SRI SIDDHARTHA INSTITUTE OF TECHNOLOGY
(A Constituent College of SSAHE, Tumkur)

DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH. - PRODUCT DESIGN & MANUFACTURING (PDM)

2018-19

I Semester

Sub Code	Name of the subject	L	T	P	C	Exam Marks		Total Marks
						CIA	SEE	
18MPDM11	Product Design and Development	4	0	0	4	50	100	150
18MPDM12	Product Life Cycle Management	4	0	0	4	50	100	150
18MPDM13	Advanced Materials Technology	4	0	0	4	50	100	150
18MPDM14	Finite Element Analysis	4	0	0	4	50	100	150
18MPDM15X	Elective - I	3	0	0	3	50	100	150
18MPDM16	Technical Seminar – I	-	0	0	2	50	-	50
18MPDML17	CAM/ FEA Laboratory	0	0	3	2	50	-	50
	Total Credits				**23**	**Total Marks**		**850**

Elective - I	
18MPDM151	Simulation and Modeling of Manufacturing Systems
18MPDM152	Computer Applications in Design
18MPDM153	Lean Manufacturing Systems

PRODUCT DESIGN AND DEVELOPMENT

Sub. Code	**: 18MPDM11**	**CIE Marks:** 50
Hrs./ Week	**:** 04 (L - T– P- C**)**	**Exam Hours :** 03
Total Hrs.	**:** 52 (4 - 0 - 0 - 4**)**	**Exam Marks:** 100

Course Objectives:

- Competence with a set of tools and methods for product design and development.
- Confidence in your own abilities to create a new product.
- Awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
- Ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective and enhance team-working skills.

UNIT-I (09 Hrs)

1. **Introduction:** Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development. Development Processes and Organizations, the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

UNIT-II (10 Hrs)

2. **Product Planning:** The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.
3. **Identifying Customer Needs:** Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

UNIT-III (12 Hrs)

4. **Product Specifications:** What are specifications, when are specifications established, establishing target specifications, setting the final specifications.
5. **Concept Generation:** The activity of concept generation, clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process. Concept Selection, Overview of methodology, concept screening, and concept scoring,

UNIT-IV (12 Hrs)

6. **Concept Testing:** Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.
7. **Industrial Design:** Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process and assessing the quality of industrial design.

UNIT-V (09 Hrs)

8. **Design for Manufacturing:** Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. **Prototyping**, Prototyping basics, principles of prototyping, technologies, planning for prototypes.

Course Outcomes:

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

CO1. Understand the product design and development process.
CO2. Apply creative thinking skills for idea generation.
CO3. Translate conceptual ideas into products.
CO4. Present ideas using various types of model.

Reference Books:

1. Product Design and Development - Karl.T.Ulrich, Steven D Eppinger - Irwin McGrawHill - 2000.
2. Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3rd Edition, 2003.
3. New Product Development - Timjones. Butterworth Heinmann - Oxford. UCI -1997
4. Product Design for Manufacture and Assembly – Geoffery Boothroyd, Peter Dewhurst and Winston Knight – 2002

PRODUCT LIFE CYCLE MANAGEMENT

Sub. Code: 18MPDM12 **CIE Marks:** 50
Hrs./ Week : 04 (L - T– P- C**)** **Exam Hours:** 03
Total Hrs.: 52 (4 - 0 - 0 - 4**)** **Exam Marks:** 100

Course Objectives:

- Utilizing each stage of the product life cycle to maximize profit.

- Distinguishing the product from other by positioning your product cleverly.
- Managing price erosion of product by implementing effective strategies.
- Increasing the time period of product maturity to reap profits.
- Penetrating the new product into the market faster.

UNIT-I (10 Hrs)

1. **Product Life Cycle Management:** Need for PLM, Implementing PLM, Responsibilities of PLM, PLM in 21st century, Components of PLM,
2. **Product Data and Product workflow**: Drivers for Change, The PLM Strategy, Developing a PLM Strategy, A Five-step Process

UNIT-II (10 Hrs)

3. **Strategy Identification and Selection**: Strategy Elements, Implications of Strategy Elements, Policies, Strategy Analysis, Communicating the Strategy
4. **Change Management for PLM**: Configuration management, cost of design changes, schemes for concurrent engineering,

UNIT-III (08 Hrs)

5. **Design for manufacturing and assembly**: Robust design, failure mode and effect-analysis

UNIT-IV (12 Hrs)

6. **Modeling, Current Concepts**: Part design, sketching, use of datum's construction features, free ovulation, pattering, copying, and modifying features, reference standards for datum specification, Standards for Engineering data exchange.

UNIT-V (12 Hrs)

7. **Tolerance Mass Property Calculations**: Rapid prototyping and tooling, finite modeling and analysis, general procedure, analysis techniques,
8. **Finite Element Modeling**: Applicability of FEM, Static analysis, thermal analysis, dynamic analysis.

Course Outcomes:

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

CO1. Extend the 4Ps for product lifecycle in B2B and B2C markets, Capture the voice of customers and product competitive information

CO2. Enhance product portfolio planning and strategy

CO3. Use product value propositions for product positioning and repositioning
CO4. Strengthen and sustain the life of current products
CO5. Assess, plan and monitor a product life cycle within the company

Reference Books:

1. Product Lifecycle Management Paradigm for century Product Realization - John Stark, Springer-Verlag, 21st, London, 3rd printing -2006. 441 pp., ISBN: 1-85233-810-5.
2. CAD/CAM Theory and Practice - Zeid, Mc Graw Hill.- 1991.
3. Computer Integrated Design and Manufacturing - MarkHenderson & Philip Wolfe, Bedworth Mc Graw hill inc.- 1991.
4. Part modeling Users Guide, Engineer - I998.

ADVANCED MATERIALS TECHNOLOGY

Sub. Code: 18MPDM13 **CIE Marks:** 50
Hrs./ Week : 04 (L - T– P- C**)** **Exam Hours :** 03
Total Hrs.: 52 (4 - 0 - 0 - 4**)** **Exam Marks:** 100

Course Objectives:

- Introduce modern composite materials and their applications to students.
- Build proper background for stress and strength analysis in the design of composite materials and structures.
- To train students to be able to design composite structures, select composite materials.
- To develop an understanding of the linear elastic analysis of composite materials. This understanding will include concepts such as anisotropic material behavior and the analysis of laminated plates.
- To understand process of development of the different composite materials with advances manufacturing techniques.

UNIT-I (12 Hrs)

1. **Introduction to Composite Materials:** Definition, Classification, Types of matrices & reinforcements, characteristics &selection, Fiber composites, laminated composites, particulate composites.
2. **Macro Mechanics of a Lamina:** Hooke's law for different types of materials, number of elastic constants, Two – dimensional relationship of compliance & stiffness matrix. Hooke's law for two dimensional angle lamina, engineering constants – angle lamina, Invariants, Theories of failure.

UNIT-II (10 Hrs)

3. **Micro Mechanical Analysis of a Lamina:** Introduction, Rule of mixture, Evaluation of Density, Elastic moduli, Ultimate strength, Co-Efficient of Thermal Conductivity. Problems on them. Mechanics of transfer of load from fiber to matrix, Halpin-Tsai Equation.

UNIT-III (10 Hrs)

4. **Macro Mechanical Analysis of Laminate:** Introduction, code, Kirchoff hypothesis – CLT, A, B, & D matrices, Engineering constants, Special cases of laminates, Failure criterion.
5. **Manufacturing Composites**: Polymer matrix composite processing (PMC'S): Hand lay-up, Spray-up, filament winding, Pultrussion, Resin Transfer Moulding, and Sheet Moulding Compound.

UNIT-IV (10 Hrs)

6. **Metal Matrix Composites (MMC'S) Processing**: Liquid state processing, solid state processing and in situ Process. Ceramic matrix composite processing, Cold pressing, sintering, hot pressing and reaction process.
7. **Application Developments:** Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites.

UNIT-V (10 Hrs)

8. **Powder Metallurgy**: Process details and special characteristics of powder metallurgy process. Compaction techniques like CIP & HIP (Cold Iso-static and Hot Iso-static pressing) Applications of Powder metallurgy. High temperature alloys, Classification of Titanium alloys, properties and applications.

Course Outcomes:

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

CO1. To select the properties of reinforcement and matrix materials used in commercial composites, as well as some common manufacturing techniques.

CO2. To predict the elastic properties and analyze a advanced material for mechanical properties and find the stresses.

CO3. To the advanced manufacturing techniques for manufacturing of the advanced materials.

CO4. Understand the recent developments in composites, including metal and ceramic matrix composites.

