SHRI GURU GOBIND SINGHJI INSTITUTE OF ENGINEERING & TECHNOLOGY, VISHNUPURI, NANDED

MECHANICAL ENGINEERING DEPARTMENT

M. Tech. (Mechanical – Product Lifecycle Management)

Academic Year 2018 - 19

Course Outline:

Subject Code	Subject	Examination Scheme (Equivalent marks)							
		L	T	P	Credits	Mid Term	End Term	Term Work	Total
SEMESTER – I									
PCC-PL501	PLM Fundamentals	3	0	4	5	30	70	100	200
PCC-PL502	New Product Design	3	0	0	3	30	70	-	100
PCC-PL503	Data Management	3	0	2	4	30	70	50	150
PEC-PL504-506	Elective-I	3	0	2	4	30	70	50	150
PEC-PL507-509	Elective-II	3	0	0	3	30	70	-	100
OEC-8*	Open Elective	3	0	0	3	30	70	-	100
AUD-9@	Audit Course II (Optional)	2	0	0	0	-	-	-	-
SUB-TOTAL		**20**	**0**	**08**	**22**	**180**	**420**	**200**	**800**
SEMESTER – II									
PCC-PL510	PLM: Advanced Concepts	3	0	2	4	30	70	100	100
PCC-PL511	Customization of PLM software	3	0	2	4	30	70	50	150
PEC-PL512-514	Elective-III	3	0	2	4	30	70	50	150
PEC-PL515-517	Elective-IV	3	0	2	4	30	70	50	150
MCC-590	Research Methodology and IPR	2	0	0	2	30	70		100
SEM-PL518	Mini Project & Seminar	0	0	4	2	-	-	100	100
MAC-591	English for Research Paper Writing	2	0	0	0				
SUB-TOTAL		**16**	**00**	**12**	**20**	**150**	**350**	**350**	**750**

L=Lecture, T= Tutorial / Seminar/Project, P=Practical.

Tutorial(s) may consist of: subject paper, minor project, assignments, case studies, technological state of art etc. related to the subject OR the requirements as designed by the concerned subject teacher

***** - Form the given list of courses student has to appeared for one of the course which is run at institute level.

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ELECTIVES:

ELECTIVE – I		**ELECTIVE – III**	
PEC-PL 504	Computer Aided Design	PEC-PL 512	Finite Element Analysis
PEC-PL 505	Computational tools and programming - I	PEC-PL 513	Computational tools and programming - II
PEC-PL 506	Reliability and Life Testing	PEC-PL 514	Assembly Planning and Management
ELECTIVE – II		**ELECTIVE – IV**	
PEC-PL 507	Supply Chain Management	PEC-PL 515	Digital Manufacturing
PEC-PL 508	Total Quality Management	PEC-PL 516	Customization of CAD/CAM Software
PEC-PL 509	Lean Manufacturing	PEC-PL 517	Web and Networking technologies

List of courses for Open Elective

OEC-801	Business Analytics
OEC-802	Industrial Safety
OEC-803	Operations Research
OEC-804	Cost Management of Engineering Projects
OEC-805	Composite Materials
OEC-806	Waste to Energy

List of Audit Courses

AUD-901	Project Management
AUD-902	Disaster Management
AUD-903	Sanskrit for Technical Knowledge
AUD-904	Value Education
AUD-905	Constitution of India
AUD-906	Pedagogy Studies
AUD-907	Stress Management by Yoga
AUD-908	Personality Development through Life Enlightenment Skills

SEMESTER III

Sr. No	**Course Type / code**	**Course Name**	**Teaching Scheme**			**Credits**
			L	T	P	
1	DIS-PL 601	Dissertation – Phase - I	--	--	32	14
					Total	**14**

SEMESTER IV

Sr. No	**Course Type / code**	**Course Name**	**Teaching Scheme**			**Credits**
			L	T	P	
1	DIS- PL 602	Dissertation – Phase - II	--	--	32	14
					Total	**14**

PCC-PL 501 PLM FUNDAMENTALS (PLMF)

Relevance of the course:

All industries that have tangible products need to understand PLM. Professionals who have responsibilities in engineering, manufacturing, or information systems or who have strategic planning responsibilities at the corporate or divisional levels will benefit from an understanding of PLM and its implementation.

Objectives of the Course:

1. To impart the latest knowledge, principles, strategies, practices, and applications in PLM domain.
2. To provide an in-depth understanding of various applications and solutions of PLM.
3. To build conceptual foundation of PLM, along with the latest industry views on PLM applications.
4. To present frameworks which provide economic justifications for PLM projects.

Evaluation scheme:

Sr. No.	Component	Weightage (%)
1	Mid Term Evaluation	30%
2	End Term Evaluation	70%

Course contents:

Unit I: Introduction: Overview, Need, Benefits, Concept of Product Life Cycle, Components / Elements of PLM, Emergence and Significance of PLM, PLM implementation cases in various industry verticals.

Unit II: PLM Strategy and Vision: Company's PLM vision, PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, PLM business goals.

Unit III: Information, Tools, Information systems and people involved in PLM. Product data and processes like New Product Development, Change Management, Concurrent Design & Process Management, product data linkages across the domain.

Unit IV: PLM Solutions: Different phases of product lifecycle and corresponding technologies, Enterprise information, knowledge and IP, Change Process, Product Structure & Configuration, Bill of Material, Requirement, Portfolio, Program & Project, Engineering Process, Supplier Relationship, Manufacturing Process, Maintenance Repair & Overhaul process and Simulation Process Management.

Unit V: Human resources in product lifecycle, Methods, Techniques, Practices, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information Standards, Vendors of PLM Systems and Components.

Course Outcomes:

a) Justify importance and need of various components/elements of PLM.
b) Able to demonstrate the benefits of PLM implementation/deployment.
c) Distinguish various tasks terminologies used in domain of PLM.
d) Apply and design the various strategies for process and product data management.
e) Build /configure organisations, product structures, bill of materials, workflow, projects and requisite tasks in PLM.
f) Evaluate and select the proper PLM system as per the need of organization.

Text Books:

- **Grieves, Michael**, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
- **Antti Saaksvuori**, **AnselmiImmonen**, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003)
- **Stark, John**. Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag, 2004. ISBN 1852338105
- **Kari Ulrich and Steven D. Eppinger**, Product Design & Development, McGraw Hill International Edns, 1999.

References:

- Relevant recent technical articles, research papers, key note addresses, etc.

PCC-PL 501 PLM FUNDAMENTALS LAB (PLMF LAB)

Relevance of the course:

Today industries are developing their products in short span of time, for that they are using software and tools such as CAD/CAE/CAM and PLM/ PDM. Through this course, students will have interface and practice with this type of software and tools.

Objectives of the course:

1. Demonstrate prerequisites of PLM
2. Make able to understand implementation procedures of PLM tools.
3. Build confidence in using CAD /CAE software along with PLM software.

Evaluation scheme:

Sr. No.	Component	Weightage (%)
1	Continuous evaluation	100

Course contents:

Introduction, Installation & maintenance of following software: Oracle / SQL Server / DB2, PLM Server, CAD Software, MS Office, Rich client, Web client, Application server, Software/ Hardware/ Network issues resolutions

CAD: Modeling (at least 5 parts) and Assembly using any High End CAD Software.

