufacturing and Assembly",CRC Press, 3rd Edition, 2013.

XV. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
1-3	Understand the basic concepts of DFMA	Materials selection of materials for design developments in material technology, criteria for material selection.	T1:1.1, 1.2
4-6	Describe overall architecture of DFMA	material selection interrelationship with process selection process selection charts.	T1:2.1
7-9	Understand the basic concepts of machining processes.	General design recommendations for machined parts.	T2:2.2, 2.3
10-13	Describe the general design recommendations of metal casting.	Metal casting: Appraisal of various casting processes, selection of casting process, general design considerations for casting, casting tolerances.	T1:4.1, 4.2, 4.3
14-16	Understand the fundamentals of casting.	Use of solidification simulation in casting design, product design rules for sand casting.	T1:4.2, 4.4
17-20	Understand the concepts of material selection.	Appraisal of various welding processes, factors in design of Weldments.	T2: 5.1, 5.2
21-22	Develop metal joining processes in simulation softwares.	General design guidelines, pre and post treatment of welds, effects of thermal stresses in weld joints, design of brazed joints;.	T2:6.1, 6.2, 6.4
23-27	Understand the working principle welding.	Development of the assemble process, choice of assemble method assemble advantages social effects of automation,	T2:7.2, 7.3, 7.4
28-36	Analyze the assembly processes.	Automatic assembly transfer systems.	T2:8.1, 8.3
37-40	Describe the design for manual assembly.	Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic	T1:5.3
41-45	Understand DFMA in real field problems.	DFA methodology, assembly efficiency, classification system for manual handling,	T1:5.5, 5.6, 5.7

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
		classification system for manual insertion and fastening	

XVI. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs
1	Friction stir welding	Seminars / Guest Lectures / NPTEL	PO 1, PO 6, PO 7
2	Friction spot welding	Work Shops/ Guest Lectures / NPTEL	PO 5, PO 6

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Mechanical Engineering

COURSE DESCRIPTOR

Course Title	**STRESS ANALYSIS AND VIBRATION**			
Course Code	**BCC213**			
Programme	**M.Tech**			
Semester	**II**			
Course Type	**Core**			
Regulation	**R16**			
Course Structure	**Theory**		**Practical**	
	Lectures	**Tutorials**	**Practical**	**Credits**
	3	**-**	**-**	**3**
Course Faculty	**Dr K .Viswanath Allamraju, Professor , ME**			

I. COURSE OVERVIEW:

This course bridges gap between theory of elasticity and vibrations of free and forced types, it introduces the principles of elasticity, components of stresses and strains, differential equations of equilibrium, boundary conditions, compatibility conditions and stress function. This course also covers the two dimensional problems in rectangular coordinates and polar coordinates. This course covers the knowledge of vibrations of lumped and distributed parameter systems.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME004	III	Mechanics of Solids	4

III. MARKS DISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Stress Analysis and Vibration	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	Seminars	✔	Videos	✔	MOOCs
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each module carries equal weight age in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
30 %	To test the analytical skill of the concept.
20 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Technical Seminar and Term Paper.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	**CIE Exam**	**Technical Seminar and Term Paper**	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 9^{th} and 17^{th} week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:
Two seminar presentations and the term paper with overview of topic are conducted during II semester. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		**Strength**	**Proficiency assessed by**
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	1	Term paper
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	1	Term paper and Guest Lectures
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	1	Seminar and Guest Lectures
PO 4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	2	Guest Lecturers
PO 5	Write and present a substantial technical report / document.	1	NPTEL Videos and Guest Lecturers
PO 6	Independently carry out research / investigation and development work to solve practical problems	2	MOOCs and Guest Lecturers

PO7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	1	Guest Lecturers

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES:

The course should enable the students to:

I	Distinguish between lumped mass and distributed mass systems.
II	Do mathematical modeling of various vibration systems.
III	Distinguish between centralized and distributed databases.
IV	Implement applications involving complex transaction processing.
V	Do query evaluation and query optimization

