ANNA UNIVERSITY, CHENNAI

NON- AUTONOMOUS COLLEGES

AFFILIATED TO ANNA UNIVERSITY

M.E. CAD / CAM

REGULATIONS 2025

PROGRAMME OUTCOMES (POs):

PO	Programme Outcomes
PO1	An ability to independently carry out research /investigation and development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PROGRAMME SPECIFIC OUTCOMES (PSOS)

PSO	Programme Specific Outcomes
PSO1	Apply advanced manufacturing and materials engineering techniques to design and optimize sustainable production systems.
PSO2	Integrate smart technologies and sustainable practices for innovative product development and lifecycle management.

ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (NON-AUTONOMOUS AFFILIATED INSTITUTIONS)

Programme: M.E., CAD / CAM **Regulations:** 2025

Abbreviations:

BS – Basic Science (Mathematics, Physics, Chemistry)

ES – Engineering Science (General (**G**), Programme Core (**PC**), Programme Elective (**PE**)

SD – Skill Development

OE – Open Elective

L –Laboratory Course

T – Theory

LIT –Laboratory Integrated Theory

PW – Project Work

TCP –Total Contact Period(s)

Semester I

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	MA25C06	Applied Mathematical and Statistical Modelling	T	3	1	0	4	4	BS
2.	CD25C01	Computer Graphics	LIT	3	0	2	5	4	ES (PC)
3.	CC25101	Applied Materials Engineering	T	3	0	0	3	3	ES (PC)
4.	CC25102	Computer Aided Manufacturing	LIT	3	0	2	5	4	ES (PC)
5.	ED25C07	Design for Sustainability	T	3	0	0	3	3	ES (PC)
6.	ED25C06	Integrated Product Design and Development	T	3	0	0	3	3	ES (PC)
7.	CC25103	Technical Seminar	-	0	0	2	2	1	SD
						Total Credits	**25**	**22**	

Semester II

S. No.	Course Code	Course Title	Type	Periods per week L	T	P	TCP	Credits	Category
1.		Finite Element Methods	LIT	2	0	4	6	4	ES (PC)
2.		Additive Manufacturing	T	3	0	0	3	3	ES (PC)
3.		Product Life Cycle Management	T	3	0	0	3	3	ES (PC)
4.		Programme Elective – I	T	3	0	0	3	3	ES (PE)
5.		Programme Elective – II	T	3	0	0	3	3	ES (PE)
8.		Advanced Computing Laboratory	L	0	0	4	4	2	ES (PC)
9.		Industry-Oriented Course I	--	1	0	0	1	1	SD
		Self-Learning Course	--	-	-	-	-	1	-
						Total Credits	**23**	**20**	

Semester III

S. No.	Course Code	Course Title	Type	Periods per week L	T	P	TCP	Credits	Category
1.		Programme Elective III	T	3	0	0	3	3	ES (PE)
2.		Programme Elective IV	T	3	0	0	3	3	ES (PE)
3.		Programme Elective V	T	3	0	0	3	3	ES (PE)
4.		Industrial Training	--	--	--	--	--	2	SD
5.		Open Elective	T	3	0	0	3	3	--
6.		Industry-Oriented Course II	--	1	0	0	1	1	SD
7.		Project Work I	PW	0	0	12	12	6	SD
						Total Credits	**25**	**21**	

Semester IV

S. No.	Course Code	Course Title	Type	Periods per week L	T	P	TCP	Credits	Category
1.		Project Work II	PW	0	0	24	24	12	SD
						Total Credits	**24**	**12**	

PROGRAMME ELECTIVE COURSES (PE)