Assembly should include top down and bottom-up approaches, Drafting (at least 1 assembly).

CAD File/data exchange amongst the various CAD software and software for CMM, CAE, CNC, CAM

FEA: Analysis (structural, thermal and both) of at least two parts, Introduction to nonlinear analysis

PLM: Exhibiting use of following modules of any PLM software through at least six assignments

- Organization
- Workflow
- Product Structure
- Access Manager
- Query Builder
- Change Management
- Schedule Manager
- Manufacturing Process Planner

Course outcomes:

a) Graduate can demonstrate practical uses of various PLM technologies.

b) Configure the various CAD/CAE and PLM tools.

c) Build the various CAD/CAE models to use in PLM applications.

PCC-PL 502 NEW PRODUCT DESIGN (NPD)

Relevance of the course:

In this course the understanding of Product development process & methodologies are discussed along with types of design, importance of design, design considerations, product life cycle, technology life cycle, benchmarking and mass customization, stages, objectives and synchronized approaches in NPD. Prototyping with its basics helps to understand the functioning and visual look of product prior to its manufacturing with realistic examples. This course helps to solve the various case studies from automotive, aerospace, communication, etc. sectors.

Objective of the course:

1. To provide conceptual understanding of product design, product development process & methodologies.
2. To integrate product development process by identifying customer needs by gathering, interpreting, organizing and establishing relative importance of the customer needs.
3. To highlight on complete design, justification and analysis (simulation), tool design, plan manufacturing, material and process selection, tools and software selection, testing (quality check) and servicing the product.
4. To promote students for selecting and solving cases from various sectors with the help of product and process systemization, identification and solving methodologies, improving product development solutions.

Course contents:

Unit I Engineering Design Process: Problem solving methodology for engineering design, design considerations, design process, design review. (7 hrs)

Unit II Product Development Process and Need Assessment: Introduction, Product Development Process, Product and Process cycle, Technological Innovation, Identifying customer need, Engineering Characteristics, Product Design specification

Unit III Idea Generation and Screening: Tools and Solution for idea generation are Brainstorming, Competitive Intelligence, Conjoint Analysis, Delphi Technique, Morphological Charts, Six Thinking Hats, TRIZ-idea generation using problem solving tool**,** Tools and Solution for Idea Screening are Qualitative Research, FMEA, SWOT Analysis, PMI Analysis.

Unit IV Concept Development and Testing: Controlled Convergence, Risk Management, Concept Testing like Quantitative Research, Quality Function Deployment, KANO Model.

Unit V Business Analysis and BETA: Product Life Cycle, Gantt Charts, Critical Path Analysis and PERT, Rapid Prototyping. **Technical Implementation:** Design for X, Industrial Design, Re-engineering, Reverse Engineering.

Unit VI Product Consideration and General-Purpose Tools: Marketing Plan, Distribution Channels, Product Pricing, Benchmarking Tool, Business Process Re-engineering, Product outsourcing.

Course Outcomes:

At the end of course, students will able to;

a) Identify and analyses the Product Design and Development processes in manufacturing industry.
b) Analyse and carry out PMI, FMEA, SWOT analysis for new product to be designed.
c) Perform the QFD, KANO Model, and Risk analysis for proper selection of elements to be considered for new product design.
d) Determine the time and cost required for new product design through various business analysis tools.

Text Books:

- **Dieter George E.**, Engineering Design, McGraw Hill Pub. Company, 2000.

References:

- **Ulrich Karl T and Eppinger Steven D.**, Product design and development, McGraw Hill Pub. Company, 1995.
- **Chitale A. K. and Gupta R. C.**, Product Design and Manufacturing, Prentice-Hall of India, New Delhi, sixth edition.
- **Bralla, James G.**, Handbook of Product Design for Manufacturing, McGraw Hill Pub. 1986
- Relevant recent technical articles, research papers, key note addresses, etc

PPC-PL 503 DATA MANAGEMENT (DM)

Relevance of the course:

Product Data Management (PDM) evolved into the now-a-days very popular Product Lifecycle Management (PLM) systems. Most of the CAD tools are marketed these days with in-built PDM systems. Design and manufacturing data is the core/heart of any industry's engineering activities. To bring products into the market in least possible time and at the lowest possible cost has been the motto of industries since ancient days. PLM tools have shown the path to integrate /collaborate for achieving these goals. DBMS like Oracle, My SQL, DB2, etc form the backbone of PLM collaboration tools like Teamcenter, Winchill, Matrix, Enovia/Smarteam, etc.

Databases are part of every organization's day to day activities. All fields of Mechanical/Production Engineering including engineering design, process planning, production planning and scheduling, shop floor management, MRP-1, MRP-2, ERP, SCM, sales and marketing, costing and estimation and manufacturing in general are flooded with management of a huge amount of data and its manipulation for running the day-to-day business activities. Information technology, Product data management and Product Lifecycle Management are keywords of successful operation of industries in the competitive global environment world over.

Objectives of the course:

1. Demonstrate the physical and logical database designs, database modeling, E-R model,relational,hierarchical, and network models.
2. To inculcate the use of data definition & manipulation language.
3. To pass on the concepts of distributed databases, Role of database in Enterprise systems like PDM / PLM.
4. To make aware of different issues involved in the design and implementation of adatabase system.

Course contents:

Unit I Fundamental Concepts of Database Management: Introduction to DBMS, Entity-Relationship model, Relational model, SQL concepts, Object-Based databases and XML, DBMS architectures, Distributed databases

Unit II Product Data and Product Data Management: Product Data, Product Data Management, Basic Functions of a PDM System, PDM Projects

Unit III Data Models: Metamodels and Company Models; Basic Data Modelling Concepts like Objects and Types, Attributes, Relations; Products: Product Structures, Configurable Products; Documents, Versioning: Revisions, Version Trees and Graphs, Variants, Configurable Documents, Revisions and Variants Combined, Component Versions, Configurable Products and Versions

Unit IV System Aspects: System Architecture, Metamodels and Company Models in Relational Databases, Schema Customisation, Access Control, Integration between PDM and Other Systems: PDM and Document Tools, PDM and ERP Systems.

Unit V PDM Standards: STEP Standard: Express Language, External Representation of EXPRESS Data, Integrated Resources, Application Protocols, STEP and Generic Product Structures; Component and Supplier Management

Course Outcomes:

At the end of course, students will able to;

a) Demonstrate program-data independence, data models for database systems, databaseschema and database instances.
b) Construct Structure Query Language statements used in creation and manipulation ofDatabase.
c) Represent the methodology of conceptual modelling through Entity Relationship model.
d) Differentiate the methodology of logical and physical datamodel.
e) Develop and evaluate a real database application using a database management system.