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Describe the two-dimensional elective theory in cartisian coordinates.	CLO 1	Outline the history of elasticity.
		CLO 2	Identify the elastic bodies and understand the behaviour of ductile and brittle materials.
		CLO 3	Understand the different coordinate systems and applications.
CO 2	Compute the contact stresses between various bodies.	CLO 4	Understand the contact stresses between plane and curved bodies.
		CLO 5	Distinguish between contact stress and normal stresses of various bodies.
CO 3	Determine the natural frequency of transverse vibration of the shaft and torsional vibrations of rotor systems	CLO 6	Understand the terminology of simple harmonic motion, natural frequency, time period and circular frequency.
		CLO 7	Understand the types of vibrations.
		CLO 8	Ability to present the natural frequency and equation of motions of rotor systems.
CO 4	Analyze the mathematical modelling of the two degrees of freedom systems and explain about the working principles of vibration absorber.	CLO 9	Ability to present the mathematical modelling of single degree of freedom systems and multi degree of freedom systems.
		CLO 10	Examine the mathematical modeling of lumped mass system and distributed parameter systems and understand the working principle of vibration absorber.
CO 5	Compute the natural frequencies and mode shapes of multi degree of freedom systems and explain the model analysis of vibrating systems.	CLO 11	Understand the natural frequencies of multi degree of freedom systems.
		CLO 12	Demonstrate the mode shapes of MDOF systems.
		CLO 13	Examine the mode shapes of continuous systems and observe in ANSYS and MATLAB.

IX. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to	PO's Mapped	Strength of Mapping
BCC213.01	CLO 1	Outline the history of elasticity.	PO 1	1
BCC213.02	CLO 2	Identify the elastic bodies and understand the behavior of ductile and brittle materials.	PO 2, PO 6	1
BCC213.03	CLO 3	Understand the different coordinate systems and applications.	PO 1, PO 3	2
BCC213.04	CLO 4	Understand the contact stresses between plane and curved bodies.	PO 2, PO 6	2
BCC213.05	CLO 5	Distinguish between contact stress and normal stresses of various bodies.	PO 3	1
BCC213.06	CLO 6	Understand the terminology of simple harmonic motion, natural frequency, time period and circular frequency.	PO 1	1
BCC213.07	CLO 7	Understand the types of vibrations.	PO 1, PO 3	2
BCC213.08	CLO 8	Ability to present the natural frequency and equation of motions of rotor systems.	PO 1, PO 3	1
BCC213.09	CLO 9	Ability to present the mathematical modelling of single degree of freedom systems and multi degree of freedom systems.	PO 5, PO 6	2
BCC213.10	CLO 10	Examine the mathematical modeling of lumped mass system and distributed parameter systems and understand the working principle of vibration absorber.	PO 1, PO 6	1
BCC213.11	CLO 11	Understand the natural frequencies of multi degree of freedom systems.	PO 6, PO 7	1
BCC213.12	CLO 12	Demonstrate the mode shapes of MDOF systems.	PO 5, PO 7	2
BCC213.13	CLO 13	Examine the mode shapes of continuous systems and observe in ANSYS and MATLAB.	PO 5, PO 7	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7
CO 1	2	1	1		1	
CO 2		1	1		1	
CO 3	2		2			
CO 4	1			2	2	
CO 5				2	1	2

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Learning Outcomes (CLOs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7
CLO 1	1					
CLO 2		1			1	
CLO 3	2		1			
CLO 4		1			2	
CLO 5			1			
CLO 6	1					
CLO 7	1		2			
CLO 8	1		1			
CLO 9				2	2	
CLO 10	1				1	
CLO 11					1	1
CLO 12				2		2
CLO 13				2		2

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO1, PO3, PO5	SEE Exams	PO1, PO3, PO5	Seminar and Term Paper	PO1, PO2, PO3, PO5
Viva	-	Mini Project	-	Laboratory Practices	-

XIII. ASSESSMENT METHODOLOGIES -INDIRECT

	Early Semester Feedback	✔	End Semester OBE Feedback
	Assessment of Mini Projects by Experts		

XIV. SYLLABUS:

UNIT I INTRODUCTION OF THEORY OF ELASTICITY
Two dimensional elasticity theory in Cartesian coordinates, plane stress problem in polar coordinates, Thick cylinders, Rotating discs, stress concentration.
UNIT II STRESS ANALYSIS OF SYMMETRIC BODIES AND CONTACT STRESSES
Torsion of non circular prismatic sections, rectangular and axi-symmetric, circular plates, introduction to shell theory, contact stresses.
UNIT III FREE AND FORCED VIBRATIONS
Single degree freedom, two degree freedom system without and with damping. Free and forced vibrations, transient vibrations.
UNIT IV TRANSIENT VIBRATIONS
Transient vibrations of single and two degree freedom systems, multi-degree of freedom systems, applications of matrix methods, continuous systems.