S. No.	Course Code	Course Title	Periods per week			Total Contact Periods	Credits
			L	T	P		
1.		Computer Integrated Manufacturing	3	0	0	3	3
2.		Mechatronics and Automation	3	0	0	3	3
3.		Industrial Robotics and Artificial Intelligence	3	0	0	3	3
4.		Advanced Optimization Techniques	3	0	0	3	3
5.		Design for Manufacturing and Assembly	3	0	0	3	3
6.		Sensors for Manufacturing and Condition Monitoring	3	0	0	3	3
7.		Composite Materials and Mechanics	3	0	0	3	3
8.		Industrial Automation	3	0	0	3	3
9.		Machine Learning for Intelligent Systems	3	0	0	3	3
10.		Digital Twin and Industry 5.0	3	0	0	3	3
11.		Quality and Reliability Engineering	3	0	0	3	3
12.		Design with Advanced Materials	3	0	0	3	3
13.		Mechanical Behaviour of Materials and their Measurements	3	0	0	3	3
14.		Design of Hydraulic and Pneumatic Systems	3	0	0	3	3
15.		Design of Hybrid and Electric Vehicles	3	0	0	3	3

Semester I

MA25C06	Applied Mathematical and Statistical Modelling	L	T	P	C
		3	1	0	4

Course Objectives:

- To equip students with advanced mathematical techniques, specifically Fourier Transforms, for formulating and solving partial differential equations that model fundamental mechanical engineering phenomena such as heat transfer, vibrations, and fluid flow.
- To provide a strong foundation in statistical inference, enabling students to estimate population parameters (like material properties and process capabilities) from experimental data and assess the quality and reliability of these estimators.
- To enable students to design efficient, structured experiments and apply appropriate statistical tests to make valid, data-driven decisions for comparing processes, optimizing designs, and solving complex engineering problems.

Fourier Transform: Definitions, Properties, Transform of elementary functions, Dirac delta function, Convolution theorem, Parseval's identity, Solutions to partial differential equations: Heat equation, Wave equation, Laplace and Poison's equations.

Estimation Theory: Unbiasedness, Consistency, Efficiency and sufficiency, Maximum likelihood estimation, Method of moments.

Testing of Hypothesis: Sampling distributions, Small and large samples, Tests based on Normal, t, Chi square, and F distributions for testing of means, variance and proportions, Analysis of r x c tables, Goodness of fit, independent of attributes.

Design of Experiments: Analysis of variance, One way and two-way classifications, Completely randomized design, Randomized block design, Latin square design, 2^2 Factorial design.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

References:

1. Andrews, L. C., & Shivamoggi, B. K. (2003). Integral transforms for engineers. Prentice Hall of India.
2. Devore, J. L. (2014). Probability and statistics for engineering and the sciences, Cengage Learning.
3. Johnson, R. A., Miller, I., & Freund, J. (2015). Miller and Freund's probability and statistics for engineers, Pearson Education Asia.

E-resources:

1. https://www.edx.org/learn/probability-and-statistics/massachusetts-institute-of-technology-probability-the-science-of-uncertainty-and-data
2. https://www.itl.nist.gov/div898/handbook/
3. https://ocw.mit.edu/courses/2-830j-control-of-manufacturing-processes-sma-6303-spring-2008

CD25C01	Computer Graphics	L	T	P	C
		3	0	2	4

Course Objectives:
The primary objective of this course is to equip students with a comprehensive understanding of computer graphics principles, algorithms, and modeling techniques essential for engineering applications. The course aims to build foundational knowledge in 2D and 3D graphics, scan-conversion algorithms, and geometric transformations. It develops the ability to model curves, surfaces, and solids using analytical and synthetic methods, including advanced tools such as NURBS. Students will gain proficiency in visibility determination and rendering techniques to simulate realistic graphics. Additionally, the course introduces concepts of assembly modeling, tolerance analysis, and product lifecycle management to integrate design, simulation, and visualization skills relevant to modern computer-aided design environments.

Fundamentals of Computer Graphics and Scan Conversion: Introduction to Computer Graphics, Scan-conversion of Lines: Digital Differential Analyzer (DDA) Algorithm, Bresenham’s Line Drawing Algorithm, Scan-conversion of Circles and Ellipses: Bresenham’s Circle Drawing Method, Midpoint Circle Algorithm, Drawing Ellipses and Other Conics

Activities: Manual Implementation of Bresenham’s Line and Circle Algorithms: Plot pixels on graph paper and replicate the same using code; observe the difference in pixel placement and accuracy.