Text Books:

- **Silberschatz, Korth and Sudarshan**, Database System Concepts, McGraw Hill, 2002
- **Peltonen, H., Concepts** and an Implementation for Product Data Management, Acta PolytechnicaScandinavica, Mathematics and Computing Series no. 105, Espoo 2000, 188 pp. Published by the Finnish Academies of Technology. ISBN 951-666-538-1. ISSN 1456-9418.
- **Burden Rodger**, PDM: Product Data Management, Resource Pub, 2003. ISBN 0970035225
- **Crnkovic, Ivica; Asklund, Ulf; &Dahlqvist, Annita Persson**, Implementing and Integrating Product Data Management and Software Configuration Management, Artech House Publishers, 2003. ISBN 1580534988

- **Grieves, Michael**, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
- **Antti Saaksvuori**,**AnselmiImmonen**, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003)
- Software documentation of Oracle, MS Access, Visual FoxPro, SQL server, MySQL, MS Excel

PCC-PL 503 DATA MANAGEMENT LAB

Relevance:

PLM engineers are required to understand how the data is being managed, stored and retrieved from the database for various applications and specific customer needs, requirements. Therefore, having skills of use of various DBMS packages and programming skills in DBMS packages are essential.

Objectives:

1. To impar process of installing and using DBMS software
2. To create tables and database in database systems.
3. To make students understand and practice use of various models like E-R model and Relational models.
4. Impart the Programmingskills in DBMS packages using SQL.

Course contents:

- **Study of DBMS**
- **DBMS Software**: Oracle/ MS SQL Server/ Visual FoxPro / MS Access/ My SQL
- **Installation and overview of the DBMS Software**
- Use PL/SQL – For Table definition/creation and modification, using tables, insertion and modification of data, manipulating data, sorting data, displaying data from multiple tables, sub-queries, constraints, creating views, controlling user access, triggers

Queries to be implemented on DBMS using SQL including and not limited to

- Data Definition and Data Manipulation language,
- Relational operators (= ,<,>,etc.),
- SQL operators (Between…. AND, IN(List), Like, ISNULL, negating expressions),
- Character, number, date and group functions,
- Relational Algebra (UNION, INTERSECT, and MINUS, etc.),
- Extracting data from more than one table (Equi-Join, Non-Equi- Join , Outer Join),
- Sub queries, nested queries,
- PL/SQL Programming.
- Concepts for Roll Back, Commit and Check Points
- Create Views, Cursors, and Triggers and Write Assertions
- Create Forms and Reports.

Micro/Mini Project to be carried out throughout the semester to understand the above-mentioned concepts of Database management.

Course Outcomes:

At the end of course, students will able to;

a) Demonstrate DBMS architecture, physical and logical database designs, database modeling, relational, hierarchical and network models and installation.
b) Apply Structured query language (SQL) for database definition and database manipulation.
c) Develop and evaluate a real database application using a database management system.
d) Identify different types of database failures and techniques to recover from such failures.

Text Books / Documentation:

1. Date C J, “An Introduction To Database System”, Addision Wesley

2. Korth, Silbertz, Sudarshan, “Database Concepts”, McGraw Hill, 2002

3. Elmasri, Navathe, “Fundamentals Of Database Systems”, Addision Wesley

4. Leon and Leon, “Database Management System”, Vikas Publishing House.

5. Bipin C. Desai, “An introduction to Database Systems”, Galgotia Publication

6. Majumdar and Bhattacharya, “Database Management System”, TMH

7. Ramakrishnan, Gehrke, “Database Management System”, McGraw Hill

8. Oracle documentation,

a. Oracle 9i Introduction to SQL Part I and II

b. Performance tuning Vol. I and II

Oracle Application development guide and other necessary documents

PEC-PL 504 COMPUTER AIDED DESIGN (CAD)

Relevance of Course

CAD is an important industrial art extensively used in many applications, including automotive, shipbuilding, and aerospace industries, industrial and architectural design, Biomedical engineering, and many more. CAD is a part of the whole Digital Product Development (DPD) activity within the Product Lifecycle Management (PLM) process. Being the first and core activity, understanding of the subject helps study other downstream applications. Hence, it is equally useful for both M. Tech. courses in Mechanical CAD/CAM and PLM.

Objectives of Course

1. To exhibit use of computers in design process.
2. To make aware facilities in different CAD Software
3. To inculcate theory of CAD techniques, data exchange.
4. To theorize the concepts of CAD transformation, mathematical representation of Solids, Curse and surfaces.
5. To Impart assembly modeling techniques in CAD.

Course contents:

Unit I Product design process: Importance of design, design process, technological innovation and the design process, Team behaviour and tools; Embodiment design: Product architecture, configuration of design, parametric design, Industrial design, Human factors design, Design for X (DFX)

Unit II CAD – Introduction, Role of CAD, CAD system architecture, Hardware and software for CAD, Software modules, ICG, Graphics Software, Ground rules for design of GS, functions of GS, modeling and simulation, Solid modeling methods

Unit III An overview of modeling software like UG/NX, Solid Works, Autodesk Inventor, Professional, AutoCAD, PRO/E, CATIA: Capabilities, Modules, Coordinate systems, Sketching tools, solid modeling tools, surface modeling tools, expression/parameters toolbox, data exchange tools, API and customization facilities

Unit IV Geometric transformations: 2D and 3D; transformations of geometric models like translation, scaling, rotation, reflection, shear; homogeneous representations, concatenated representation; Orthographic projections **CAD/CAM Data exchange and data storage**: Introduction, graphics and computing standards, data exchange standards like IGES, STEP, Model storage - Data structures - Data base considerations - Object oriented representations - Organizing data for CIM applications - Design information system

Unit V Mathematical representations of solids: Fundamentals, Solid models, Classification of methods of representations, half spaces, boundary representation, CSG, sweep representations, Octree representations, primitive instancing, cell decomposition, spatial occupancy enumeration **Mathematical representations of curves and surfaces**: Curve representation, parametric representation of analytic and synthetic curves; Surface models, Surface representations, parametric representation of analytic and synthetic surfaces

Unit VI Assembly modeling: Representation, mating conditions, representation schemes, generation of assembling sequencesVisualization, Multi CAD system (JT etc.), how to manage non-geometric data for eg. Visualization data, light weight representations techniques such as tessellation / voxalization their motivation, how visual representation can be obtained from tessellated, voxelized data, reverse engineering, evolutionAI approaches and applications in CAD, Knowledge Based Engineering, OpenGL, Introduction to Advanced visualization topics in CAD like Modern representation schemes like FBM, PM, Feature recognition, Design by features, Tolerance modeling, System customization and design automation, Open Source CAD like Open CASCADE

Course Outcomes:

At the end of course, students will able to;

a) Classify CAD hardware and software for variety of applications.
b) Exhibits importance and use of various CAD modeling techniques.
c) Exhibits the idea and procedure of data transfer in various CAD tools
d) Calculate the position, shape and geometry of CAD model after translation or transformation.
e) Demonstrate the assembly procedure of CAD applications.

Term Work:

- **Introduction, Installation & maintenance of following software**: Oracle / SQL Server / DB2, various CAD Software and Software/ Hardware/ Network issues resolutions.
- **CAD**: Modeling (at least 10 parts) and Assembly using any High End CAD Software.
- Assembly should include top down and bottom-up approaches, Drafting (at least 3 assembly).
- CAD File/data exchange amongst the various CAD software and software for CMM, CAE, CNC, CAM.