UNIT V CONTINUOUS SYSTEMS
Free and forced vibrations of strings bars and beams, principle of orthogonality, classical and energy methods.
TEXT BOOKS:
3. S.P. Timoshenko, J. N. Goodier, "Theory of Elasticity", Mc Graw Hill, 10 th Edition,2016.
4. J. P. Den Hartog, "Mechanical Vibrations", Dover Publications, 3rd Edition,2016.
REFERENCES:
3. W.T.Thomson,"TheoryofVibrationswithApplications",CBSPublishing,3rdEdition,2013.
4. S. S. Rao, "Mechanical Vibrations", Addison WesleyLongman.

XV. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
1-3	Understand the basic concepts of elasticity	Two dimensional elasticity theory in Cartesian coordinate system.	T1:1.1, 1.2
4-6	Describe overall architecture of theory of elasticity.	Plane stress problem in polar coordinates.	T1:2.1
7-9	Understand the basic concepts of contact stresses	Hertzian contact stress theory basics	T2:2.2, 2.3
10-13	Compute the contact stresses of plane and circular bodies	Contact stress calculation by using Hertzian contact stress theory.	T1:4.1, 4.2, 4.3
14-16	Understand the fundamentals of vibrations	Fundamentals of vibrations, types of vibrations, natural frequency and time period.	T1:4.2, 4.4
17-20	Understand the concepts of distributed mass and lumped mass	Calculation of natural frequencies of single degree of freedom systems such as spring mass system, simple pendulum.	T2: 5.1, 5.2
21-22	Develop mathematical models of mechanical systems	Calculate the natural frequencies of single degree of freedom and multi degree of freedom systems.	T2:6.1, 6.2, 6.4
23-27	Understand the working principle of vibration absorber.	Dynamic vibration absorber, calculation of vibration absorption, Resonance principle.	T2:7.2, 7.3, 7.4
28-36	Analyze the mode shapes of lumped and distributed mass parameter systems.	Mode shapes of multi degree of freedom systems.	T2:8.1, 8.3
37-40	Compute the simulations of various bodies under excitation.	Simulation of damped and undamped processes of motion of vibrations under various excitations.	T1:5.3
41-45	Understand the infinite degree of freedom systems	Free and forced vibrations of strings bars and beams	T1:5.5, 5.6, 5.7

XVI. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs
1	Modal Analysis	Seminars / Guest Lectures / NPTEL	PO 1, PO 6, PO 7
2	Vibration energy harvesting	Work Shops/ Guest Lectures / NPTEL	PO 5, PO 6

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	Design for Manufacturing of MEMS and MICRO SYSTEMS				
Course Code	BCC003				
Programme	M.Tech				
Semester	II	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Dr.G.V.R.Seshagiri Rao, Professor, ME				
Course Faculty	Mr.M.Sunil Kumar, Assistant Professor, ME				

I. COURSE OVERVIEW:

This course bridges gap between idea and production. Rapid prototyping is a group of methods used to rapidly manufacture a scale model of a physical part or assembly using three-dimensional computer aided design (CAD), Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) data. Construction of the part or assembly is usually done using 3D printing technology. Rapid prototyping techniques are often referred to solid free; computer automated manufacturing, form fabrication. This course covers the knowledge of rapid prototyping systems.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME533	VII	Robotics	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Design for Manufacturing of MEMS and Microsystems	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into fiveunits and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Independently carry out research / investigation and development work to solve practical problems	3	Presentation on Real-world problems
PO 2	Write and present a substantial technical report / document	2	Seminar
PO 3	Abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	2	Assignments
PO 4	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues	1	Seminars
PO5	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	3	Projects
PO6	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	2	projects
PO7	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	1	Seminars

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understanding of modern trends in design and manufacturing using CAD/CAM
II	Applying advanced aspects of enabling computer aided technologies used in design.
III	Enumerate fundamental theories and technologies in computer aided manufacturing.