Reference Books:

1. Mechanics of Composite Materials - Autar K.- Kaw CRC Press New York. – 1st edition, 1997.
2. Composite Material Science and Engineering - Krishan K - Chawla Springer – 1999.
3. Composite Materials Handbook - Mein Schwartz - Mc Graw Hill Book Company - 1984.
4. Mechanics of Composite Materials - Rober M. Joness – McGraw Hill Kogakusha Ltd. – 2008
5. Fiber Reinforced Composites - P.C. Mallik Marcel Decker- 2nd edition, New York -1993.
6. ASM Handbook on Powder Metallurgy, Vol 17, ASM publications

FINITE ELEMENT METHODS

Sub. Code: 18MPDM14 **CIE Marks:** 50
Hrs./ Week : 04 (L - T– P- C**)** **Exam Hours :** 03
Total Hrs. : 52 (4 - 0 - 0 - 4**)** **Exam Marks:** 100

Course Objectives:

- To provide the fundamental concepts of the theory of the finite element method:
- To develop proficiency in the application of the finite element method: modeling, analysis, and interpretation of results
- To develop to realistic engineering problems through the use of a major commercial general-purpose finite element code.

UNIT-I (12 Hrs)

1. **Introduction:** Equations of equilibrium, stress-strain relations for 2-d and 3-d, Potential energy and equilibrium, Boundary conditions, Von Misses Stresses
2. **FEM for 1-D Problems:** General procedure for FEA, Raleigh Ritz method, Galerkin Approach, shape functions, stiffness matrix, load vectors, temperature effects.

UNIT-II (10 Hrs)

3. **Applications of boundary conditions** using elimination, penalty and multi-constraint approaches, Application problems – 1-d bar element. Trusses and beams.

4. **FEM for 2-D Problems:** Shape functions, stiffness matrix, strain matrix, load vectors for CST Elements and application problems.

UNIT-III (10 Hrs)

5. **FEM for Axisymmetric problems:** Axisymmetric formulation, triangular elements, PE approach, Body force term, Rotating flywheel, Problem modeling and boundary conditions –Disks and Cylinders.

UNIT-IV (10 Hrs)

6. **FEM for Scalar field problems:** 1-d and 2-d Steady state heat transfer, torsion, potential flow and fluid flow in ducts and application problems.

UNIT-V (10 Hrs)

7. **DYNAMIC ANALYSIS:** Equations of motion for dynamic problems -- consistent and lumped mass matrices --formulation of element mass matrices free vibration and forced vibration problems formulation.

Course Outcomes:

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

CO1. Understanding the fundamental theory of the FEA method;

CO2. Develop the ability to generate the governing FE equations for systems governed by partial differential equations;

CO3. Understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements; and model multi-dimensional heat transfer problems using ANSYS;

CO4. Demonstrate the ability to evaluate and interpret FEA analysis results for design and evaluation purposes;

CO5. Develop a basic understanding of the limitations of the FE method and understand the possible error sources in its use.

Reference Books:

1. Introduction to Finite Elements in Engineering (Third Edition), Tirupathi R. Chandrupatla, Ashok D Belegundu, Prentice Hall India Pvt. Ltd., New Delhi – 2003
2. Cook R.D, Malkus D.S & Plesha M,E, "Concepts and Applications of finite Element Analysis", John Wiley & Sons, 1989.
3. Segerlind L .J "Applied Finite Element Analysis" John Wiley & Sons Edition, 1984.
4. Rao SS "The Finite Element Method in Engineering", Pergomon Press, Oxford, 2nd Edition, 1984.
5. Bathe K .J "Finite Element Procedures in Ind, Engineering Analysis", prentice Hall NewJersey, 1982.

6. Shames III & Dym C L "Energy and Finite Element Methods in Structural mechanics", Wiley eastern ltd, 1995,

ELECTIVE – I

SIMULATION AND MODELING OF MANUFACTURING SYSTEMS

Sub. Code: 18MPDM151 **CIE Marks:** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours :** 03
Total Hrs. : 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:

- To apply knowledge of mathematics and engineering to discrete event simulation problems
- To provide accurate description to the random number generation, input modeling, output analysis and comparison of alternative system design questions.
- To determine appropriate simulation models to solve any real world problems.

UNIT-I (10 Hrs)

1. **Principles of Computer Modeling and Simulation:** Monte Carlo simulation. Nature of computer- modeling and simulation. Limitations of simulation, areas of applications.
2. **System and Environment:** Components of a system -discrete and continuous systems, Models of a system -a variety of modeling approaches.

UNIT-II (10 Hrs)

3. **Discrete Event Simulation:** Concepts in discrete event simulation, manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem.
4. **Statistical Models in Simulation:** Discrete distributions, continuous distributions.

UNIT-III (11 Hrs)

5. **Random Number Generation:** Techniques for generating random numbers-Mid square method -the mod product method -Constant multiplier technique -Additive congruential method -Linear congruential method -Tests for random numbers -The Kolmogorov-Smirnov test -the Chi-square test, Runs test, Autocorrelation test, gap test, poker test.

UNIT-IV (11 Hrs)

6. **Random Variable Generation:** Inversion transforms technique-exponential distribution. Uniform distribution, Weibul distribution, continuous distribution, generating approximate normal variates-Erlang distribution.
7. **Empirical Discrete Distribution:** Discrete uniform -distribution Poisson distribution -geometric distribution -acceptance -rejection technique for Poisson distribution gamma distribution.

UNIT-V (10 Hrs)

8. **Design and Evaluation of Simulation Experiments:** variance reduction techniques -antithetic variables, variables-verification and validation of simulation models. Simulation Software**,** Selection of simulation software, simulation packages.

Course Outcomes:

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

CO1. Identify the components of the system in order to model a system.
CO2. Generate and test random numbers, variates and apply them to develop simulation models.
CO3. Fit statistical distribution to input data.
CO4. Design and Evaluation of Simulation data**.**
CO5. Evaluate the suitability of available simulation packages in relation to particular requirements.

Reference Books:

1. System Simulation with Digital Computer - Nusing Deo - Prentice Hall of India - 1979.
2. Computer Simulation and Modeling - Francis Neelamkovil - John Wiley & Sons -1987
3. Discrete Event System Simulation - Jerry Banks & .John S Carson II - Prentice Hall Inc.-1984.
4. Systems Simulation - Gordan. G - Prentice Hall India Ltd -1991.

COMPUTER APPLICATIONS IN DESIGN

Sub. Code : 18MPDM152 **CIE Marks:** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours :** 03
Total Hrs. : 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:

- Understand how CAD technology can be leveraged in the design process

- To sensitize the students with the basics of computer integrated manufacturing systems
- To gain insight into the various softwares used for modeling and manufacturing simulation
- Learn and apply all of the steps of the computer aided design process in proposing and building models in design projects.
- To provide the students with a foundation in computer aided design.

UNIT-I (12 Hrs)

1. **Introduction to CAD/CAM/CAE Systems**: Overview, Definitions of CAD.CAM and CAE, Integrating the Design and Manufacturing Processes through a Common Database-A Scenario, Using CAD/CAM/CAE Systems for Product Development-A Practical Example.
2. **Components of CAD/CAM/CAE Systems**: : Hardware Components ,Vector-Refresh (Stroke- Refresh) Graphics Devices, Raster Graphics Devices, Hardware configuration, Software Components, Windows-Based CAD Systems.

UNIT-II (08 Hrs)

3. **Basic Concepts of Graphics Programming**: Graphics Libraries, Coordinate Systems, Window and View port, Output Primitives - Line, Polygon, Marker Text, Graphics Input, Display List, Transformation Matrix, Translation, Rotation, Mapping, Other Transformation Matrices, Hidden-Line and Hidden-Surface Removal, Back-Face Removal Algorithm.

UNIT-III (08 Hrs)

4. **Geometric Modeling Systems**: Wireframe Modeling Systems, Surface Modeling Systems, Solid Modeling Systems, Modeling Functions, Data Structure, Euler Operators, Boolean Operations, Calculation of Volumetric Properties, Non manifold Modeling Systems, Assembly Modeling Capabilities, Basic Functions of Assembly Modeling, Browsing an Assembly.

UNIT-IV (12 Hrs)

5. **Representation and Manipulation of Curves**: Types of Curve Equations, Conic Sections, Circle or Circular Arc, Ellipse or Elliptic Arc, Hyperbola, Parabola, Hermite Curves, Bezier Curve, Differentiation of a Bezier Curve Equation, Evaluation of a Bezier Curve, B-Spline Curve, Evaluation of a B-Spline Curve, Composition of B-Spline Curves, Differentiation of a B-Spline Curve.

6. **Representation and Manipulation of Surfaces**: Types of Surface Equations, Bilinear Surface, Coon's Patch, Bicubic Patch, Bezier Surface, Evaluation of a Bezier Surface, Differentiation of a Bezier Surface, B-Spline Surface, Evaluation of a-B-Spline Surface, Differentiation of a B-Spline Surface, NURBS Surface, Interpolation Surface, Intersection of Surfaces.

UNIT-V (12 Hrs)

7. **CAD and CAM Integration** : Overview of the Discrete Part Production Cycle, Process Planning, Manual Approach, Variant Approach, Generative Approach, Computer-Aided Process Planning Systems, CAM-I CAPP, MIPLAN and Multi CAPP, Met CAPP, ICEM-PART, Group Technology, Classification and Coding, Existing Coding Systems, Product Data Management (PDM) Systems.
8. **Standards for Communicating Between Systems**: Exchange Methods of Product Definition Data, Initial Graphics Exchange Specification, Drawing Interchange Format, Standard for the Exchange of Product Data. Tutorials, Computational exercises involving Geometric Modeling of components.