Text Books

- **Chris McMahon and Jimmie Browne**, CAD/CAM – Principle Practice and Manufacturing Management, Addision Wesley England, Second Edition, 2000.
- **Dieter George,** Engineering Design –A materials and processing approach, McGraw Hill Publishers, 2000
- **Ibrahim Zeid**, Matering CAD/CAM, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- **Rogers, D.F. and Adams, A**., Mathematical Elements for Computer Graphics, McGraw Hill Inc, NY, 1989
- **P.Radhakrishnan, S.Subramanayan and V.Raju**, CAD/CAM/CIM, New Age International (P) Ltd., New Delhi.
- **Groover M.P. and Zimmers E. W.**, CAD/CAM: Computer Aided Design and Manufacturing, Prentice Hall International, New Delhi, 1992.
- **Dr. Sadhu Singh**, Computer Aided Design and Manufacturing, Khanna Publishers, New Delhi, Second Edition, 2000.
- **Software Documentation, tutorials, manuals of following software namely** UG/NX, Solid Works, CATIA, Autodesk Inventor Professional, AutoCAD, Open CASCADE, ANSYS Design modeller, Pro/E

References:

- **Ibrahim Zeid**, CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1992.

PEC-PL 505 COMPUTATIONAL TOOLS AND PROGRAMMING – I

Relevance:

PLM engineers are required to understand and customize the PLM software for various applications and specific customer need, requirements. Therefore, programming skills as well as computational tools for customization of either the server or clients or the other middleware are essential.

Objectives:

1. To familiarize computational tools like MATLAB/OCTAVE for Application issue solving, C, C++ programming and related Integrated Development Environments (IDEs)
2. To impart Java programming and related IDEs.
3. To Comprehend the Software Engineering.
4. Inculcate the cloud computing & IOT concepts.

Course contents:

- Introduction to Computational tools like MATLAB / OCTAVE, Spreadsheet.
- Programming in C language.
- Introduction to Software Engineering.
- Software project develop in C.
- OOPS and programming in C++, VB, core Java.
- Introduction to Cloud Computing and Internet of things.

Course Outcomes:

a) Construct the various programmes for development of software.

b) Predict the output of various programs.

c) Build various interfaces through programming skill sets.

d) Solve real life issues by using various computational tools and programs.

Term Work:

At least 10 Practical assignments on above syllabus.

Text Books / Documentation:

1. **Holzner Steven**, Java 2 Programming Black Book, Dreamtech Publishers
2. **Savitch**, Java Programming
3. **Yashwant Kanetkar**, Visual C++ Programming, BPB Publications, 1998
4. **Herbert Schildt**, OOP with C++
5. **Ray J. Rafaels,** Cloud Computing: From Beginning to End
6. **Arshdeep BAhga and Vijay Madisetti** Cloud Computing: A Hands-On Approach, Published December 2013
7. **Cuno Pfister** Getting started with Internet of Things, Publisher: O' Reilly, 2011
8. **Miller** The Internet of Things : How Smart TVs, Smart Cars, Smart Homes and Smart Cities are Changing the World 1st Edition, Publisher: PEARSON 2015 June

PEC-PL 506 RELIABILITY ENGINEERING & LIFE TESTING (RE&LT)

Relevance to industry: The course is relevant as customer satisfaction depends on product performance for the said purpose. Reliability analysis helps improve the reliability of any product or system which ultimately maintains the customers' base of any industry.

Objectives:

1. To Demonstrate the importance of Reliability Engineering & Life Testing for manufacturing systems.
2. To impart skills for finding reliability of any component or system.
3. To inculcate how to improve the reliable life of a component or system.

Course contents:

Unit I Basic concepts in Reliability: Risk and Reliability, Bath tub curve, Failure Mechanism of mechanical components: causes, modes, function of mechanical elements, failure theories. **Component Reliability**: Failure data analysis, reliability function, hazard rate, failure rate, and their relationship, MTTF, mean failure rate, MTBF.

Unit II System Reliability: Series, parallel, mixed configuration, r-out of-n structure, solving complex systems, reliability logic diagrams (RLD). Techniques of Reliability Estimation: Fault Tree analysis, tie sets and cut-sets, Boolean algebra.

Unit III System Reliability Improvement: use of better components, simplification, derating, redundancy, working environment control, maintenance, etc. Redundancy Techniques: Introduction, component vs unit redundancy, weakest link technique, mixed redundancy, standby redundancy, redundancy optimization, double failure and redundancy. **Case Application of complex systems**: Marine power plant, computer system, Nuclear power plant, combats aircraft, etc.

Unit IV Reliability Testing: Introduction, objectives, assumption, different types of test. Life testing in practice: Methodology, problems and difficulties. Economics of Reliability engineering.

Unit V Life Cycle Testing: Intro, basic concepts, data qualification. Accusations faster, stress combination methods, limitations, step stress method for AST, various AST models, recent development recommended approach. Highly accelerated life testing (HALT), HASS

Unit VI Self-Learning Component Through Sessional: Case application, assignments, subject paper/project, presentation etc.

Course outcomes:

At the end of course, students will able to;

a. Decipher multiple roots of failure that lead to Root Cause Analysis (RCA).
b. Represent failure data statistically and to plot density function, survival probability and hazard rate by using appropriate probability distribution.
c. To Compute system reliability using Reliability Block Diagrams.
d. Compute reliability, MTTF and MTBF from accelerated life testing data using failure rate models.
e. Carry out FMEA and FTA to improve machine or equipment or product reliability.

Term Work:

At least 8 Practical assignments on above syllabus.

Text Books:

- **Srinath LS**, Mechanical Reliability, Affiliated East-West Press Pvt. Ltd, New Delhi.
- **Srinath LS**, Reliability Engineering Third Ed., Affiliated East-West Press Pvt. Ltd, New Delhi.
- V.N.A. Naikan, Reliability Engineering and Life Testing, PHI Learning Pvt. Ltd. New Delhi.
- **E. Balagurusamy**, Reliability Engineering, TMH, New Delhi.

PEC-PL 507 SUPPLY CHAIN MANAGMENT (SCM)

Relevance of the Course:

As a PLM professional the students should know the relation between the different concepts and related technologies such as SCM, ERP, CRM, etc. with PLM. As industries are looking to take advantage of all such technologies to have the competitive advantage, the students should be provided with the right knowledge and tools to be industry ready.

Objectives:

1. To develop an understanding of key drivers of supply chain performance and their inter-relationships with strategy and other functions of the company such as marketing, manufacturing and accounting.
2. To impart analytical and problem-solving skills necessary to develop solutions for a variety of supply chain management and design problems and develop an understanding for use of information technology in supply chain optimization.
3. To develop the ability to design logistics systems and formulate integrated supply chain strategy, so that all components are not only internally synchronized but also tuned to fit corporate strategy, competitive realities and market needs.
4. To identify improvement opportunities that exist within supply chains in different industries and to quantify the improvements that various supply chain strategies offer.