VIII. COURSE OUTCOMES (COs):

CLO Code	CO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BCC210.01	CO 1	Understand the working principles of MEMS and Microsystems	PO 1	3
BCC210.02	CO 2	Apply the concepts of Atomic structure molecular theory and various theories	PO 1	3
BCC210.03	CO 3	Visualize and Design the Micro system design	PO 1, PO 2	3
BCC210.04	CO 4	Understand state-of-the-art micromachining and packaging technologies	PO 1, PO 2	2
BCC210.05	CO 5	Identification of materials for MEMS and their fabrication processes with applications.	PO 2	2
BCC210.06	CO 6	Understand the working principles of MEMS and Microsystems	PO 1, PO 2, PO 3	2
BCC210.07	CO 7	Apply the concepts of Atomic structure molecular theory and various theories	PO 2	1
BCC210.08	CO 8	Visualize and Design the Micro system design	PO 2, PO 3	1
BCC210.09	CLO 9	Understand state-of-the-art micromachining and packaging technologies	PO 2	2

BCC210.10	CLO 10	Identification of materials for MEMS and their fabrication processes with applications.	PO 1, PO 2	2
BCC210.11	CLO 11	Understand the working principles of MEMS and Microsystems	PO1, PO 2, PO 3	3
BCC210.12	CLO 12	Apply the concepts of Atomic structure molecular theory and various theories	PO 3, PO 6, PO 7	3
BCC210.13	CLO 13	Visualize and Design the Micro system design	PO 2, PO 6, PO7	3
BCC210.14	CLO 14	Understand state-of-the-art micromachining and packaging technologies	PO 3, PO 2	3
BCC210.15	CLO 15	Identification of materials for MEMS and their fabrication processes with applications.	PO 3, PO 6	1
BCC210.16	CLO 16	Identification of materials for MEMS and their fabrication processes with applications.	PO 6, PO7	1

3 = High; 2 = Medium; 1 = Low

IX. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Course Learning Outcomes						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 1	3						
CLO 2	3			3		3	
CLO 3	3	3		3		3	
CLO 4	3	2		3	3	3	3
CLO 5		2		3	2	3	2
CLO 6	2	2	2		2		2
CLO 7		1		3		3	
CLO 8		1	1	3		3	
CLO 9		2					
CLO 10	2	2					
CLO 12			3			3	
CLO 13		3				3	
CLO 14		3	3				
CLO 15			1			1	
CLO 16						1	

3 = High; 2 = Medium; 1 = Low

X. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1,PO2 PO3,PO6	SEE Exams	PO1,PO2, PO3,PO6	Assignments	PO 2	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 3						

XI. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XII. SYLLABUS

UNIT-I	**OVERVIEW AND WORKING PRINCIPLES OF MEMS AND MICROSYSTEMS**
Overview and working principles of mems and microsystems: MEMS and microsystems, evolution of micro fabrication, microsystems and microelectronics, microsystems and miniaturization, applications of MEMS in industries, micro sensors, micro actuation, MEMS with micro actuators micro accelerometers, micro fluidies.	
UNIT-II	**ENGINEERING SCIENCE FOR MICROSYSTEMS DESIGN AND FABRICATION**
Engineering science for microsystems design and fabrication: Atomic structure of matter, ions and ionization, molecular theory of mater and intermolecular force, doping of semiconductors, diffusion Process, plasma physics, electrochemistry, quantum physics.	
UNIT-III	**ENGINEERING SCIENCE FOR MICROSYSTEMS DESIGN AND FABRICATION**
Engineering mechanics for microsystems design: Static Bending of thin Plates, mechanical vibration. Thermo mechanics fracture mechanics, thin-film mechanics, overview of finite element stress analysis	
UNIT-IV	**THERMO FLUID ENGINEERING AND MICROSYSTEMS DESIGN**
Thermo fluid engineering and microsystems design: Overview of basics of fluid mechanics in macro and meso scales, basic equations in continuum fluid dynamics, laminar fluid flow in circular conduits, computational fluid dynamics, incompressible fluid flow in micro conduits, fluid flow in sub micrometer and nano scale, overview of heat conduction in solids, heat conduction in multilayered thin films and in solids in sub micrometer scale, design considerations, process design mechanical design, mechanical design using finite element method, design of a silicon die for a micro pressure sensor.	
UNIT-V	**MATERIALS FOR MEMS, MICROSYSTEMS AND THEIR FABRICATION**
Materials for mems and microsystems and their fabrication: Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon Compounds, Silicon Piezoresistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers, Photolithography, Ion implantation, Diffusion and oxidation, chemical and physical vapor deposition, Etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process	
Text Books:	
1. Tai-Ran Hsu, “MEMs & Microsystems: Design & Manufacture”, Tata McGraw Hill, 1st Edition, 2002. 2. M. Maluf, “ An Introduction to Microelectromechanical Systems Engineering”, Artech House,1st Edition, 2000 3. Trimmer, W.S.N, “Micro robots and Micromechanical Systems Sensors & Actuators”, 19th Edition, 1989.	
Reference Books:	
1.. Madou, M, “Fundamentals of Microfabrication”, CRC Press, 1st Edition, 1997. 2. Hsu, T.R, “The Finite Element Method in Thermomechanics”, Alien & Unwin, London, 1st Edition, 1986.	