Course Outcomes:

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

CO1. Knowledge of various levels of the automation that can be implemented in different departments of medium and high volume production industry for better quality products at lower price.

CO2. Impart knowledge of the computer software used in all the stages of product manufacturing in an industry.

CO3. Write the discrete part program for the new product.

Reference Books:

1. Computer Integrated Design and Manufacturing - Bedworth, Mark Henderson & Philip Wolfe - McGraw hill inc.
2. Principles of CAD/CAM/CAE systems – Kunwoo - Lee Addison Wesley -1999
3. CAD/CAM/CIM - Radhakrishnan P. et al. - New Age International - 2008
4. CAD/CAM – Theory & Practice - Ibrahim Zeid - McGraw Hill - 1998

LEAN MANUFACTURING SYSTEMS

Sub. Code: 18MPDM153 **CIE Marks:** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours:** 03
Total Hrs.: 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:

- To teach the process-level dependence of manufacturing systems.
- To expose the students to the evolution of manufacturing paradigms.
- To teach the impact of system configuration on product quality.
- To teach the analysis and impact of system configuration on productivity.
- To provide a technical understanding of the impact of machine reliability, maintainability, and buffers on system throughput.

UNIT-I (08 Hrs)

1. **Just in Time Production System:** JIT Logic -Pull system Japanese approach to production elimination of waste - JIT implementation requirements JIT application for job shops, Case studies

UNIT-II (10 Hrs)

2. **Kanban System:-** Kanban rules supplier Kanban and sequence scheduleused by supplier. Monthly information & daily information. Later replenish system by Kanban sequenced withdrawal P system by sequence schedule table -problems & counter measures in applying Kanban system to subcontractors -Supplier Kanban circulation in the paternal manufacturer - structure of supplier Kanban sorting office.

UNIT-III (12 Hrs)

3. **The rise & fall of Mass Production** Mass production, work force, organization, tools, product –logical limits of mass production, Sloan as a necessary compliment to Ford. Case study:- Rouge Production Plant.
4. **The Rise of Lean Production**: - Birth place, concrete example, company as community, Final assembly plant, product development and engineering. Changing customer demand, dealing with the customer, future of lean

UNIT-IV (10 Hrs)

5. **Elements of Lean Production viz G M Framingharn** : Toyota Takaoka Mass Production V /s lean production, diffusing lean production.

6. **Managing Lean Enterprise**: Finance, Career ladders, geographic spread and advantages of global enterprise, Shortening of Production Lead Times**,** reduction of setup times, practical procedures for reducing setup time.

UNIT-V (12 Hrs)

7. **Standardization of Operations:** Machine layout, multi-function workers and job rotation. Improvement activities to reduce work force and increase worker morale -foundation for improvements.
8. **Prospects for Catching up. Simplicity in the Natural State**: institutional factors -life time employment -educational commodities -quality & productivity in full circle. An Action Plan, Getting started - Creating an organization to channel your streams. Install business system to encourage lean thinking.

Course Outcomes:

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

CO1. Identify candidate manufacturing systems that are capable of creating the part to specification.

CO2. Weigh tradeoffs between similar manufacturing systems based on general pros and cons in terms of heuristic guidelines.

CO3. Compute quality characteristics that are associated with different manufacturing systems.

CO4. Determine throughput of different manufacturing systems capable of producing a given part.

CO5. Manage an enterprise through lean manufacturing.

Reference Books:

1. Productions and Operations Management - Chasel Aquilino - Dreamtech latest edition.
2. Toyota Production System -An integrated approach to Just in Time - Yasuhiro Monden - Engineering and Management Press -Institute of Industrial Engineers Norcross Georgia-1983
3. The Machine that changed the World. The Story of Lean Production - James P Womack - Daniel T Jones - and Daniel Roos -Harper Perennial - edition published 1991.
4. Lean Thinking - James Womack – ISBN 0743249275 – 2003.
5. Japanese Manufacturing Techniques. The Nine Hidden Lessons by simplicity - Richard Schourberger - ASQC Press 1991.
6. Quality Function Development - James Bossert - ASQC Press 1991.

Technical Seminar-I

Sub. Code: 18MPDM16 **CIE Marks:** 50
Hrs./ Week : 02 **Credits: 02**

Students have to select the on recent advances in Product Design Technology / Manufacturing in discussion with the guide. He/ She have to register the topic along with the synopsis. There will be two seminars and they have to submit the seminar report according to University norms.

CAM / FEA Laboratory

Sub. Code: 18MPDML17 **CIE Marks:** 50
Hrs./ Week : 03 **Credits: 02**

Part - A

- Writing and execution of manual part programming using ISO codes for machining of parts in turning, taper turning and thread cutting.
- CNC milling- Writing and execution of part program for contour milling and etc.
- Simulation of Cutting / Milling operations on a computer using CAM packages.

Part - B

- Static (Structural) Analysis of 1-D problems
- Static (Structural) Analysis of plane stress and Plane Strain problems
- Static (Structural) Analysis of 2-D problems
- Static (Structural) Analysis of 3-D problems
- Static Analysis of Axisymmetric problems
- Transient Heat Transfer Analysis of 1D problems
- Transient Heat Transfer Analysis of 2D problems

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DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH - PRODUCT DESIGN & MANUFACTURING (PDM)

II Semester

Sub Code	Name of the subject	L	T	P	C	Exam Marks		Total Marks
						CIA	SEE	
18MPDM21	Industrial Design & Ergonomics	4	0	0	4	50	100	150
18MPDM22	Product Data Management	4	0	0	4	50	100	150
18MPDM23	Robust Design	4	0	0	4	50	100	150
18MPDM24	Design for Manufacture	4	0	0	4	50	100	150
18MPDM25X	Elective - II	3	0	0	3	50	100	150
18MPDM26	Technical Seminar - II	-	-	-	2	50	-	50
18MPDML27	Product Design Laboratory	0	0	3	2	50	-	50
	Total Credits				**23**	**Total Marks**		**850**

Elective - II	
18MPDM251	Virtual Design and Manufacturing
18MPDM252	Non Traditional Machining Processes
18MPDM253	Quality By Design

INDUSTRIAL DESIGN AND ERGONOMICS

Sub. Code : 18MPDM21 **CIE Marks :** 50
Hrs./ Week : 04 (L - T– P- C**)** **Exam Hours :** 03
Total Hrs. : 52 (4 - 0 - 0 - 4**)** **Exam Marks:** 100

Course Objectives:

- To understand the methods and procedures.
- To design the man machine systems.
- To eliminate unnecessary work.
- To study the most effective procedures.

UNIT-I (10 Hrs)

1. **Introduction:** An approach to industrial design -elements of design structure for industrial design in engineering application in modern manufacturing systems.
2. **Ergonomics and Industrial Design:** Introduction -general approach to the man- machine relationship- workstation design-working position.

UNIT-II (12 Hrs)

3. **Control and Displays:** Shapes and sizes of various controls and displays multiple, displays and control situations -design of major controls in automobiles, machine tools etc., design of furniture -redesign of instruments.
4. **Ergonomics and Production:** ergonomics and product design –ergonomics in automated systems- expert systems for ergonomic design. Anthropometric data and its applications in ergonomic, design- limitations of anthropometric data- use of computerized database. Case study.

UNIT-III (09 Hrs)

5. **Visual Effects of Line and Form:** The mechanics of seeing- psychology of seeing general influences of line and form.

UNIT-IV (10 Hrs)

6. **Colour:** Colour and light -colour and objects- colour and the eye –colour consistency- colour terms- reactions to colour and colour continuation - colour on engineering equipments.

UNIT-V (11 Hrs)

7. **Aesthetic Concepts:** Concept of unity- concept of order with variety - concept of purpose style and environment-Aesthetic expressions. Style components of style- house style, observation style in capital goods, case study.

8. **Industrial Design in Practice:** General design -specifying design equipments- rating the importance of industrial design -industrial design in the design process.

Course Outcomes:

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

- **CO1.** To learn the concept of industrial design and the ergonomics.
- **CO2.** Design the various controls and displays by knowing the anthropometric data's.
- **CO3.** To learn the psychology of visuals effects.
- **CO4.** Learning the different colour combinations for optimal design of engineering equipments.
- **CO5.** Realize the importance of environmental factors and aesthetics in industrial design.

Reference Books:

1. Industrial Design for Engineers - Mayall W.H. - London Hiffee books Ltd. -1988.
2. Applied Ergonomics Hand Book - Brain Shakel (Edited) - Butterworth scientific. London - 1988.
3. Introduction to Ergonomics - R. C. Bridger - McGraw Hill Publications - 1995.
4. Human Factor Engineering - Sanders & McCormick – McGraw Hill Publications – 6th edition, 2002.