Course contents:

Unit I Introduction:

Definitions, Historical perspective, objectives of Supply Chain Management (SCM), Decision phases, Process Views, Strategies and achieving strategic fit, Performance measures, Drivers of SCM and associated framework, case studies

Unit II Network Design: Role of distribution, influencing factors, design options, online sales, role of network design, influencing factors and framework for network design, models for facility location and capacity allocation, designing global supply chain networks, dealing with uncertainty, case studies

Unit III Coordinating Demand and Supply: Demand forecasting, forecast error and its impact, role of Information Technology (IT) in forecasting, Aggregate Planning and Master Production Schedule for SCM, role of IT in aggregate planning, managing supply and demand, operational planning issues, coordination in SCM, case studies

Unit IV Inventory Management: Cycle inventory, related costs, multi-echelon cycle inventory, managing uncertainty, role of IT in inventory management, product availability: importance, influencing factors and improvement, product availability and capacity constraints, optimal availability, case studies

Unit V Transportation: Role of transportation, transportation: modes, performance of modes, infrastructure and policies, transportation network design, role of IT, sourcing, 3rd and 4th party logistics, supplier selection,contracts, procurement process, pricing and revenue management: multiple customer segments, perishable assets, seasonal demand, bulk and spot contracts, case studies

Unit VI IT in SCM: Supply chain IT framework, macro processes, case studies

Course Outcomes:

At the end of course, students will able to;

a) Analyse structure of supply chains and the different ways through which supplychains can become competitive in the market.
b) Find the method to use the levers of the logistics strategy to redefine the points necessary tomake this harmonization.
c) Analyse the importance of the term “value creation” and to propose actions in the field ofmanagement of logistics costs towards the creation of value.
d) Computing the Demand forecasting, Aggregate Planning and Master Production Schedule,managing supply and demand.
e) Demonstrate Use of IT services for managing Transportation and Inventory Management.

Text Books

- **Sunil Chopra, Peter Meindl, D. V. Kalra –** Supply Chain Management: Strategy, Planning and Operations, 5th Edition, Pearson Education Inc., 2013

Reference Book

- **Rahul V.Altekar** – Supply Chain Management: Concepts and Cases, Eastern Economy Edition, Prentice Hall of India, 2005
- **Jeremy F**.**Shapiro**– Modeling the Supply Chain, Duxbury, Thomson Learning Inc., 2001
- **Martin Christopher**, - Logistics and Supply Chain Management – Strategies for reducing cost and improving service, Pitman Publishing, II Edition, 1998.
- **B S Sahay**, Supply Chain Management for Global Competitiveness, Macmillan India Ltd., New Delhi, 2000.

PEC-PL 508 TOTAL QUALITY MANAGEMENT (TQM)

Relevance of the course:

Every organization strives to have a competitive advantage over others. Strategies for competitive advantage need effective management. The strategies, tools and techniques that shall be studied in this course can help provide the student with the knowledge of broad spectrum of operations management approaches. A student who masters this subject can be a very valuable asset for any industry.

Course Objectives:

1. To impart fundamentals of Customer satisfaction.
2. To familiarize philosophies of total quality management by renown quality gurus.
3. To make aware of the scientific tools for quality improvement.
4. Demonstrate off-line quality control for quality improvement.
5. To Inculcate the contemporary quality assurance standards.

Course content:

Unit I Introduction: Quality revolution.The changing business conditions. Forces of competitiveness. Significance and meaning of quality. The quality functions. Various definitions of quality and their comparisons. Two-dimensionaldefinition of quality. Eight dimensions of quality, Components of Customer satisfaction.

Quality concept ofTQM,Definitions of TQM, Elements, Issues Concepts, and Principals of TQM. TQM Philosophies of Deming, Juran, P.Crossby,Imai, Ishikawa, Conway.

Unit II Assessment of Quality Cost: Objectives, Cost of poor quality, Quality cost classification, Analysis of quality cost, hidden quality costs, Economic models of quality cost, guidelines to establish and cut down quality cost.

Unit III Tools for Quality Improvement: Seven old and new Q.C. tools, Benchmarking, Quality Circles, The PDCA cycle, Hoshin Kanri Plan. Six Sigma approach.

Unit IV Quality Function Development: Concept & defining QFD, product development system, QDF process, QFD matrix concept. Deployment - part, process. T- type matrix.

Unit V Off Line Quality Control: Robust design, Loss function, Taguchi's recommended design techniques, O.A., Linear graphs, Taguchi's analysis techniques, performance measures S/N ratios, parameter design, inner and outer arrays

Design and Analysis of Experiments: Factorial experiments, Analysis of variance, Analysis of means

Unit VI Quality Standards: ISO 9000: Concepts, methods & implementation. Quality management practices worldwide, interpretation of key ISO 9000 clauses, Implementing ISO 9000, Indian equivalent for ISO 9000, The ISO 9001:2000 standard; steps for certification under ISO9001:2000

Course Outcomes:

At the end of course, students will able to;

a) Compute the cost of the Quality.
b) Implements, Perform and use Benchmarking, Brainstorming, Quality circles, for quality improvement.
c) Select proper resources by using QFD analysis.
d) Build confidence for better quality by using various quality control techniques.
e) Implements the quality standards as per need of product / Organization.

References Books:

1. Quality planning & analysis - J.M. Juran, Frank M.Gryna.

2. Total Quality Management – Logothetis

3. Total Quality Management – Banks

4. Fundamentals of Quality Control and Improvement – Amitava Mitra Pearson Education Inc.

5. Total Quality Control Essentials - Sarv Singh Soin - McGraw Hill Ltd.

6. Quality Circles Master Guide- Sud Ingle (PHI Publication)

7.Taguchi Techniques for quality engineering -Philip J. Ross - McGraw Hill Ltd.

8. QFD linking a company with its customers- Ronald G.Day. - McGraw Hill Ltd.

9. The complete ISO Manual - Denniss Green

Relevant recent technical articles, research papers, key note addresses, etc.

PEC- PL 509 LEAN MANUFACTURING (LM)

Relevance of the course:

In this subject the understanding and reimbursement of the lean manufacturing system is discussed along with (Just In Time) JIT production system. The subject emphasizes on waste elimination technique which can be widely implemented in any manufacturing and mass production industry. The general idea of Kanban system can help to counter problems & dealings of both suppliers and contractors. Shortening of production lead times along with set up time reduction helps for standardization of operations. Elements of lean production system help to manage lean enterprise as a career ladder.

Objective of the course:

1. To impart conceptual understanding of JIT Logic along with Pull and Push production system.
2. To impart the importance of Implementation of JIT principles to waste elimination along with understanding of Japanese approaches.
3. To emphasis on Kanban system to counter problems & dealings of both suppliers and contractors with the help of related Kanban cards.
4. To make understanding of the rise of lean production along with birthplace, concrete example, company as community, final assembly plant, product development and engineering, changing customer demand and future of lean production.
5. To promote people for creating an organization and installing business system to encourage lean thinking

Course contents:

Unit I Introduction to Lean Manufacturing: Production System and its types, Transition to Lean, Lean Thinking, Manufacturing Strategies, Benefits of Lean Manufacturing

Unit II Elements of Lean Manufacturing: Elimination of Waste, Value Stream Mapping, 5S, Kaizen Approach, Introduction to and comparative study of Toyota Production System, Total Productive Maintenance, Total Quality Management and Six Sigma, Lean Indicators and Organizational Performance