XIII. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No.	Course learning outcomes	Topics to be covered	Reference
1-3	Identify and understand of basic concepts of Rapid prototyping technologies	Introduction To Rapid Prototyping, Prototyping fundamentals, Historical Development	T1, R1
4-7	Understand and Apply concepts of Rapid prototyping	Advantages And Limitations Of Rapid Prototyping, Commonly Used Terms Classification Of Rp Process, Rapid Prototyping Process Chain	T1
8-11	Apply the concepts of prototyping technology	Fundamental Automated Processes, Process Chain, Types Of Prototyping Systems, Liquid-Based Rapid Prototyping Systems	T1, R2, R1
12-16	Understand the selection	Stereo Lithography Apparatus (Sla): Models And Specifications, Process Working Principle,Photopolymers, Photo polymerization	T1
17-20	Identify the Layering Technology, Applications.	Layering Technology, Laser And Laser Scanning, Applications, Advantages And Disadvantages, Case Studies, Solid Ground Curing (Sgc)	T1,R2
21-25	Understand the different models and specifications	Models And Specifications, Process, Working Principle, Applications, Solid-Based Rapid Prototyping Systems	T1, R1
26-29	Understand and apply the Laminated Object Manufacturing	Laminated Object Manufacturing (Lom), Models And Specifications Process, Working Principle, Applications, Advantages And Disadvantages, Case Studies.	T1, R1
30-33	Understand and apply the Fused Deposition Modeling	Fused Deposition Modeling (Fdm) Models And Specifications, Process, Working Principle, Applications, Advantages And Disadvantages, Case Studies.	T1, R1

XIV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs
1	Design of a pressure sensor	Seminars	PO 1
2	overview of finite element stress analysis	Seminars / NPTEL	PO 2, PO 3
3	Mechanical design using finite element method, design of a silicon die for a micro pressure sensor.	NPTEL	PO 2,PO 6,PO7

Prepared by:
Mr. M. Sunil Kumar, Assistant Professor

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	Research Methodology				
Course Code	BCS703				
Programme	M.Tech (CAD/CAM)				
Semester	II	ME			
Course Type	ELECTIVE				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lectures	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Faculty	Dr. G. Naveen Kumar, Associate Professor				

I. COURSE OVERVIEW:

The course covers the identification of research problem and scientific approaches of research. This course helps the students to gain the knowledge on research design and overall research process is requirements for different types of researches and the data collection approaches and experimental setup for research. This course helps the students in identifying their research problem, plan of research, methodology, data collection, measuring errors and scalability of research. Topics include data visualizations, report writing standards and basics in intellectual property rights for their work. This course in reached to student by power point presentations, lecture notes, and lab involve the problem solving in mathematical and engineering areas.

II PRE-REQUISITE(S):

Level	Course Code	Semester	Prerequisites	Credits
-	-	-	-	-

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Research Methodology	70 Marks	30 Marks	100 Marks

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	Seminars	✔	Videos	✔	MOOCs
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
30 %	To test the analytical skill of the concept.
20 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Technical Seminar and Term Paper.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	**CIE Exam**	**Technical Seminar and Term Paper**	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 9th and 17th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:
Two seminar presentations and the term paper with overview of topic are conducted during II semester. The evaluation of technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		**Strength**	**Proficiency assessed by**
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of Embedded Systems and sub areas IoT, Processor technology, and Storage technology.	3	CIE, SEE, Seminar
PO 2	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	2	Seminars

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 3	Respond to global policy initiatives and meet the emerging challenges with sustainable technological solutions in the field of electronic product designing.	3	Seminars
PO 6	Independently carry out research / investigation and development work to solve practical problems.	2	Guest Lectures

3= High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Identify an appropriate research problem in their interesting domain.
II	Organize and conduct research project.
III	Prepare a research project thesis report.
IV	Understand the law of patent and copyrights.
V	Adequate knowledge on process for filing Patent.