PRODUCT DATA MANAGEMENT

Sub. Code : 18MPDM22 **CIE Marks:** 50
Hrs./ Week : 04 (L - T– P- C) **Exam Hours:** 03
Total Hrs. : 52 (4 - 0 - 0 - 4) **Exam Marks:** 100

Course Objectives:

- To understand the importance of Product Data Management (PDM) in modern industry.
- Developing the ability to apply PDM technologies in different stages of product development.
- Reviewing new PDM technologies developed in the future through the use of the PDM systems available in IC in executing their tutorials and projects.

UNIT-I (09 Hrs)

1. **Product Data Management**: Present market constraints, components of a typical PDM setup, hardware and document creation and viewing of documents, creating parts-version, control of parts and documents, Product life cycle, Complexity in Product Development.

UNIT-II (12 Hrs)

2. **General Description of PDM:** History overview, Basic functionality, Information architecture, system architecture, applications, trends in PDM.
3. **Basic functionality of PDM:** Information architecture, PDM System architecture, Applications used in PDM systems. Trends in PDM, Baseline product structure, configuration management.

UNIT-III (12 Hrs)

4. **Workflow Management in PDM**: Structure Management, Engineering Change Management, Release Management, Version Management, Configuration Management.
5. **Document Management Systems:** Document management and PDM, Document life cycle, Content Management, Document management and related technologies, Document management resources on the Internet.

UNIT-IV (10 Hrs)

6. **Analysis and general findings:** Development process, information management, complex products, integration requirements and constraints
7. **Evaluation and deployment:** Complex systems, evaluation, deployment, PDM Tools, PDM resources on the internet, PDM systems, list of PDM tools.

UNIT-V (09 Hrs)

8. **PDM Implementation Case Studies**: Sun Microsystems, Inc., Mentor Graphics Corporation, Ericsson Radio Systems AB, Ericsson Mobile Communications AB, ABB Automation Technology Products, Saab Tech Electronics AB.

Course Outcomes:

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

- **CO1.** Demonstrate and understand the importance of product data management in industries.
- **CO2.** Apply product data management technologies in various stages of product development.
- **CO3.** Understand the latest developments in product data management.
- **CO4.** Apply the various PDM tools in industries.

Reference Books:

1. Product Data Management - Rodger Burden - Publisher: Resource Publishing- ISBN-10: 0970035225, ISBN-13: 978-0970035226 –2003
2. Implementing and Integrating Product Data Management and Software Configuration Management - 21 - Ivica Cmkovic Ulf Asklund - Annita Persson Dahlqvist - Archtech House Publishers.
3. The AutoCAD Database Book – Accessing and Managing CAD Drawing Information – Galgotia Publications - Third Edition.

ROBUST DESIGN

Sub. Code : 18MPDM23 **CIE Marks :** 50
Hrs./ Week : 04 (L - T– P- C**)** **Exam Hours :** 03
Total Hrs. : 52 (4 - 0 - 0 - 4**)** **Exam Marks:** 100

Course Objectives:

- To understand the importance of design of experiments
- To describe how to design experiments ,carry them out and analyse the data they yield
- To investigate the logic of hypothesis testing including analysis of variance and detailed analysis of experimental data. Create designs that have a minimal sensitivity to input variation
- Determine which design parameters have the largest impact on variation
- Optimize designs with multiple outputs.

UNIT-I (10 Hrs)

1. **Robust Design :** Steps in robust design : parameter design and tolerance design, reliability improvement through experiments, illustration through numerical examples, Quality by Experimental Design, Quality, western and Taguchi quality philosophy, Elements of cost, Noise factors causes of variation, Quadratic loss function and variation of quadratic loss functions.

UNIT-II (10 Hrs)

2. **Experimental Design:** Classical experiments: factorial experiments, terminology, factors. Levels, Interactions, Treatment combination, randomization, 2-level experimental design for two factors and three factors. 3-level experiment deigns for two factors and three factors, factor effects, factor interactions, Fractional factorial design, Saturated design, Central composite designs, Illustration through numerical examples**.**

UNIT-III (10 Hrs)

3. **Measures of Variability:** Why analyze variability, Measure of Variability Mean absolute deviation, Sum of square, Variance and Standard deviation. Numerical example on two level design to minimize variability.
4. **Analysis and interpretation of experimental data:** Measures of variability, Ranking method, column effect method and plotting method, Analysis of variance (ANOVA), in factorial experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data, illustration through numerical examples.

UNIT-IV (12 Hrs)

5. **Taguchi's Orthogonal Arrays :** Types orthogonal arrays, Selection of standard orthogonal arrays, Linear graphs and interaction assignment, dummy level technique, Compound factor method, modification of linear graphs, Column merging method, Branching design, Strategies for constructing orthogonal arrays.
6. **Signal to Noise ratio (S-N Ratios) :** Evaluation of sensitivity to noise, Signal to noise ratios for static problems, Smaller the better types, Nominal the better type, larger the better type. Signal to noise ratios for dynamic problems, Illustrations through numerical examples.

UNIT-V (10 Hrs)

7. **Parameter Design and Tolerance Design:** Parameter and tolerance design concepts, Taguchi's inner and outer arrays, Parameter design strategy, Tolerance deign strategy, Illustrations through numerical examples**.**
8. **Reliability Improvement Through Robust Design:** Role of S-N ratios in reliability improvement, Case study; illustrating the reliability improvement of routing process of printed wiring boards using robust design concepts.

Course Outcomes:

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

CO1. Describe how to design the experiments, carry them out and analyze the data they yield

CO2. Design an experiment including factorial and fractional factorial designs

CO3. Formulate the problems including experimentation in the social and economic sciences.

Reference books:

1. Quality Engineering using Robust Design - Madhav S. Phadake: Prentice Hall, Englewood Clifts, New Jersey 07632, 1989.

2. Design and analysis of experiments - Douglas Montgomery: Willey India Pvt. Ltd., V Ed., 2007.
3. Techniques for Quality Engineering - Phillip J. Ross: Taguchi 2nd edition. McGraw Hill Int. Ed., 1996.
4. Quality by Experimental Design - Thomas B. Barker : Marcel Dekker Inc ASQC Quality Press, 1985
5. Experiments planning, analysis and parameter design optimization - C.F. Jeff Wu, Michael Hamada: John Willey Ed., 2002.
6. Reliability improvement by Experiments - W.L. Condra, Marcel Dekker: Marcel Dekker Inc ASQC Quality Press, 1985

DESIGN FOR MANUFACTURE

Sub. Code: 18MPDM24 **CIE Marks :** 50
Hrs./ Week : 04 (L - T– P- C**)** **Exam Hours:** 03
Total Hrs.: 52 (4 - 0 - 0 - 4**)** **Exam Marks:** 100

Course Objectives:

- To teach students various steps in the product development process and the significance of early phases of design
- To teach fundamental principles of design and application of these principles in practical design problems.
- To teach design of systems for ease of assembly and manufacture.
- To teach interrelations among part geometry, tolerances, materials and manufacturing processes.
- To teach principles of robust design procedures and how to set values for various design variables.

UNIT-I (10 Hrs)

1. **Material and Process Selection:** Introduction, Advantages of applying DFMA, General requirements of early materials and process selection, Selection of Manufacturing processes, Process capabilities, Selection of materials, Primary process/ materials selection, Systematic selection of processes and materials.
2. **Engineering Design Features:** Dimensioning, Tolerances, General Tolerance, Geometric Tolerances, Assembly limits, achieving larger machining tolerances. Screw threads, Ground surfaces, holes. Examples

UNIT-II (10 Hrs)

3. **Datum features** – Functional datum, Machining sequence, manufacturing datum, changing the datum. Examples
4. **Component Design – Machining Considerations:** Drills, Milling cutters, Drilling, Keyways, Dowels, Screws, Reduction in machining areas, Simplification by separation and amalgamation, work piece holding, surface grinding, Examples.

UNIT-III (12 Hrs)

5. **Component Design – Casting Considerations:** Pattern, Mould, parting line, cast holes, machined holes, identifying parting line, special sand cores, designing to obviate sand cores. Examples
6. **Design for Injection Molding and Sheet Metal Working:** Injection molding materials, Molding cycle, Systems, molds, machine size, cycle time, Cost estimation, Insert molding, Design guidelines, Introduction to sheet metalworking, Dedicated Dies and Press working, Press selections, Design Rules.

UNIT-IV (12 Hrs)

7. **Design for Die Casting and Powder Metal Processing:** Die casting alloys, cycle, machines, dies, finishing, Assembly techniques, Design principles, Powder metallurgy processing, stages, compaction characteristics, Tooling, Sintering, Design guidelines.

UNIT-V (08 Hrs)

8. **Geometric Tolerance –** Symbols, Three datum concept of dimensioning, Straightness, concentricity, Run-out, Location Tolerance, Assembly of parts having concentric cylinders, Control of feature location by true position, Body of revolution, Roundness, Profile dimensioning, Tapers, Shaft of two diameters. Examples.