Unit III Cellular Manufacturing: Layouts, Group Technology - part families, clustering methods - Rank Order Clustering, Single-Pass Heuristic considering Capacities (Askin and Standridge), Clustering using Similarity Coefficients, Production Flow Analysis, Utility Layout

Unit IV Just In Time Production System: JIT Philosophy, JIT implementation requirements, Production Smoothening – philosophy and methods, Pull system - Production Authorization, Kanban Systems, scheduling Kanban production, CONWIP system, Base Stock System, Inventory Management in JIT, Information Management in JIT

Unit V Shortening of Production Lead Times: Reduction of setup times, practical procedures for reducing setup time, Transfer Lots, Economic implications of setup time reduction, Standardization of operations, multi function workers and job rotation

Unit VI Human Approach for Lean Implementation: Lean Leadership, Total Employment Involvement**,** Small Group Activities like Quality Circles, SMTs, etc. **Scheduling:** Scheduling System Requirements, Bottleneck Scheduling, Single Machine Scheduling, Flow Shop Scheduling, Job Shop Scheduling

Course Outcomes:

At the end of course, students will able to;

a) Recognize the importance of Just In Time Production System
b) Analyze and evaluate problems related to Kanban system
c) Apply lean manufacturing tools to reduce lead time
d) Use elements of lean production to manage lean enterprise
e) Understand the background behind the rise of lean production

Term Work:

At least 08 Practical assignments on above syllabus.

Text Books

- **Ronald G. Askin and Jeffrey B. Goldberg**, "Design and Analysis of Lean Production Systems"
- **Chasel Aquilino**, "Productions and Operations Management"
- **Yasuhiro Monden**, "Toyota Production System -An integrated approach to Just in Time", Engineering and Management Press, Institute of Industrial Engineers, Norcross Georgia
- **James P Womack, Daniel T Jones, and Daniel Roos,** "The Machine that changed the World. The Story of Lean Production", Harper Perennial edition, 1991.
- **James Womack**, "Lean Thinking".
- **Richard Schourberger,** "Japanese Manufacturing Techniques. The Nine Hidden Lessons by simplicity".
- **Jeffrey Liker** "The Toyota Way : 14 Management Principles from the World's Greatest Manufacturer: 14 Management Principles from the World's Greatest Manufacturer"

OEC-8 OPEN ELECTIVE

List of courses for Open Elective

OEC-801	Business Analytics
OEC-802	Industrial Safety
OEC-803	Operations Research
OEC-804	Cost Management of Engineering Projects
OEC-805	Composite Materials
OEC-806	Waste to Energy

Form above list student have to appeared for one of the course which is run at institute level.

AUD-9 AUDIT COURSE II (OPTIONAL)

List of Audit Courses:

AUD-901	Project Management
AUD-902	Disaster Management
AUD-903	Sanskrit for Technical Knowledge
AUD-904	Value Education
AUD-905	Constitution of India
AUD-906	Pedagogy Studies
AUD-907	Stress Management by Yoga
AUD-908	Personality Development through Life Enlightenment Skills

Form above list student have to appeared for one of the course which is run at institute level.

PCC-PL 510 PLM: ADVANCE CONCEPT (PLM-AC)

Relevance of the course:

This course will train the students so that they can work with latest technologies such as PLM/PDM, by going through this course they will be able to implement and develop such systems also which the growing need of the industries is today to have competitive edge.

Objectives of the course:

1. To demonstrate the important concepts in PLM like Multisite collaboration, change management, Legacy System Integration & data transfer, product architecture, and CAD BOM alignment.
2. To impart the use of workflow, product structuring, visualization of data, and architectures of PLM systems.
3. To comprehend various elements of PLM like Security Management, Item management, Document management and Configuration Management.
4. To promote for using, learning and demonstrating new trends in PLM.
5. To motivate to work in multi cad and environment.

Course contents:

Unit I: Multisite, how to configure Multisite? Importing other sites to FMS MASTER, Replica Creation (Cloning DB for test or QA), Data share and import-export between multisite, Global Change Management System (GTS), Legacy System Integration, Legacy Data Transfer, Security in PLM (SSO/SSL etc),

Unit II: Product master management (managing the deployment of the finished design into the production environment), product architecture (Functional architecture, Physical architecture etc), understanding business object, CAD-BOM alignment, security services, PLM localization, Business modeling, classification structure, PLM System Architecture (2tier/3tier/4tier etc) Managing Changes and Workflows, Classifying Data, Managing Documents, Reports, Requirements, and Schedules, Sharing Data, Managing Product Structures, Managing Manufacturing Data, Visualizing Products, Managing CAE Data, Repeatable Digital Validation, Managing Quality Data, Managing Maintenance, Repair, and Overhaul Data.

Unit III: Product Data: Data objects to represent product data, such as parts, assemblies, processes, product changes, requirements, and specifications, Simple parts (with JT /with CAD /with CAD+JT/ with CAD + drawing / with CAD + JT + drawing + other documents), Simple assembly, multilevel assembly, Hybrid assembly, concurrency in data transfer (replica transfer/delta transfer/re-export), collision.

Unit IV: Concepts of Product Structure management such as Configurations, Multi CAD Integrations, issues involved, data management of heterogeneous CAD systems, management of product data interfaces, GD&T, annotations, manufacturing notes, Integration of CAM with PLM.Introduction to augmented reality, Digital twin and IOT

Unit V: PLM Implementation: Activities Involved under various phases of PLM implementation like Pre-Align, Align, Plan, Build, Test, Deploy and Close. Project Planning, Documentation and Deliverables involved.

Course outcomes:

At the end of course, students will able to;

a) Graduate exhibits the use of various elements of PLM
b) Selects proper architecture of PLM tools for an Industry.
c) Administer for installing, configuring, integrating and efficient management of PLM tools.
d) Select proper methodology for data transfer and implementation in CAD and PLM systems.

Text Books:

- **Grieves, Michael**, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
- **Antti Saaksvuori**,**AnselmiImmonen**, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003)
- **Stark, John**. Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag, 2004. ISBN 1852338105
- **Kari Ulrich and Steven D. Eppinger**, Product Design & Development, McGraw Hill International Edns, 1999.

References:

Relevant recent technical articles, research papers, key note addresses, etc.

PCC-PL 510 PLM: ADVANCE CONCEPT (PLM-AC)LAB

Relevance of the course:

Data management is the key issue for the OEM and designers, so through this course student will develop this skill which will enhance their ability to develop and implement software for the same.

Objectives of the course:

1. Demonstrate various functions of the PDM and PLM tools.
2. Provide opportunity to enhance skills needed in domain of PLM.
3. Impart use of various applications of CAD and PLM tools.

Evaluation scheme:

Sr. No.	Component	Weightage (%)
1	Continuous evaluation	100

Course contents:

Unit I: PDM Functions - Workflow Management, Project Management, Search Management,

Unit II: Product Lifecycle Management (PLM) Concept and Special Functions - Creating Organization (Users, Roles, Group, Volume etc),Defining rights (Object/Rule Based), Creating required hierarchy of folders, item, form, dataset types, Defining business model Customizing different queries and reports out of the box, Creating different workflows, Creating and managing engineering change, Adding custom attribute to forms / in class, Creating different BOM view (PSE),Resource classification.