2D and 3D Transformations and Clipping: Introduction to 2D and 3D Transformations, Transformation Matrix, 2D Transformations: Identity, Scaling, Rotation, Translation, Reflection, Shear, Rotation about Arbitrary Point, Combined Transformations. Clipping Techniques: 2D Clipping: Point, Line, Polygon Clipping, 3D Viewing and Clipping, Text Clipping

Activities: Hands-on 2D Transformations Using Paper Cutouts: Physically perform translation, rotation, scaling, reflection, and clipping on shape cutouts to understand transformation matrices.

Curve and Surface Modeling: Introduction to Curves: Analytical Curves: Line, Circle, Conics, Synthetic Curves: Hermite Cubic Spline, Bézier Curve, B-Spline Curve, Curve Manipulations, Introduction to Surfaces: Analytical Surfaces: Plane, Ruled, Revolution, Tabulated Cylinder, Synthetic Surfaces: Hermite Bicubic, Bézier, B-Spline, Surface Manipulations

Activities: Sketching and Interpreting Bézier Curves: Manually construct Bézier curves using control points and then compare results with simulation using MATLAB or Python.

Nurbs and Solid Modeling Techniques: NURBS Basics: Curves, Lines, Arcs, Circle, Bilinear Surface, Solid Modeling Techniques: Regularized Boolean Set Operations, Primitive Instancing, Sweep Representations, Boundary Representations, Constructive Solid Geometry (CSG) Comparison of Solid Representations, User Interface for Solid Modeling

Activities: Solid Modeling Using Free CAD Tools: Design simple components by applying Boolean operations and sweep features to reinforce constructive solid geometry concepts.

Visibility, Rendering, and Shading Techniques: Visible and Hidden Surface Removal: Coherence, Bounding Volumes, Back Face Culling, Painter's Algorithm, Z-Buffer, Floating Horizon, Roberts Algorithm, Object Rendering: Lighting and Illumination Models, Shading Techniques: Flat, Gouraud, Phong, Polygon Mesh Shading, Advanced Effects: Transparency, Shadows, Texture Ray Tracing, Ray Casting, Radiosity, Color Models

Activities: Shadow and Visibility Demonstration Using 3D Block Models: Use a torchlight on physical models to simulate surface visibility, shading, and hidden surface removal principles.

Assembly Modeling and Product Lifecycle: Assembly of Parts: Design for Manufacture (DFM), Design for Assembly (DFA), Computer-Aided DFMA, Position & Orientation Inferences, Tolerance Analysis, Center of Gravity & Mass Property Calculation, Mechanism Simulation, Product Lifecycle Management (PLM): Product Development and Management, Models for New Product Development, Graphics & Computing Standards, Data Exchange Standards

Activities: CAD activity: Assemble 2–3 parts with constraints and generate exploded views**.,** Case study discussion: How PLM integrates design, manufacturing, and lifecycle management**.**

List of Experiments:

Cad Module

1. Sketching and Part modelling (Solid modelling, Surface modelling, Feature manipulation) of mechanical components using CAD software package.
2. Assembly (Constraints, Exploded Views, Interference check) and Drafting (Layouts, Geometric Dimensions &Tolerance Standards, Sectional Views, & Detailing) of mechanical components using CAD software package
3. Working with CAD Data Exchange formats: IGES, PDES, PARASOLID, DXF and STL.
4. Study and exercise on freeform modelling.
5. Reverse engineering the given product/component and convert the data into 3Dmodel.
6. Exercise on. STL file Preparation, Slicing, Support Structure Generation & Build setup Preparation.

List of items (hardware/software) required:

1. Computers 24 Nos. 2. CAD software Package 3. Open source CAD software for Additive Manufacturing 4. CAE Software package

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References:

1. Boothroyd, G. (1991). Assembly automation and product design. Marcel Dekker.
2. Chitale, A. K., & Gupta, R. C. (2023). Product design and manufacturing (7th ed.). PHI Learning Private Limited.
3. Rogers, D. F., & Adams, J. A. (2017). Mathematical elements for computer graphics (2nd ed.). Tata McGraw-Hill.
4. Hearn, D. D., & Baker, M. P. (1997). Computer graphics C version (2nd ed.). Prentice Hall.
5. Zeid, I. (2006). Mastering CAD/CAM (2nd ed.). McGraw Hill.
6. Newman, W. M., & Sproull, R. F. (2001). Principles of interactive computer graphics (1st ed.). McGraw Hill.