Course Outcomes:

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

- **CO1.** Establish a list of candidate materials for each component of design through identification of functional requirements and selection criteria based on loading.
- **CO2.** Identify control factors, noise factors, and an appropriate orthogonal array to set up an experiment to establish relation between various design variables and performance requirements.
- **CO3.** Evaluate and improve the assembly efficiency for a given product.
- **CO4.** Identify and apply the suitable manufacturing process to product or product mix.

CO5. Apply all of the design methods learned in this course to redesign a product for ease of manufacture, and robustness (insensitive to variations).

Reference Books:

1. Product Design for Manufacture and Assembly – Geoffrey Boothroyd - Peter Dewhurst - Winston Knight – Marcel Dekker, Inc. – Newyork - Second Revision, ISBN 0-8247-0584-X
2. Designing for Manufacturing – Harry Peck - Pitman Publications – 1983.
3. Dimensioning and Tolerance for Quantity Production – Merhyle F Spotts –Inc. Englewood Cliffs - New Jersey – Prentice Hall, 5th edition.

ELECTIVE – II

VIRTUAL DESIGN AND MANUFACTURING

Sub. Code: 18MPDM251 **CIE Marks :** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours:** 03
Total Hrs.: 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:

- To teach students how to formulate the design and manufacturing problem for simple systems and mechanical components
- To teach students how to apply the general mechanical engineering sciences in analyses specific to the design of mechanical components and systems
- To teach students in a laboratory setting how to generate concepts, conduct analyses to size components, construct and assemble a prototype of a system and test its function
- To reinforce students team skills through team projects, including problem formulation, problem solutions and written and oral reporting of results
- To reinforce student's visualization and hands-on skills through project virtual prototyping and/or physical construction exercises.

UNIT-I (11 Hrs)

1. **Review of Computer Graphics:** Review of computer graphics, 2D graphics.2D primitives and transformations. Algorithm to digitize the graphic entities, cauterization.

UNIT-II (09 Hrs)

2. **3D graphics**. 3D primitives and transformations, projections and viewing, algorithms for hidden line removals, lighting. Shading and ray tracing.

UNIT-III (11 Hrs)

3. **VR Devices:** Input devices-track balls, 3D Mouse, data gloves, Virtual hand and trackers, output devices graph terminal, stereo glasses, head mounting devices, vision dome, caves.
4. **Applications:** Virtual prototyping, behavior simulation, digital mockup, walk through/flythrough. Virtual training/simulation, micro electro mechanical systems and nanotechnology.

UNIT-IV (09 Hrs)

5. **Virtual Modeling Language:** History, Concepts, syntax, basic nodes-group, transform switch, LOD etc, geometry nodes-indexed face set, indexed line set, coordinate, coordinating, textures etc.

UNIT-V (12 Hrs)

6. **Sensor nodes**-time sensor touches sensor, sphere sensor, cylinder sensor and proximity sensor, scriping- VRML Script and JAVA Script.
7. **Tutorials and Samples:** VRML authoring tools-3D studio MAX, cosmo World, VRML Pad (editor) VRML Viewing tools-cosmo player, auto Vue, SGI's open inventor, virtual collaborative tools-V collab.

Course Outcomes:

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

CO1. Understand functional and manufacturing requirements, utilize concept generation methods within a team setting to achieve a consensus for a product concept

CO2. Weigh tradeoffs in concept and detail design from the perspectives of function, manufacture, design effort and available resources.

CO3. Compile reference (catalog, handbook and textbook) resources to formulate an analysis for a specific mechanical component addressed within those resources.

CO4. Make decisions regarding buy or build for individual components of a design.

CO5. Formulate, in a team setting or independently, a test plan that encompasses all failure modes that may be present per the analyses conducted during the design stage.

Reference Books:

1. Computer Graphics-Principles and practice - Janes D,Foley et al., - Second edition. in C,Addision -Wesley 1997.
2. The VRML- 2.0 Hand book - Jed Hartman and Josie wernecke - Addison-Wesley -1997.
3. The Annocated VRML 2.0 hand book Addison - R Carey and G Bell -Wesley 1997.

NON TRADITIONAL MACHINING PROCESSES

Sub. Code : 18MPDM252 **CIE Marks :** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours :** 03
Total Hrs. : 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:

- To understand and identify of the need for non-conventional machining processes.
- To understand and identifying the characteristics of non-conventional machining and basic mechanism of material removal in non-conventional machining.
- To understand the theoretical knowledge and working principle of non-conventional machining processes and applications and limitations of non-conventional machining processes.
- To provide the students with a proper understanding of non traditional machining processes.

UNIT-I (11 Hrs)

1. **Introduction**: Need for non-traditional machining processes. Processes selection c1assification on – comparative study of different processes. Mechanical Process, Ultrasonic Machining-Definition-Mechanism of metal elements of the process- Tool feed mechanism. Theories of mechanics of causing effect of parameter applications.
2. **Abrasive Jet Machining**: Principles - parameters of the process applications-advantages and advantages.

UNIT-II (09 Hrs)

3. **Thermal Metal Removal Process**: Electric discharge machining Principle of operation – mechanism of meta removal basic EDM circuitry-spark erosion get Analysis of relaxation type of circuit material removal rate in

relaxation circuits- critical resistance parameters in Ro Circuit-Die electric fluids- Electrodes for spare surface finish. Applications.

UNIT-III (10 Hrs)

4. **Electro Chemical and Chemical Processes**: Electro chemical machining (ECM) Classification ECM process-principle of ECM Chemistry of the ECM parameters of the processes-determination of the metal removal rate - dynamics of ECM process-Hydrodynamics of ECM process-polarization. Tool Design-advantages and disadvantages - applications. Electro Chemical Grinding-Electro Chemical holding Electrochemical deburring.
5. **Chemical Machining**: Introduction-fundamental principle types of chemical machining Maskants- Etchants- Advantages and disadvantages-applications.

UNIT-IV (10 Hrs)

6. **Plasma Arc Machining**: Introduction-Plasma-Generation of Plasma and equipment Mechanism of metals removal, PAN parameters-process characteristics - type of torches applications. Electron Beam Machining (EBM),-Equipment for production of Electron beam - Theory of electron beam machining Thermal & Non thermal types characteristics - applications.

UNIT-V (12 Hrs)

7. **Laser Beam Machining (LBM)**: Introduction-principle of generation of lasers Equipment and Machining procedure-Types of Lasers-Process characteristics-advantages and limitations-applications, Ion Beam Machining, Introduction-Mechanism of metal removal and associated equipment-process characteristics applications
8. **High Velocity Forming Process**: introduction - development of specific process selection-comparison of conventional and high velocity forming methods - Types of high velocity forming methods- explosion forming process-elector hydraulics forming magnetic pulse forming.

Course Outcomes:

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

- **CO1.** Identify of the need for non-conventional machining processes in the industry.
- **CO2.** Understand the working principle of non-conventional machining processes with limitations of non-conventional machining processes.
- **CO3.** Study the different non-conventional machining Mechanical Process with design parameters.
- **CO4.** Understand the different PAN, EBM and LBM, how they occur, and how to analyse & interpret machining-related problems.

CO5. Understand and appreciate the use of an Electro Discharge Machine as a non traditional method of machining complex and hard materials.

Reference Books:

1. Production Technology - HMT - Tata Mc Graw Hill - ISBN-10; 0070964432
2. Modern Machining Process - P.C Pandey & H.S. Shan – Tata McGraw Hill - ISBN: 0070965536 **–** Publishing
3. New Technology Institution of Engineers - Bhattacharya – India
4. Metals Hand Book - ASM - Vol-3.
5. High Velocity Forming of Metals - F.M Wilson - ASTME Pretice Hall.
6. Modern Manufacturing Method - Adithan **-** New Age International (p) Limited - ISBN**:** 8122408176, 2007.
7. Modern Machining Processes - P.K. Mishra - Narosa Publishing House, New Delhi- 997.

QUALITY BY DESIGN

Sub. Code : 18MPDM253 **CIE Marks :** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours :** 03
Total Hrs. : 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:

- The students to develop an understanding of total quality management principles, frameworks, tools and techniques for effective real life applications in both manufacturing and services.
- To gain how to determine the voice of the customer and the impact of quality on economic performance and long-term business success of an organization;
- To apply and evaluate best practices for the attainment of total quality.

UNIT-I (10 Hrs)

1. **Basic Concepts:** Quality Engineering and Management: Statistical process control, SPC tools
2. **Total Quality Management:** perspective, methodologies and procedures; Roadmap to TQM, ISO 9000

UNIT-II (10 Hrs)

3. **KAIZEN**, Quality Models for organizational excellence.
4. **Quality Circles,** Cost of Quality**,** Six Sigma Concepts, Steps and Tools

UNIT-III (10 Hrs)

5. **DMAIC-**Define, Measure, Analyze, Improve and Control- Methodology of Six Sigma implementation

UNIT-IV (10 Hrs)

6. **DMADV-**Define, Measure, Analyze, Design and Verify-the methodology for creating high performance designs

UNIT-V (12 Hrs)

7. **Quality Function Deployment,** Process evaluation and Improvements by Design of Experiments**,** ANOVA
8. **Value Engineering-** Failure-Analysis (FMEA), TQM v/s Six Sigma –the Contrast

Course Outcomes:

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

CO1. Develop an understanding on quality management philosophies and frameworks

CO2. Develop in-depth knowledge on various tools and techniques of quality management

CO3. Learn the applications of quality tools and techniques in both manufacturing and service industry.