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Define the terms research and methodology.	CLO 1	Identify and understand the Research process and strength of research.
		CLO 2	Develop good research design with experimental work.
CO 2	Describe research approaches, techniques and strategies in the appropriate manner for decision making.	CLO 3	Design Error measurement and scaling parameters.
		CLO 4	Use various data forecasting techniques.
CO 3	Demonstrate knowledge and understanding of data analysis and interpretation in relation to the research process.	CLO 5	Understand the concept of regression analysis to find the hidden relations in data.
		CLO 6	Understand the professional attitude, ethics and excellence in engineering and science.
CO 4	Collect data for designs and methodologies to apply to a specific research project.	CLO 7	Understand the techniques of data interpretation and making effective research presentation.
		CLO 8	Analyze the Public debates on Scientific Issues.
CO 5	Discuss about patent laws and ownership rights.	CLO 9	Understand the fundamentals of copy rights laws.
		CLO 10	Understand the importance and process of patents and ownership rights.

IX. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to	PO's Mapped	Strength of Mapping
BCS703.01	CLO 1	Identify and understand the Research process and strength of research.	PO 1	3
BCS703.02	CLO 2	Develop good research design with experimental work.	PO 1	2
BCS703.03	CLO 3	Design Error measurement and scaling parameters.	PO 2	2
BCS703.04	CLO 4	Use various data forecasting techniques.	PO 2	2
BCS703.05	CLO 5	Understand the concept of regression analysis to find the hidden relations in data.	PO 3	3
BCS703.06	CLO 6	Understand the professional attitude, ethics and excellence in engineering and science	PO 3	3
BCS703.07	CLO 7	Understand the techniques of data interpretation and making effective research presentation.	PO 6	1
BCS703.08	CLO 8	Analyze the Public debates on Scientific Issues.	PO 6	1
BCS703.09	CLO 9	Understand the fundamentals of copy rights laws.	PO1, PO 6	2
BCS703.10	CLO 10	Understand the importance and process of patents and ownership rights.	PO1, PO6	2

3= High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcomes (COs)	Program Outcomes (PO)			
	PO 1	PO 2	PO 3	PO 6
CO 1	2	1	1	1
CO 2		1	1	
CO 3	1			
CO 4	2		1	1
CO 5			3	1

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Learning Outcomes (CLOs)	Program Outcomes (PO)			
	PO1	PO2	PO3	PO6
CLO 1	3			
CLO 2	2			
CLO 3		2		
CLO 4		2		
CLO 5			3	
CLO 6			3	
CLO 7				1
CLO 8				1
CLO 9	3			2
CLO 10	3			2

3= High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES – DIRECT:

CIE Exams	PO 1, P02, PO 3, PO 6	SEE Exams	PO 1, PO 2, PO 3, PO 6	Seminar and Term Paper	PO 1, P0 2, PO 3, PO 6
Viva	-	Mini Project	-	Laboratory Practices	-

XIII. ASSESSMENT METHODOLOGIES – INDIRECT:

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIV. SYLLABUS:

UNIT -I	INTRODUCTION
Definition, types of research, research approaches, research process, validity and reliability in research, features of good design, types of research design, and basic principles of experimental design.	
UNIT - II	**MEASUREMENT AND SCALING TECHNIQUES**
Errors in measurement, tests of sound measurement, scaling and scale construction techniques, forecasting techniques, time series analysis, interpolation and extrapolation.	
UNIT - III	**METHODS OF DATA COLLECTION**
Primary data, questionnaire and interviews, collection of secondary data, cases and schedules. Professional attitude and goals, concept of excellence, ethics in science and engineering, some famous frauds in science, case studies.	

UNIT - IV	INTERPRETATION OF DATA AND REPORT WRITING
Layout of a research paper, techniques of interpretation, making scientific presentation at conferences and popular lectures to semi technical audience, participating in public debates on scientific issues.	
UNIT - V	**INTRODUCTION TO INTELLECTUAL PROPERTY**
Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights; Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law; Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.	