E-Resources:

1. Bhattacharya, S. (2025). Computer Graphics [NPTEL Online Course]. Indian Institute of Technology Guwahati. Retrieved from https://onlinecourses.nptel.ac.in/noc25_cs133
2. Indian Institute of Technology Delhi, Department of Computer Science & Engineering. (2023). Introduction to Computer Graphics [NPTEL Course No. 106102065]. National Programme on Technology Enhanced Learning (NPTEL). Retrieved from https://nptel.ac.in/courses/106/102/106102065
3. Das, S. (2008). Lecture Series on Computer Graphics [YouTube Video Lectures]. Indian Institute of Technology Madras. Retrieved from https://www.youtube.com/watch?v=_f_pHgRQPPE

	Description of CO	PO	PSO1	PSO2
CO1	Understand and implement fundamental computer graphics algorithms such as scan-conversion, 2D/3D transformations, and clipping techniques.	PO3 (3)	2	2
CO2	Model curves, surfaces, and solids using analytical and synthetic methods, including NURBS and solid modeling techniques.	PO3 (3)	3	2
CO3	Apply visibility determination, rendering, and shading techniques to generate realistic images and simulations.	PO3 (3)	3	2
CO4	Integrate CAD assembly modeling, tolerance analysis, and product lifecycle management concepts for effective product design and visualization.	PO1 (2), PO2 (2), PO3 (3)	3	3

CC25101	Applied Materials Engineering	L	T	P	C
		3	0	0	3

Course Objectives:

- To provide knowledge in the areas of elastic and plastic behavior of materials, and fracture behavior of materials.
- To elaborate the theories on plastic forming and applications of advanced materials.
- To study about the selection of material.

Elastic and Plastic Behaviour: Deformation Mechanisms: Elastic, plastic, and viscoelastic behavior; mechanisms of elastic and plastic deformation.Crystalline Deformation: Shear strength of perfect and real crystals; deformation by slip and twinning. Strengthening Mechanisms: Solid solution strengthening, grain boundary strengthening, polyphase mixture strengthening, precipitation strengthening, particle, fiber, and dispersion strengthening; work hardening.

Fracture Behaviour: Fracture: Types of fracture (ductile, brittle), Griffith's theory, ductile-to-brittle transition in steel.

Fatigue of Metals: Strain-life equation, low and high cycle fatigue tests, crack initiation and propagation mechanisms.

High Temperature Fracture: Creep and stress rupture; characteristics of high-temperature alloys; brittle-fracture problem.

Activities: Calculate elastic strain energy, yield strength, and plastic strain for given stress–strain data. Use software (ANSYS/ABAQUS/CAE tools) to visualize crack propagation under cyclic load, Paper clip bending experiment → students observe crack initiation and failure.

Plastic Forming of Metals: Fundamentals of Metal Working: Mechanics of metal working, flow-stress distribution, residual stresses, temperature effects in metal working.

Forging: Forging in plane strain, open and closed die forging.

Rolling: Forces and geometrical relationships in rolling, theories of cold and hot rolling.

Sheet Metal Forming: Bending and stretch forming.

Activities: Sheet metal bending with simple fixtures to observe spring-back.

Advanced Materials: Advanced Metallic Alloys: High strength ferrous and non-ferrous alloys; properties and applications.

Engineering Plastics: Properties and applications of various engineering plastics.

Composites: Introduction to composite materials, types, properties, and applications.

Emerging Materials: Functionally gradient materials (FGMs), Smart materials (e.g., shape memory alloys, piezoelectric materials), Nano materials, Biomaterials.