CO4. Develop analytical skills for investigating and analyzing quality management issues in the industry and suggest implement able solutions to those.

Reference Books:

1. An Introduction to Six Sigma and Process Improvement - Evans, J R and W M Lindsay (2005), CENGAGE.
2. Total Quality**:** Management, Organization and Strategy - Evans, J R and W M Lindsay (2005)., 4th ed, CENGAGE.
3. The Six Sigma Handbook-Revised and Expanded - Pyzdek, Thomas (2005)., Quality America Incorporated.
4. Design and Analysis of Experiments - Montgomery, D C (2007), 5th ed., Wiley.
5. Fundamentals of Quality Control and Improvement - Mitra, Amitava(2005), Pearson.

Technical Seminar-II

Sub. Code: 18MPDM26 **CIE Marks:** 50
Hrs./ Week : 02 **Credits: 02**

Students have to select the on recent advances in Product Design Technology / Manufacturing in discussion with the guide. He/ She have to register the topic along with the synopsis. There will be two seminars and they have to submit the seminar report according to University norms.

Product Design Laboratory

Sub. Code: 18MPDML27 **CIE Marks:** 50
Hrs./ Week : 03 **Credits: 02**

General Guidelines:

1. Students need to generate the Solid Model and Draft the required views.
2. The orthographic views and solution shall be drawn.
3. If required, various manufacturing sequences shall be shown in the model and drawing.
4. Any 3D Modeling and Drafting CAD tools are permitted.
5. Dimensions that are not defined may be assumed.
6. Results, including the calculations shall be shown along with the drawing.

Sl. No	Description	Suggested Books and references
1	The shaft assembly of the intermediate transmission unit shown in Fig.1.42 is required to have an axial freedom of maximum 0.18 mm and minimum 0.06 mm when assembled in working condition. Using the nominal sizes specified for the miter bevel gear, shaft, housing, bearing bushes and spur gear, shown in Fig. 1.43, draw only the relevant components and state only the appropriate limits to achieve the required axial freedom.	Fig.1.42 and Fig.1.43 from the book "DESIGN FOR MANUFACTUR E" by Harry Peck.

2	The partial assembly of an oil pump is shown in Fig.1.45. A four lobe inner rotor is mounted off-set to the body bore in which a five lobe outer rotor rotates, driven by the inner rotor. Both the specified clearances are to be measured by a feeler gauge when the parts are assembled. Taking this procedure into account, and also the fact that the outer rotor can "float" radially, state the appropriate limits for the relevant dimensions which will ensure that the specified clearance limits are not exceeded. Assume zero clearance between inner rotor stem and body bore (20 mm diameter). Nominal sizes are shown in Fig.1.46.	Fig.1.45 and Fig.1.46 from the book "DESIGN FOR MANUFACTUR E" by Harry Peck.
3	The shaft is to be manufactured from any metal/ alloy to the sizes shown in Fig. 2.31. The 30 mm and the 25 mm diameter are to be ground. Prepare a production detail drawing for the shaft.	Fig.2.31 from the book "DESIGN FOR MANUFACTUR E" by Harry Peck.
4	The slide block shown in Fig.3.42 is to be manufactured in batches of 100. 1. Describe a method of manufacture intended to reduce machining time to a minimum. 2. Redraw the block showing the appropriate manufacturing dimensions.	Fig.3.42 from the book "DESIGN FOR MANUFACTUR E" by Harry Peck.
5	In the fulcrum block shown in Fig.4.39, a lever, mounted on a hinge pin, oscillates 30° each side of the vertical centre line; this lever is shown, chain dotted, in the two extremes of the position. Comment on the machining involved and show design modifications to facilitate the machining.	Fig.4.39 from the book "DESIGN FOR MANUFACTUR E" by Harry Peck.
6	Suggest a suitable operation sequence for the stub carrier shown in Fig.4.40 and redraw the component incorporating features to facilitate manufacture. The carrier is to be produced from a steel casting and the symbol 'G' indicates a ground surface for the 30 mm diameter f8 limits.	Fig.4.40 from the book "DESIGN FOR MANUFACTUR E" by Harry Peck.

7	Indicate the parting line for any metal/ alloy casting seen in Fig.5.27, and also the necessary sand cores. Maintaining as nearly as possible, the existing weight of the casting, offer a design modification that will alleviate the sand core requirements.	Fig.5.27 from the book "DESIGN FOR MANUFACTUR E" by Harry Peck
8	For the pedestal shown in Fig.5.28 indicate the probable parting line and any unnecessary sand cores, accepting that the probable parting line is the one involving the minimum sand cores. Show a design modification to reduce or eliminate the need for sand cores; maintain approximately same weight of casting in the modified design	Fig.5.28 from the book "DESIGN FOR MANUFACTUR E" by Harry Peck

SRI SIDDHARTHA INSTITUTE OF TECHNOLOGY
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DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH - PRODUCT DESIGN & MANUFACTURING (PDM)

III Semester

Sub Code	Name of the subject	L	T	P	C	Exam Marks		Total Marks
						CIA	SEE	
18MPDM31	Internship	0	0	-	15	100	100	200
18MPDM32	Project Work: Phase - I	0	4	6	4	50	-	50
Total Credits					**19**	**Total Marks**		**250**

INTERNSHIP

Sub. Code: 18MPDM31 **CIE Marks:** 100
Credits: 15 **Exam Marks:** 100

Internship: Comprises the following;

1. Report Evaluation on Internship (100 Marks)
2. Viva-Voce and Evaluation on Internship (100 Marks)

PROJECT WORK: PHASE - I

Sub. Code: 18MPDM32 **CIE Marks:** 50
Credits: 04

Project Phase – I: Candidate in consultation with the guide shall carryout literature survey / visit industry to finalize the topic of project and present the same (50 Marks)

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DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH - PRODUCT DESIGN & MANUFACTURING (PDM)

IV Semester

Sub Code	Name of the subject	L	T	P	C	Exam Marks		Total Marks
						CIA	SEE	
18MPDM41X	Elective - III	3	0	0	3	50	100	150
18MPDM42X	Elective -IV	3	0	0	3	50	100	150
18MPDM43	Project Work: Phase –II				17	100	125+75	300
Total Credits					**23**	**Total Marks**		**600**

Elective - III	
18MPDM411	Advanced Manufacturing Practices
18MPDM412	Product Planning and Marketing
18MPDM413	Agile Manufacturing

Elective - IV	
18MPDM421	Rapid Prototyping
18MPDM422	Product Analysis and Cost Optimization
18MPDM423	Optimization Techniques

Semester	**I**	**II**	**III**	**IV**	**Total**
Credits	**23**	**23**	**19**	**23**	**88**

ELECTIVE – III

ADVANCED MANUFACTURING PRACTICES

Sub. Code: 18MPDM411 **CIE Marks:** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours:** 03
Total Hrs: 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:

- To recognize manufacturing organizations, including job shops, flow lines, assembly lines, work cells.
- To have a basic understanding of time and motion study, work sampling, and process flow charting.
- Students will have a basic understanding of current manufacturing control theories, such as lean thinking, Opt and JIT.
- Students will be able to solve basic scheduling problems for assembly lines, job shops and conduct Process analysis as a prelude for Value Stream Mapping.
- To see opportunities for the application of continual improvement techniques and understand the Kanban and other 'single piece' production methods

UNIT-I (10 Hrs)

1. **JIT – Introduction** – The spread of JIT Movement, some definitions of JIT, core Japanese practices of JIT, Creating continuous Flow Manufacture, Enabling JIT to occur, Basic elements of JIT, Benefits of JIT.
2. **Just in Time Production** – Primary purpose, profit through cost reduction, Elimination of over production, Quality control, Quality Assurance, Respect for Humanity, Flexible work Force, JIT Production Adapting to changing production Quantities, process layout for shortened lead Times, Standardization of operation, Automation.

UNIT-II (12 Hrs)

3. **Sequence and Scheduling used by Suppliers:** Monthly and daily Information. Sequenced withdrawal system by sequenced schedule table, problems and counter measures in applying the Kanban system to sub contractors.
4. **Just-in-Time Production** with Total Quality Control just in time concept, cutting lot sizes, cutting set-up times, cutting purchase order costs, the JIT cause-Effect chain, Scrap/Quality Improvements, Motivational effects, Responsibility effects, small Group improvement

Activities, withdrawal of Buffer Inventory, the total Quality Control Concept.