Text Books:

1. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International Publishers,
2. P. Gupta, "Statistical Methods", Sultan Chand and Sons, New Delhi, 1st Edition, 2005.
3. Richard W. Stim, "Intellectual Property: Patents, Trademarks, and Copyrights", Cengage Learning, 2nd Edition, 2001.

Reference Books:

1. P. Narayana Reddy, G. V. R. K. Acharyulu, "Research Methodology and Statistical Tools", Excel Books, New Delhi, 1st Edition, 2008.
2. Prabuddha Ganguli, "Intellectual Property Right, Unleashing the Knowledge Economy", Tata Mc Graw Hill Publishing Company Ltd, 1st Edition, 2001.

XV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topic Outcomes	Topics to be covered	Reference
1-3	Describe research approaches, techniques and strategies in the appropriate manner for decision making process.	Definition, types of research, research approaches, research process, validity and reliability.	T1:1
4-6	Describe the features of design, experimental design.	Features of good design, types of research design, and basic principles of experimental design.	T1:1.5
7-9	Understand the errors in measurement, scale construction techniques.	Errors in measurement, tests of sound measurement, scaling and scale construction techniques	T1:1.5
10-13	Evaluate the forecasting techniques and describe the interpolation and extrapolation.	Forecasting techniques, time series analysis, interpolation and extrapolation.	T2:4.1
14-16	Understand the requirement of primary data and secondary data.	Primary data, questionnaire and interviews, collection of secondary data, cases and schedules.	T2:7.8
17-20	Understand the professional attitude and goals, excellence.	Professional attitude and goals, concept of excellence, ethics in science and engineering, some famous frauds in science, case studies, models, validating models.	T2:2.3
21-24	Describe the research paper, public debates on scientific issues.	Layout of a research paper, techniques of interpretation, making scientific presentation at conferences and popular lectures to semi technical audience, participating in public debates on scientific issues.	T2:5.1
25-28	Identify the types of intellectual property.	Introduction, types of intellectual property, international organizations, agencies and treaties	T1: 5.3, T2:3.2
29-32	Understand the Importance of intellectual property rights.	Importance of intellectual property rights.	T2:10.2

Lecture No	Topic Outcomes	Topics to be covered	Reference
32-36	Describe the Law of copy rights.	Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly.	T2:11
37-40	Describe the Copy right ownership issues.	Copy right ownership issues, copy right registration, notice of copy right, international copy right law.	T2:11
41-45	Understand the law of patents.	Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.	T1:96-97

XVI. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs
1	Product development	Project/ Term Paper	PO 2, PO 3, PO 6
2	Research programs	Seminars / Guest Lectures / NPTEL	PO 2, PO 3

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MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPUTER AIDED MACHINING AND ROBOTICS LABORATORY**			
Course Code	BCC102			
Programme	M. Tech (CAD/CAM)			
Semester	II	ME		
Course Type	Core			
Regulation	**IARE - R16**			
	Lectures	**Tutorials**	**Practical**	**Credits**
	-	-	3	2
Course Faculty	Mr. C. Labesh Kumar, Assistant Professor			

I. COURSE OVERVIEW:

This course provides knowledge of machining and robotic simulations. It covers the concepts for Part programing for sequence of operation, tool setting, sub routines and use of cycles. Numerical control programing for tool path generation for milling and turning operations. 3-D simulation for operations like picks and place robot

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
PG	BCC005	II	Computer Aided Manufacturing	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Computer Aided Machining And Robotics Laboratory	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	CHALK &TALK	✔	VIVA	✘	ASSIGNMENTS	✘	Moocs
✔	LCD / PPT	✘	SEMINARS	✘	MINI PROJECT	✘	VIDEOS
✘	OPEN ENDED EXPERIMENTS						

V. EVALUATION METHODOLOGY:

Continuous internal assessment (CIA):

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, with 20 marks for day to day evaluation and 10 marks for Internal Examination (CIE).