Activities: Case Study**:** Students research and present applications of smart materials

(SMA in medical stents, piezoelectric in sensors, nanomaterials in coatings), Prepare comparison tables for engineering plastics vs composites vs biomaterials.
Selection of Materials: Fundamentals of Material Selection: Motivation for material selection, cost basis, and service requirements. **Selection Criteria:** Selection for mechanical properties (strength, stiffness, toughness), selection for surface durability (wear, corrosion, fatigue). **Processing-Selection Relationship:** Relationship between materials processing and material selection. **Case Studies:** Practical examples of materials selection with relevance to diverse applications such as aerospace, automotive, marine, machinery, and nuclear sectors. **Activities:** Case Study Problems: Select materials for an aircraft wing, car body, ship propeller, and biomedical implant, Rank materials based on strength-to-weight ratio and cost efficiency.
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%
Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)
References: 1. ASM International. (2002). ASM handbook, volume 11: Failure analysis and prevention. ASM International. 2. ASM International. (1990). ASM handbook, volume 02: Properties and selection: Nonferrous alloys and special-purpose materials. ASM International. 3. Dieter, G. E., & Bacon, D. (2021). Mechanical metallurgy (4th ed.). McGraw Hill Education. 4. Smallman, R. E., & Ngan, A. H. W. (2007). Physical metallurgy and advanced materials. Butterworth-Heinemann. 5. Crane, F. A. A., Charles, J. A., & Furness, J. A. G. (2006). Selection and use of engineering materials. Reed Elsevier India.

E-Resources:
1. "Introduction to Materials Science and Engineering" by Prof. Rajaraman G. (IIT Madras): https://nptel.ac.in/courses/112106198 (Covers fundamentals, structure, properties, and some processing). 2. "Mechanical Behavior of Materials" by Prof. S. Sankaran (IIT Madras): https://nptel.ac.in/courses/112106290 (Directly relevant to Unit I and II). 3. "Fundamentals of Manufacturing Processes" by Prof. D. K. Dwivedi (IIT Roorkee): https://nptel.ac.in/courses/112107212 (Covers metal forming processes relevant to Unit III). 4. "Advanced Engineering Materials" by Prof. B.S. Murty (IIT Madras): https://nptel.ac.in/courses/113106032 (Covers advanced materials, relevant to Unit IV).
Other Resources: Science and Technology of Materials": https://ocw.mit.edu/courses/3-016-science-and-technology-of-materials-fall-2009/

	Description of CO	PO	PSO1	PSO2
CO1	Understand and explain the elastic, plastic, and fracture behavior of engineering materials.	PO1 (3), PO3 (3)	1	1
CO2	Analyze and apply theories of plastic deformation and metal forming processes such as forging, rolling, and sheet metal forming.	PO1 (3), PO3 (3)	2	1
CO3	Evaluate the properties and applications of advanced materials including composites, engineering plastics, smart materials, and biomaterials.	PO1 (3), PO3 (3)	3	3
CO4	Develop skills in selecting appropriate materials based on mechanical properties, surface durability, cost, and processing considerations for various engineering applications.	PO1 (3), PO2 (2), PO3 (3)	2	3

CC25102	Computer Aided Manufacturing	L	T	P	C
		3	0	2	4

Course Objectives:

- To introduce the evolution of CAD, CAM, CIM, engineering product specification and interpreting geometric specifications.
- To train the candidates on the integration of Computer Aided Design and Computer Aided Manufacturing and to introduce with the implementation of CAD and CAM in manufacturing process
- To impart knowledge on manual part program and generation of CNC part program using Computer Aided Manufacturing packages and to introduce the importance of Internet of Things in Computer Aided Manufacturing

Introduction to CAM and CAD/CAM Integration: Introduction to CAD, CAM, CAE, CIM, system configuration for CAM including hardware and software, evolution of product realization, historical development, engineering product specification, geometric tolerancing – ASME, ISO and DIN standards, interpreting geometric specifications, multiple part features and datum. Introduction to CAD and CAM integration, networking – techniques, components, interface cards, network standards, graphics standards – graphical kernel system, data exchange formats – IGES and STEP, integration of CAD and CAM in CNC turning center and machining center.

Activities: Students create a simple CAD model in SolidWorks/AutoCAD and apply GD&T symbols, Group Activity**:** Explore different CAD–CAM–CAE software (AutoCAD, SolidWorks, CATIA, NX, ANSYS) and present integration capabilities.

Process Planning and Enterprise Systems: Process planning, computer-aided process planning (CAPP), product life cycle management (PLM), enterprise resource planning (ERP).