Unit III: CAD Integration - CAD Manager/ Embedded Client, Seed/Template Creation, Attribute Mappings – NX3, AutoCAD, Solid Edge, PDM Functionalities Mappings (Setting Customer Options etc)

Unit IV: Sample Data Migration - Removing Broken Links and Duplicates, Associated Files (TIFF, CGM etc), Attribute Mappings, Define Search File, Define Map File, Importing Data

Unit V: Testing & QA - Typical Server Tests (Database Testing, Utilities Database and Volume, Backup & Restore), Typical Client Tests (Rich client test, CAD client test, Web client test), Industry Cases, Project Presentation.

Course outcomes :

At the end of course, students will able to;

a) Graduate exhibits the skill of using advanced Product lifecycle Management Tools.

b) Selects proper architecture of PLM tools for an Industry.

c) Integrate various CAD /data management tools with PLM systems.

d) Administer for installing, configuring, integrating and efficient management of PLM tools.

e) Investigate and solve various problems, errors in use of PLM tools.

PCC-PL 511 CUSTOMIZATION OF PLM SOFTWARE (CPLMS)

Relevance of the Course:

LPG related policies of the Government world over have increased the demand for digital engineering services with a broad number of new engineering technologies

Ranging from Data Exchange Service to CAD data Designing and Modeling Service, CAE Analysis and simulation, CAD Data Conversion Service, PLM solution and Outsourcing Services

CAD /CAM/CAE/PLM companies providing these services work with vision to bring over innovative technologies and unique solutions to help organizations grow competitively. They provide value added solution and services in the area of new engineering technologies.

Most PLM software is designed with features that may not be suitable to the customer's day to day specific /specialized needs. Many industries provide system customization services, to design solutions according to custom requirements and business need, making the work and life easier.

The course is aimed to enable students understand customization concepts and develop skills related to customization of PLM software.

Objectives of the Course:

1. Demonstrate rapid development concepts, SDLC and Prototyping
2. Add more features and functions in the existing PLM software tools
3. To make aware of user interface customization, e.g. Icon/ menu, naming and arrangement.
4. Develop PLM Software customization skills.

Course Contents:

Unit I: Introduction to customization, need, types; introduction, Basic customization concepts, common customization tasks, software engineering concept; Software Development Life Cycle (SDLC), Requirement analysis, Rapid application Development (RAD) tools, programming languages. Customization of World processing and spreadsheet tools

Unit II: PLM Software Data & Application Modeling: Data and Application Modeling Interface like View, Perspective, Menu usage, connection, Overview, Codeless and Codeful customization of Data and Application Modeling.

Unit III: Server-Side Customization: Understanding Server-Side API, Finding APIs for your needs, writing new APIs, Samples, Call Server-Side Program/Code from the Client-Side Environment.

Unit IV: Client-Side Customization: Client-Side Platform, Client-Side Non-programming customization Client-Side customization environment setup, Basics Client-Side Plug –in, Overriding Command, Adding menu command to a menu, toolbar and shortcut menu; Client Side –UI form introduction

Unit V: Service Based Customization: Basic of Service based framework, Using Existing Service based API, writing new Service API, Calling API through rich client and thin client.

Course outcomes:

At the end of course, students will able to;

a) Identify the correct customization tools for implementing PLM in Organization /Firm.
b) Customize PLM Software as per the requirement of Organization /Firm.
c) Suggest proper methodology for implementation of PLM through application data modelling.
d) Customize the PLM system for server-side applications.
e) Customize the Rich client applications for PLM system as per the requirement of Organization /Firm.

References:

a) PLM Software Customization Documentation /Help Manuals,
b) Getting started with Customization,
c) Client-Side Customization- Programmer's Guide,
d) Integration Toolkit Programmer's Guide
e) Data & Application Modeling Guide,

f) Application interface Web Service (AIWS) configuration and customization Guide.

PCC-PL 511 CUSTOMIZATION LAB (CPLM LAB)

Relevance of the Course:

This program is designed for students are willing to get transformed to successful PLM professional by exploring PLM Software Usage, Administration, Installation & Integration along with Server & Client customization at its depth.

The course is aimed to enable students understand customization concepts and develop skills related to customization of PLM software.

Objectives of the Course:

1. Demonstrate PLM Software Application and Data Model Administration
2. Provide opportunity to enhance skills of PLM Software Installation and Integration
3. To inculcate PLM Software Server and Client Customization

Course Content:

It will consist of Assignments on Following Topics

- PLM Software Data & Application Modeling (creating Items, Forms, LOVs, Options, Extensions, Different Rule like Naming, GRM, Deep Copy etc) Codeless and Codeful customization.
- Server side Customization for creating Items, Objects, Custom Handlers, writing new APIs, Samples, Call server function from the Rich Client.
- Client side Customization for creating User Interface, Adding Custom menu bar, custom menu items, using Eclipse Rich Client Plug –in.
- Service Based Customization for Writing new Services API, Calling API through rich client and thin client.

Course outcomes:

At the end of course, students will able to;

a) Create custom Item, Item Revision, Form, Rules, LOV's
b) Customized the Sever as per the requirement of the Organization / Industry.
c) Writing the new Application Program Interfaces for retrieving and uploading data from the sever.
d) Writing new Services API's for integrating third party applications.
e) Use the out of the box utilities for customizing the Sever, Clients, and Data models as per the requirement of the Organization / Industry.

References:

a) PLM Software Customization Documentation /Help Manuals,
b) Getting started with Customization,
c) Client-Side Customization- Programmer's Guide,
d) Integration Toolkit Programmer's Guide
e) Data & Application Modeling Guide,
f) Application interface Web Service (AIWS) configuration and customization Guide.

PEC-PL 512 FINITE ELEMENT ANALYSIS (FEA)

Relevance of the subject: The objective of this subject is to teach numerical method like finite element analysis, which are used in the industries extensively. The topics on shape functions, element formulation, assembly procedure, and solution techniques help understand commercial FEA soft wares and its effective utilization. The subject improves the problem-solving capabilities and useful for research in future.

Course Objectives:

1. To make aware of the general steps of finite element methods and basic finite element formulation techniques.
2. To theorize the challenges Finite Element Modeling.
3. To exhibit the importance Finite Element Techniques.

Course contents:

Unit I: Introduction to Finite Element Method: Basic Concept, Historical Background, Engineering applications, general Description, comparison with other methods.

Unit II: Finite Element Modeling: Introduction, Mesh Generation, mesh requirements, Semi-Automatic Methods, Node-based approach, Region based approach, Solid-modeling-based methods. Fully Automatic Methods- Element-based approach, Application. Modeling Hints - utilizing symmetricity – symmetric and anti symmetric B.C, proper and effective usage of different types of elements, warping limit, corner angle, aspect ratio, Acceptable and Unacceptable Distortion, Mesh Refinements using Isoparametric Finite Elements, Meshing in high gradient areas, Transition Regions. Sub modeling Concept, Interface of CAD and FEA software packages.

Unit III: Finite Element Techniques: Applications to solid and structural mechanics problems: External and internal equilibrium equations, one-dimensional stress-strain relations, plane stress and strain problems, axis symmetric and three-dimensional stress strain problems, strain displacement relations, boundary conditions compatibility equations, analysis of trusses, frames and solid of revolution, computer programs.