Semester End Examination (SEE):
The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the this courses is contains 12 experiments. The question paper pattern is as follows: Two full questions with 'either' 'or' choice will be drawn from each set. Each set contains 4 questions.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 10 marks for Continuous Internal Examination (CIE), 20 marks for Day to Day Evaluation.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Day to Day Evaluation	
CIA Marks	10	20	30

Continuous Internal Examination (CIE):
Two CIE exam shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration consisting of two sets.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		**Strength**	**Proficiency assessed by**
PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineeringspecialization to the solution of complex engineering problems.	3	Lab related Exercises
PO 2	Identify, formulate, review research literature, and analyze complex engineering problemsreaching substantiated conclusions using first principles of mathematics, natural sciences, andengineering sciences	2	Lab related Exercises
PO 5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT toolsincluding prediction and modeling to complex engineering activities with an understanding of thelimitations.	3	Lab related Exercises

3= High; 2 = Medium; 1 = Low

VII. COURSEOBJECTIVES:

The course should enable the students to:	
I	Create the part model using CAM software.
II	Generate computer numerically part program for computer numerically control turning and milling operation.
III	Demonstrate the tool path for turning operation using CAM software

VIII. COURSEOUTCOMES (COs):

CLO Code	CO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BCC102.01	CO 1	Understanding the concepts of machining and robotic simulations	PO1	3
BCC102.02	CO 2	Understand Part programing for sequence of operation, tool setting, sub routines and use of cycles.	PO1 PO5	3
BCC102.03	CO 3	Numerical control programing for tool path generation for milling and turning operations	PO1 PO2	3
BCC102.04	CO 4	3-D simulation for operations like picks and place robot	PO1 PO2	2
BCC102.05	CO 5	Practice of robotic languages	PO1 PO2	2

3= High; 2 = Medium; 1 = Low

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes (COs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3						
CO 2	3				3		
CO 3	3	3					
CO 4	2	2					
CO5	2	2					

3= High; 2 = Medium; 1 = Low

X. ASSESSMENT METHODOLOGIES–DIRECT:

CIE Exams	PO 1, PO 2, PO 5	SEE Exams	PO 1, PO 2, PO5	Assignments	-	Seminars	-
Laboratory Practices	PO 1, PO 2, PO 5	Student Viva	PO 1, PO 2, PO 5	Mini Project	-	Certification	-
Term Paper	-						

XI. ASSESSMENT METHODOLOGIES–INDIRECT:

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XII. SYLLABUS:

S No.	Experiment
1	Tool planning and selection of sequences of operation, tool setting on machine-practice
2	Practice in part programming and operation of CNC turning machines, sub routines and use of cycles.
3	Practice in part program and operation of a machine center, joining and selection of sequence ofoperation, tool setting on machine.
4	Generate APT based NC programming and tool simulation for drilling operation.
5	Practice in APT based NC programming and tool simulation for facing operation.
6	Generate of NC code generation and tool path simulation for profile milling operation using CAMsoftware.
7	Develop NC code and tool path simulation for thread operation using CAM software.
8	Practice of robotic languages, 3-D Robot Simulation for operation of pick-place robot

XIII. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No.	Learning Objectives	Topics to be covered
1-3	Over view of Tool planning and selection of sequences of operation, tool setting on machine-practice.	Tool planning and selection of sequences of operation, tool setting on machine-practice.
4-6	Understand part programming and operation of CNC turning machines	Part programming on CNC Turning.
7-9	Understand sub routines and use of cycles	Part programming on CNC Turning.
10-12	Understand APT based NC programming and tool simulation for drilling operation.	NC programming and tool simulation for drilling operation.
13-15	Understand APT based NC programming and tool simulation for facing operation	NC programming and tool simulation for facing operation.
16-18	Understand the NC code generation and tool path simulation for profile milling operation using CAM software.	NC code generation and tool path simulation for profile milling operation using CAM software.
19-21	Understand NC code and tool path simulation for thread operation using CAM software.	NC code and tool path simulation for thread operation using CAM software.
22-24	Understand the characteristics of 3-D Robot Simulation	Demo on 3-D Robot Simulation
25-27	Understand the concepts of operations in 3-D Robot.	3-D Robot Simulation operation
28-30	Understand the functionality of 3-D Robot Simulation operation	Practice of robotic languages
31-33	Understand robotic languagesfor operation of pick-place.	Designing a program for operation of pick-place.

Lecture No.	Learning Objectives	Topics to be covered
34-36	Understand 3-D Robot operation and timers.	Designing a program to understand the operation of 3-D Robot.
37-39	Internal Lab Exam	CIE-I

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