Activities: Use a CAPP software/demo version to generate process routes, Simulate how PLM/ERP integrates design, manufacturing, and supply chain in a classroom scenario.

CNC Machines and Hardware Components: CNC machine building, structural details, guide ways – friction, anti-friction and other types, motion conversion elements – screw and nut, recirculating ball screw, spindle assembly, torque transmission elements – gears, timing belts, flexible couplings, bearings, spindle and feed drives, linear motors –

open loop and closed loop control, axis measuring systems – grating, linear scale, encoder, laser interferometer, spindle cooling systems, coolant types – through and shower coolant, integral spindle with HSK & Big Plus spindle, double ball screws, grease lubricating system, probing for zero offsets and first-off inspection, tool breakage detecting system, in-process gauging system, ATC, APC

Activities: Disassemble and assemble a ball screw or spindle bearing (if lab facility exists), : Use online CNC simulator (e.g., FANUC Simulator, NC Viewer) to understand hardware/software interaction.

CNC Programming and IoT in CAM: Structure of CNC program, coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, mirroring features, manual part programming for CNC turning and machining center, macro programming, wire EDM, abrasive water jet cutting, bulk and sheet metal forming, generation of CNC program using CAM software. Introduction to IoT in CAM, overview of IoT-enabled manufacturing systems, real-time and multi-source manufacturing information sensing, IoT-enabled smart assembly station, cloud computing-based manufacturing resources configuration, real-time key production performance analysis, real-time information-driven production scheduling.

Activities: Write G & M code manually for turning and milling operations, Students create a cloud-based dashboard mock-up for real-time machine status visualization.

List of Experiments:

1. Programming and simulation for various operations using canned cycle for CNC turning Centre.
2. Programming and simulation for machining of internal surfaces in CNC turning Centre
3. Programming and simulation for profile milling, circular and rectangular pocket milling operations
4. Programming and simulation using canned cycle for CNC Milling such as peck drilling and tapping cycle
5. CNC code generation using CAM software packages – Milling and Turning
6. Study on RDBMS and its application in problems like inventory control MRP.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References:

1. Radhakrishnan, P. (2014). Computer numerical control machines and computer aided manufacture. New Academic Science.
2. Nee, Y. C., Soh, K., Ong, Y. G., & Wang, Y. (2012). Computer applications in near net shape operations (softcover reprint of 1st ed.). Springer Nature.
3. Zhang, Y., & Tao, F. (2017). Optimization of manufacturing systems using the internet of things. Academic Press.
4. Chang, T. C., Wysk, R. A., & Wang, H. P. (2009). Computer aided manufacturing Pearson Prentice Hall.
5. HMT. (c. 2011). Mechatronics. Tata McGraw Hill Publishing Company.
6. Rao, P. N. (2010). CAD/CAM: Principles and applications. Tata McGraw Hill.

E-Resources:

1. Chawla, A., & Madhusudan Rao, P. V. (2012). *Computer Aided Design and Manufacturing* [Video lectures]. National Programme on Technology Enhanced Learning (NPTEL), IIT Delhi. Retrieved from https://nptel.ac.in/courses/112102101
2. Ramkumar, J., & Singh, A. (2021). *Computer Integrated Manufacturing (CIM)* [Online course]. National Programme on Technology Enhanced Learning (NPTEL), IIT Kanpur. Retrieved from https://onlinecourses.nptel.ac.in/noc21_me65/preview
3. Ramkumar, J. (2022). *Automation in Manufacturing* [Online course]. National Programme on Technology Enhanced Learning (NPTEL), IIT Kanpur. Retrieved from https://onlinecourses.nptel.ac.in/noc22_me123/preview

Other Resources:

1. Subirana, B., & Malone, T. W. (2003). *Information Technology as an Integrating Force in Manufacturing* (Course No. 15.566). MIT OpenCourseWare, Massachusetts Institute of Technology. Retrieved from https://ocw.mit.edu/courses/15-566-information-technology-as-an-integrating-force-in-manufacturing-spring-2003/
2. Boning, D. S., & Hardt, D. E. (2008). *Control of Manufacturing Processes* (Course No. 2.830J). MIT OpenCourseWare, Massachusetts Institute of Technology. Retrieved from https://ocw.mit.edu/courses/2-830j-control-of-manufacturing-processes-spring-2008/