UNIT-III (10 Hrs)

5. **Toyota Production System**-The philosophy of TPS, Basic Frame work of TPS, Kanban, Determining the Number of Kanban in Toyota Production System.
   - Kanban Number under Constant Quantity Withdrawal System.
   - Constant Cycle, Non-constant Quantity Withdrawal
   - System Supplier Kanban and the Sequence Schedule for Use by Suppliers.
   - Later Replenishment System by Kanban.
   - Sequenced Withdrawal System.
   - Circulation of the Supplier Kanban within Toyota.

   Production Smoothing in TPS, Production Planning, Production Smoothing Adaptability to Demand Fluctuations, Sequencing Method for the Mixed Model Assembly Line to Realize Smoothed Production of Goal.

UNIT-IV (10 Hrs)

6. **Total Quality Control-**Introduction-Total Quality Control concepts, responsibility, learning from the west, TQC concepts categorized, Goals, Habit of improvement, perfection, Basics, process control, Easy to see Quality control as facilitator, small lot sizes, Housekeeping, Less than full capacity scheduling, Daily machine checking, Techniques and Aids, Exposure of problems, Fool proof Devices, Tools of Analysis, QC Circles, TQC in Japanese-owned US Electronics plant, TQC in Japanese-owned Automotive plants.

UNIT-V (10 Hrs)

7. **Plant Configurations: U**ltimate plant configuration, job shop Fabrication, Frame Welding, Forming Frame parts from Tubing, Dedicated production lines, overlapped production, the daily schedule, Forward Linkage by means of Kanban, physical merger of processes,
8. **Adjacency**, mixed Models, Automated production Lines, Pseudo Robots, Robots, CAD and Manufacturing, Conveyors and stacker Cranes, Automatic Quality Monitoring.

Course Outcomes:

At the end of the course the students will have:

CO1. Students who take this course will gain a basic understanding of manufacturing systems

CO2. ability to manage, including work organization, work measurement, basic scheduling mechanisms,
CO3. Ability to understanding the current theories of manufacturing management, including lean thinking, OPT, JIT and group technology.
CO4. The concept of dependent and independent demand and Capacity planning methodologies
CO5. The logic and applications of order release mechanisms such as MRP and JIT based systems

Reference Books:

1. Toyota Production system – An integrated approach to just in time –by Yasuhiro Monden - Hardcover – 1993.
2. Lean Thinking – By James Womack.- ISBN: 0-7432-4927-5.
3. The machine that changed the World – The story of Lean production – by James P. Womack, Daniel T Jones, and Daniel Roos – Harper Perennial edition published 1991.
4. Just in Time Manufacturing (manual) – Kargoanker.

PRODUCT PLANNING AND MARKETING

Sub. Code: 18MPDM412 **CIE Marks:** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours:** 03
Total Hrs. : 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:
The aim is to motivate the students to proactively develop their integrative skills for product development. Specific objectives are as follows:

- To present an understanding of the importance of product development in the global manufacturing environment.
- To present a comprehensive understanding of major activities that are involved in product development from market research to after-sale customer support.
- To develop ability to make design decisions independently as well as collectively and to develop communication and presentation skills for teamwork.

UNIT-I (12 Hrs)

1. **Introduction**: Basic concepts of Product, Classification of Product, Product mix and line decisions, growth strategies, organizing for

product market, market strategies for leaders, challengers and followers.

2. **Market Planning:** Planning process, Demand analysis, components of marketing plan, competition analysis, Product category, attractiveness analysis, customer analysis and competitors analysis, Segmenting-Targeting- Positioning (STP), basis for segmenting differentiation and positioning, Techniques of good positioning, Pricing and Change management strategy.

UNIT-II (12 Hrs)

3. **Product Appraisal**: Functional analysis, manufacturing analysis, economical analysis, aesthetic and ergonomic considerations, environment and safety, installation, service and maintenance. Design theory and methodology.
4. **Executing The Plan:** Project Scheduling, Working with the Development organization, Measuring Customer Loyalty, Building the Team, The Sales Channel and CRM, Launch and Track the Product.

UNIT-III (10 Hrs)

5. **Organisational Buying Behavior (OBB**): Key characteristics of organizational customer buying process, Personas and Customer Insight Generation, Attributes and Perceptual Gap User Scenarios, maps, organization and stages, concepts of buying center, Buying motivations, purchasing, evaluations of potential suppliers, environmental influence, Organizational buying process, Marketing information system for organizational market

UNIT-IV (08 Hrs)

6. **Managing Product Development Process And Projects:** Product development process, the role and nature of design, project brief, project plan, types of design organization, information and literature search, patents, standards and codes, The New Product Development Process, Proactive new product development process.

UNIT-V (10 Hrs)

7. **Market Research And Customer Requirement Analysis:** The product life cycle, product position and benchmark analysis, market estimates, market segmentation and product diversification, lead user analysis, customer requirement analysis.
8. **Brand and Brand Management:** Customer based brand equity, Brand positioning and values, Choosing brand and elements to build brand

equity, design and implementing branding strategies, managing brand over time.

Course Outcomes:

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

- **CO1.** Implement practical solutions to complex product development and management problems
- **CO2.** Apply analytical perspectives and decision tools, underlying new product management decisions.
- **CO3.** Able to execute the plan of action.
- **CO4.** Develop the new product process in an organization.
- **CO5.** Under the customer and build the brand image.

Reference Books:

1. Product Planning and Management, William L Moore and Edger, A Pessemier
2. Marketing Management, Philip Kotler, Prentice Hall, 12th Edn.
3. Design and marketing of new products, Glen L Urban John R Hauser.
4. Marketing Management-Text & Cases, Rajagopal,Vikas Publishing House, ISBN 81-259-773-4

AGILE MANUFACTURING

Sub. Code : 18MPDM413 **CIE Marks :** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours :** 03
Total Hrs. : 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:

- It aims to provide an understanding of the characteristics of internationally competitive manufacturing systems and knowledge of agile manufacturing philosophy and techniques.
- To understand the practices in carrying out the redesign process and to know the appropriate methodologies/ tools for the practical and detailed realisation of the newly designed or redesigned agile manufacturing system
- To understand integrated approaches to efficient manufacturing.

UNIT-I (12 Hrs)

1. **Introduction:** what is agile Manufacturing? -Competitive environment of the future- the business case for agile manufacturing conceptual framework for agile manufacturing.
2. **Four Core Concepts:** strategy driven approach- integrating organization, people technology interdisciplinary design methodology.

UNIT-II (08 Hrs)

3. **Agile Manufacturing and Change Management:** The change implications, post failures in advanced manufacturing, changes on the way, traditional management accounting, paradigm, investment appraisal.

UNIT-III (08 Hrs)

4. **Product costing** - performance, Measurement and control systems. Control technological and Design paradigms - traditional problems in workplace- organizational issues -role of technology.

UNIT-IV (12 Hrs)

5. **Agile Manufacturing Enterprise Design:** Agile manufacturing – enterprise design -system concepts as the basic manufacturing theory-joint technical & organizational design as a model for the design of agile manufacturing enterprise.
6. **Enterprise design process** -insights into design processes, what is interdisciplinary design, Main issues -simple design example.

UNIT-V (12 Hrs)

7. **Skill & Knowledge Enhancing Technologies for Agile Manufacturing:** Skill and Knowledge enhancing Technologies - scheduling –technology design strategic.
8. **Design Concepts.** Design & Skill of Knowledge enhancing Technologies for machine tool systems- Historical Overview, Lessons, Problems and Future Development.

Course Outcomes:

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

CO1. Gain knowledge of the Agile manufacturing philosophies and the respective tools/ enablers

CO2. Be capable of carrying out a manufacturing system design process through the use of appropriate tools/ methodologies and simulation techniques.

Reference Books:

1. Agile Manufacturing -Forging new Frontiers - Paul T. Kidd -Addison Wesley- Publication- 1994.
2. Agile Manufacturing -Proceeding of International Conference on Agile Manufacturing, Dr. M.P Chowdaiah (Editor), TATA McGraw Hill Publications 1996.
3. Concurrent Engg - Paul T Kidd – Addison Wesley Publication -1994
4. World Class manufacturing - Paul T Kidd – Addition Wesley Pub - 1994

ELECTIVE – IV

RAPID PROTOTYPING

Sub. Code: 18MPDM421 **CIE Marks:** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours:** 03
Total Hrs. : 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:

- To introduce students to the different additive manufacturing processes as well as their capabilities and limitations.
- To give students hands-on experience with using and evaluating a variety of additive manufacturing processes.
- To provide students considering research in this area with an advanced course in which they are exposed to state of the art research that helps them develop novel concepts of their own.

UNIT-I (10 Hrs)

1. **Introduction:** Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems.
2. **Stereo Lithography Systems:** Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.

UNIT-II (10 Hrs)

3. **Selective Laser Sintering and Fusion Deposition Modeling:** Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modeling, Process parameter, Path generation, Applications

UNIT-III (10 Hrs)

4. **Solid Ground Curing:** Principle of operation, Machine details, Applications.
5. **Laminated Object Manufacturing:** Principle of operation, LOM materials. Process details, application.

UNIT-IV (10 Hrs)

6. **Concepts Modelers:** Principle, Thermal jet printer, Sander's model market, 3-D printer. Genisys Xs printer HP system 5, object Quadra systems.
7. **RP Process Optimization:** factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.

UNIT-V (12 Hrs)

8. **Rapid Tooling:** Indirect Rapid tooling -Silicone rubber tooling –Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, etc Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.

Course Outcomes:

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

- **CO1.** Use tools to explore digital manufacturing techniques and CAD modeling software.
- **CO2.** Produce a range of work which uses digital manufacturing techniques and CAD modeling software to explore your professional and creative growth and refinement of your work
- **CO3.** Explore digital manufacturing utilizing a range of art, craft and design based processes
- **CO4.** Critically reflect on your own work and the work of others with an emphasis on digital manufacturing and modeling techniques and processes
- **CO5.** Identify and apply specific occupational, health and safety measures when making works using digital manufacturing techniques and hand making processes

Reference Books:

1. Stereo lithography and other RP & M Technologies - Paul F. Jacobs - SME, NY 1996.
2. Rapid Manufacturing - Flham D.T & Dinjoy S.S - Verlog London 2001
3. Rapid automated - Lament wood - Indus press New York
4. Wohler's Report 2000 - Terry Wohlers - Wohler's Association - 2000.

PRODUCT ANALYSIS AND COST OPTIMIZATION

Sub. Code: 18MPDM422 **CIE Marks :** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours :** 03
Total Hrs. : 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:

- To understand the basic knowledge of accounting, types of accounting and importance of accounting.
- To understand various financial ratios and their applications in decision making.
- To learn about various elements and methods of costing.
- To prepare engineering students to analyze cost/revenue data.
- To carry out or make economic analyses in the decision making process.
- To justify or reject alternatives/projects on an economic basis.

UNIT-I (08 Hrs)

1. **Introduction:** New products, new product strategy -market definition Idea generation introduction to the design process -forecasting sales potential - product engineering and markets-monopoly competitive.

UNIT-II (10 Hrs)

2. **Manufacturing Planning:** Selection of optimum process, standardization. Break even analysis- application and area of use – problems, multi – product analysis.

UNIT-III (10 Hrs)

3. **Value Analysis:** Steps in selection, analysis and implementation, Selection of cutting speed for optimum cost -problems.
4. **Cost Accounting:** Cost estimation -difference -types -steps involved in cost estimation.

UNIT-IV (14 Hrs)

5. **Types of Cost:** Cost Centres, Direct –indirect, material cost -direct indirect material cost Overhead cost, Elements in overheads: Preparation of cost sheet, machine hour rate, apportioning methods.
6. **Variance Analysis –** Labour variance, Material variance and Overhead variance**,** Activity based costing - Introduction to target costing.

UNIT-V (10 Hrs)

7. **Cost Calculation:** Cost calculation for machined components, welding, casting and forged components illustrations -calculation of sales cost.
8. **Cost Optimization Techniques:** Analytical, Graphical and incremental methods, Learning curves.

Course Outcomes:

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

CO1. To understand the concept of new products, market definition and Idea generation introduction
CO2. To carryout and evaluate optimum cost, break even analysis on one or more economic alternatives.
CO3. To learn value analysis and cost estimation for decision making.
CO4. Learn the different types of costs, preparation of cost sheet and variance analysis.
CO5. Know the sales cost calculation of machine components.

Reference Books:

1. Design and Marketing of New Products - Glen L Urban - John R Hauser- Prentice Hall. New Jersey, 1980.
2. Production and Costing - Narang CBS & Kumar V – Khanna Publishers- 2001.
3. Cost management in the New Manufacturing Age –Yasuhiro Monden, ProductivityPress-1992.
4. Technique for Value Analysis And Engineering – Miles Lewrence.D - McGraw Hill, New york-1972.

OPTIMIZATION TECHNIQUES

Sub. Code: 18MPDM423 **CIE Marks:** 50
Hrs./ Week : 03 (L - T– P- C**)** **Exam Hours :** 03
Total Hrs. : 39 (3 - 0 - 0 - 3**)** **Exam Marks:** 100

Course Objectives:

- To learn basic understanding of numerical optimization algorithms.
- To formulate engineering design problems as mathematical optimization problems.
- Use mathematical software for the solution of engineering problems.
- To know the applications of numerical optimization algorithms.

UNIT-I (12 Hrs)

1. **Introduction:** Engineering application of optimization, multivariable optimization Statement of optimization problem. Design Vector, Design constraints, objective function, and classification of optimization problems.
2. **Classical Optimization Technique:** Single variable optimization, with equality Constraints solution by direct substitution, solution by the method of constrained Variation. Solution by the method of Lagrange multipliers, multivariable optimization with inequality constraints Kuhn – Tucker condition.

UNIT-II (08 Hrs)

3. **Non-linear Programming:** (One Dimensional minimization method) Numerical method, Unimodal function, Unrestricted search, Exhaustive search. Dichotomous search, Fibonacci and Golden section method.

UNIT-III (08 Hrs)

4. **Interpolation Method:** Quadratic and Cubic Nonlinear programming (Unrestricted Optimization Technique) Random search methods, Univariate method, powels method, Simplex method.

UNIT-IV (12 Hrs)

5. **Descent Methods:** Steepest descent, conjugate gradient, variable metric method.
6. **Non Linear Programming:** (Constrained Optimization problem) Characteristic of a constrained problem.

UNIT-V (12 Hrs)

7. **Direct Methods:** The complex method, cutting plane method, methods of Feasible directions.
8. **Indirect Methods:** Transformation technique, change variables and elimination of variables, penalty function methods- interior and exterior penalty function.

Course Outcomes:

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

CO1. Have a basic understanding of numerical optimization algorithms.
CO2. Formulate engineering design problems as mathematical optimization problems.
CO3. Use mathematical software for the solution of engineering problems.
CO4. Several homework assignments delving on core concepts and reinforcing analytical skills learned in class.

Reference Books:

1. Optimization, "Theory and Application**" -** S.S. Rao – Willey Eastern - 1984
2. Optimization methods for Engg. Design **-** R.L Fox - Addison – Wesley – ISBN 0201020785 -1971
3. Optimisation Theory and Practice - GSG Beveridge and R.S. Schechter - McGraw Hill, New York – 1970.
4. Optimisation and Probability in System Engg**.-** Ram – Van Nostrand – 1974.

PROJECT WORK: PHASE- II

Sub. Code: 18MPDM43 **CIE Marks:** 50+50
Exam Hours: 03 **Exam Marks:** 125+75

Project Phase – II: comprises the following;

1. **Project work Seminar –I**: Presentation of the Project work carried for the first six weeks (Evaluate for 50 Marks)
2. **Project work Seminar –II**: Presentation of the Project work carried for the next eight weeks (Evaluate for 50 Marks)
3. **Project Work Evaluation** – Taken up at the end of fourth Semester.

   - **Report evaluation:** Average of Marks evaluated by internal and external examiners (125 Marks)

   - **Viva-Voce:** Conducted and evaluated jointly by internal and external examiners (75 Marks).

GUIDELINES FOR PREPARATION OF PROJECT REPORTS

ARRANGEMENT OF CHAPTERS -

1**. Cover title page -**Format enclosed
2**. Inner title page –** Same as cover title page
3**. Certificate** from guide and head with declaration by the student
4**. Certificate** from Company / Firm where the project work is carried out. (Not required if done in the college)
5. **Acknowledgement**
6**. List of tables and figures**

7. **Abbreviations** / operational definitions used
8. **Introduction** should include the following:

    a. Problem definition / statement. This will cover company profile to the topic chosen pertain to the company – 5 pages
    b. Research Objectives (maximum 5) – 1 page
    c. Research Methodology – state the basic and secondary research design. If it a simple survey, explain sampling design and questionnaire design, sources of data and techniques of data analysis – 3, 4 pages
    d. Limitations of Project study – 1 page

9**. Chapter – 1: Literature review**

Discuss the theory, concepts, hypotheses, models, etc., underpinning the project work (Project report is an application of the theoretical knowledge in analyzing a real life problem/issue faced by an organization) – 15 pages

10**. Chapter – II, III & IV**: **Findings**

This is the longest section of the project report. In this chapter, data collected will be presented and analysed without drawing any inference. Depending on the volume of the data presented, there could be 3 to 4 chapters in this section. – at least 40 pages

11**. Chapter V: Summary of Findings**

This chapter be a brief statement of analysis already stated in the findings section – 3 pages

12**. Chapter VI: Conclusions and suggestions –** 3 pages

Total number of pages must be at least 80 but not more than 100.

13**. Bibliography:** References like articles, books, websites, etc., used in the project work must be included in this section strictly following the citation style prescribed by the University.

14**. Appendix:** This will include printed secondary data (only if it is very critical) and any questionnaire used for the study.