	Description of CO	**PO**	**PSO1**	**PSO2**
CO1	Understand the fundamentals of CAD, CAM, CIM, and their integration in manufacturing processes, including geometric tolerancing standards.	PO1 (3), PO3 (3)	1	1
CO2	Develop and simulate CNC part programs manually and using CAM software for turning and milling operations.	PO1 (3), PO3 (3)	2	1
CO3	Analyze CNC machine components, their functions, and control systems including tool compensation and probing systems.	PO1 (3), PO3 (2)	3	2
CO4	Apply Internet of Things (IoT) concepts in CAM for smart manufacturing, real-time monitoring, and production optimization.	PO1 (3), PO2 (2), PO3 (3)	2	3

ED25C07	Design for Sustainability	L	T	P	C
		3	0	0	3

Course Objective:

The main learning objective of this course is to prepare the students for understanding the design for sustainable behaviour and design practices.

Foundations of Sustainable Design: Understanding sustainability through design**-** Challenges and evolution toward sustainable solutions**-** Product lifecycle design and eco-efficient product-service systems (PSS)**-** Eco-design principles, strategies, and green design methodologies

Activities: Lifecycle Mapping and Eco-Design Redesign

Design for Sustainable Behaviour (DSB): Behavioral change through design**-** Comprehensive Action Determination Model (CADM), Methods and tools to support sustainable behaviour**-** Individual cognitive vs context-driven approaches**-** Frameworks and future research in DSB

Activities: Designing for Sustainable User Behavior Using CADM

Design for Environment (DE): Global, regional, and local environmental objectives**-** Lifecycle assessment (LCA) methods and tools, Environmentally responsible product assessment (e.g., AT&T method), Design techniques: minimizing material use, disassembly, recyclability, energy efficiency.

Activities: Lifecycle Assessment of Competing Product Designs

Product-Service Systems and Systemic Sustainability Design: Transition from product to integrated product-service design- Categories and practices of PSS for sustainability- Systemic design at regional/territorial levels- Regulatory frameworks, innovation levels, and evolution of sustainable design.

Activities:

Conceptualizing a Sustainable Product-Service System (PSS)
Systemic Design Case Study: Regional Sustainability in Practice

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References:

1. Ceschin, F., & Gaziulusoy, I. (2020). Design for sustainability: A multi-level framework from products to socio-technical system. Routledge.
2. Boothroyd, G. (1980). Design for assembly automation and product design. Marcel Dekker.
3. Bralla, J. G. (1999). Design for manufacture handbook. McGraw-Hill.
4. Boothroyd, G., Heartz, W., & Nike, P. (1994). Product design for manufacture. Marcel Dekker.

5. Dickson, J. R., & Corroda, P. (1995). Engineering design and design for manufacture: A structural approach. Field Stone Publishers.
6. Fixel, J. (1996). Design for the environment. McGraw-Hill.
7. Graedel, T. E., & Allenby, B. R. (1996). Design for the environment. Pearson.
8. Otto, K., & Wood, K. (2009). Product design (4th impression). Pearson.

E-resources:

1. Massachusetts Institute of Technology, Department of Civil & Environmental Engineering. (2006). *Design for Sustainability* (Course No. 1.964, Fall 2006). MIT OpenCourseWare. Retrieved from https://ocw.mit.edu/courses/1-964-design-for-sustainability-fall-2006/
2. University of Melbourne, Department of Mechanical Engineering. (2023). *Sustainable and Life Cycle Engineering* (Subject Code: MCEN90060). University of Melbourne Handbook. Retrieved from https://handbook.unimelb.edu.au/2023/subjects/mcen90060
3. Jolliet, O. (2023). *Life Cycle Assessment*. University of Michigan. Coursera Online Course. Retrieved from https://www.coursera.org/learn/life-cycle-assessment

Other Resources:

Science and Technology of Materials": https://ocw.mit.edu/courses/3-016-science-and-technology-of-materials-fall-2009/

	Description of CO	PO	PSO1	PSO2
CO1	Understand the foundations of sustainable design, including eco-design principles, lifecycle thinking, and sustainable product-service systems.	PO1 (3), PO3 (3)	1	1
CO2	Analyze and apply design strategies to influence sustainable behavior using models like the Comprehensive Action Determination Model (CADM).	PO1 (3), PO3 (3)	2	3
CO3	Conduct lifecycle assessment (LCA) and environmentally responsible product evaluations to minimize environmental impact in design.	PO1 (3), PO3 (3)	3	2
CO4	Develop sustainable product-service systems and systemic design approaches addressing regional and global sustainability challenges.	PO1 (3), PO2 (2), PO3 (3)	2	3

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Course Objective:

This course aims to provide a comprehensive understanding of the generic product development process, including product planning and customer need analysis. It enhances students' abilities to set product specifications and effectively generate, select, and test design concepts. Emphasis is placed on product architecture, industrial design, and Design for Manufacturing (DFM) principles. The course also introduces prototyping techniques, robust design through Design of Experiments (DoE), and the importance of patenting innovations. Additionally, it integrates economic principles and project management practices essential for successful new product development.

Introduction to Product Development: Overview of Product Development, Characteristics of Successful Products, Product Development Teams and Organizations- Challenges, Duration and Cost of Product Development, Product Development Process (Generic and Front-End), Process Flows and Opportunity Identification.

Activities: Brainstorming Session: Identifying latent vs stated needs for a new product

Product Planning and Customer Needs: Product Planning Process, Identifying and Understanding Customer Needs, Importance of Latent Needs, Establishing Target and Final Specifications

Activities: Design Review Meeting: Present and defend a selected product concept

Concept Generation, Selection and Testing: Concept Generation Activities- Concept Selection: Screening and Scoring- Concept Testing Techniques and Caveats

Activities: Use mind maps to visually expand product features and functions

Product Architecture and Industrial Design: Product Architecture, Definition, Planning, and System, Level Design; Delayed Differentiation and Platform Planning; Industrial Design, Need, Process, Management, Quality Assessment.

Activities: Product Platform Case Study: Explore delayed differentiation in brands (e.g., Dell, Toyota)

Design for Manufacturing (DFM) Principles: DFM Process Overview- Integration of Design and Manufacturing Early in the Development Cycle- Cost and Complexity Considerations; Cross-functional Collaboration for Manufacturability.

Activities: Presentation: Pros and cons of different DFM strategies in a selected industry

Prototyping, Economics & Project Management: Prototyping: Principles, Planning, and Technologies, Product Development Economics, Cost Estimation and Analysis, Project Management: Task Representation, Planning, Execution, Postmortem Evaluation of Projects. **Activities:** Prototype Demo: Create and explain a low-fidelity prototype (paper or digital)
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%
Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)
References: 1. Ulrich, K. T., Eppinger, S. D., & Goyal, A. (2012). Product design and development, McGraw-Hill Education (India) Pvt. Ltd. 2. Crow, K. (n.d.). Concurrent engineering/integrated product development [Workshop book]. DRM Associates. 3. Otto, K. N., & Wood, K. L. (2016). Product design: Techniques in reverse engineering and new product development. Pearson Education, Inc. 4. Rosenthal, S. (1992). Effective product design and development. Business One Irwin. 5. Pugh, S. (1991). Total design: Integrated methods for successful product engineering. Addison Wesley Publishing.

	Description of CO	PO	PSO1	PSO2
CO1	Understand and apply the generic product development process including product planning, customer needs analysis, and specification setting.	PO3 (3)	1	2
CO2	Generate, select, and test product concepts effectively using brainstorming, screening, scoring, and testing techniques.	PO1 (3), PO3 (2)	2	3
CO3	Apply principles of product architecture, industrial design, and Design for Manufacturing (DFM) to optimize product development for manufacturability and cost.	PO1 (3), PO3 (3)	3	2
CO4	Plan and manage product prototyping, economic analysis, and project execution using tools such as Design of Experiments (DoE) and project management techniques.	PO1 (3), PO2 (2), PO3 (3)	2	3