Applications to heat transfer problems: Variational approach, Galerikn approach, one dimensional and two-dimensional steady state problems for conduction, convection and radiation, transient problems.

Unit IV: Parameters affecting Accuracy of the FEA results: How to validate and check accuracy of FEA results? Computational accuracy: strain energy norm, residuals, Reaction forces and moments; convergence test, Average and unaverage stress difference. Correlation with actual testing: strain gauging-stress comparison; natural frequency comparison; Dynamic response comparison, temperature and pressure distribution comparison.

Practical/ Lab work

At least six Practical assignments on above syllabus.

Course Outcomes:

At the end of course, students will able to;

a) Derive equations in finite element methods for 1D, 2D and 3D problems
b) Formulate and solve basic problems in heat transfer, solid mechanics and fluid mechanics.
c) Write computer program based on finite element methods.
d) Use of a commercial software, to solve basic engineering problems in heat transfer, solid mechanics and fluid mechanics.

Text Books:

- **R.D. Cook, D. S. Malku**, Concepts and applications of Finite Element Analysis, John Wiley and Sons, New York, Second Edition, 1981
- **J. N. Reddy**, An introduction to Finite Element Analysis, Tata McGraw- Hill Pub. Co., 2005.
- **T. J. R. Huges**, The Finite Element Method: Linear Static and Dynamic Finite Element Analysis, Dover Publications, 2000
- **Chandrupatala and Belegundu**, Introduction to Finite Elements in Engineering. Prentice Hall India,2003

PEC-PL 513 COMPUTATIONAL TOOLS AND PROGRAMMING –II

Relevance:

PLM engineers are required to understand and customize the PLM software for various applications and specific customer need, requirements. Therefore, programming skills as well as computational toolsfor customization of either the server or clients or the other middleware are essential.

Objectives:

1. Develop Advance Computational tools likeMATLAB/OCTAVE for Application issue solving, C, C++ programming and related Integrated Development Environments (IDEs),
2. Impart Advance Java programming and related IDEs
3. Inculcate the process of the Advance Software Development.

Course contents:

Unit I: Advance concepts in Spreadsheet.

Unit II: Advance Programming in MATLAB/OCTAVE.

Unit III: Introduction to .Net

Unit IV: OOPS using C++, C#.

Unit V: Advance Java Programming.

Unit VI: Software development using PL/SQL, DBMS Software development.

Practical/ Lab work

At least six Practical assignments on above syllabus.

Course Outcomes:

At the end of course, students will able to;

a) Construct the various programmes for development of software.
b) Predict the output of various programs.
c) Build various interfaces through programming skill sets.
d) Solve real life issues by using various computational tools and programming languages.

Text Books / Documentation:

1. **Holzner Steven**, Java 2 Programming Black Book, Dreamtech Publishers
2. **Savitch**, Java Programming
3. **Yashwant Kanetkar**, Visual C++ Programming, BPB Publications, 1998
4. **Herbert Schildt**, OOP with C++
5. **Date C J, "An Introduction To Database System", Addision Wesley**
6. **Korth, Silbertz, Sudarshan, "Database Concepts", McGraw Hill**
7. **Elmasri, Navathe, "Fundamentals Of Database Systems", Addision Wesley**
8. **Leon and Leon, "Database Management System", Vikas Publishing House.**
9. **Oracle documentation,**
    a. Oracle 9i Introduction to SQL Part I and II
    b. Performance tuning Vol. I and II
    c. Oracle Application development guide and other necessary documents

PEC-PL 514 ASSEMBLY PLANNING AND MANAGEMENT (APM)

Relevance of the course:

Assembly, as the final production stage, must cope with continuously shifting market requirements in regard to timing, batch sizes and product design or style, thus making it sensitive to any changes and requiring a flexibility that is not always possible. Assembly is known to have an important share in both the manufacturing lead time and resources used for production and is, therefore, an important candidate in the attempt to reduce them. A shift in the research focus on assembly in the last two decades is evident from the huge amount of research articles. However, there has been almost no movement in the academics towards including a course on assembly at under-graduate or post-graduate level. Introduction of this course is an attempt to make students aware of the importance of assembly systems and intrigue them into studying, analyzing and designing assembly systems which represent a very complex and interesting area of study.

Objectives of the course:

1. To create interest in the assembly line design practices prevalent in industry.
2. To gain ability to recognize situations in an assembly system environment those suggest the use of certain quantitative methods to assist in decision making.
3. To analyze and solve assembly system problems using people, skills (predominantly) and technology.
4. To increase knowledge and broaden perspective of the "industrial world" in which one will contribute his / her talent and leadership as an Industrial Engineer.

Course Contents:

Unit I: Introduction: Assembling a product, manual and automatic assembly, robotic assembly, Liaison diagram, assembly process, key characteristics of assembly, variation risk and its management.

Unit II: Assembly Sequence Planning: Introduction, assembly sequence design process, Bourjault method of generating all feasible sequences, cutest method, stability of subassemblies, softwares

Unit III: Assembly Line Design: Process of Assembly Line Design (ALD), components of ALD, consideration of equipment's, buffers, etc. Introduction to assembly line balancing and defining assembly line balancing problem using precedence diagrams.

Unit IV: Simple Assembly Line Balancing Problem (SALBP): Performance Characteristics, types of SALBP, optimal solution methods for SALBP, heuristics and meta-heuristics, introduction to Genetic Algorithm, applying simple genetic algorithmic approach to SALBP.

Unit V: Generalized Assembly Line Balancing Problem (GALBP): Considerations leading to GALBP, formulation and solution approaches for a few types of GALBP such as assignment restrictions, mixed model ALBP, U-line ALBP, parallelization, etc.

Unit VI: Reconfiguration: Need and importance of reconfiguration / rebalancing, approaches for reconfiguration.

Practical/ Lab work

At least six Practical assignments on above syllabus.

Course outcomes:

At the end of course, students will able to;

a) Determine the requisite layout of the manufacturing system as per industry needs.
b) Calculate number of workstations, cycle time, smoothness index to improve the performance of assembly line.
c) Suggest a proper assembly line design methodology to manufacturing or service industry.
d) Apply various optimization techniques to improve the performance of assembly lines.

Text Books and References

- **Daniel E. Whitney,** Mechanical Assemblies, Oxford University Press, 2004
- **Mikell P.Groover**, Automation , Production Systems and Computer Integrated Manufacturing, Second edition, Prentice Hall of India, 2002
- **Relevant Research Papers such as and not limited to:** a. Baybars, I., 1986, A survey of exact algorithms for the simple assembly line balancing problem, Management Science 32, 909-932.

b. Becker, C., Scholl, A., 2006, A survey on problems and methods in generalized assembly line balancing, European Journal of Operational Research 168, 694 - 715.

c. Falkenauer, E., 2005, Line balancing in the real world. In: Proceedings of the International Conference on Product Lifecycle Management PLM 05, Lumiere University of Lyon, France, 2005 (http://www.optimaldesign.com/Download/OptiLine/Falkenauer PLM05.pdf)

d. Gökcen, H., Erel, E., 1998, Binary integer formulation for mixed-model assembly line balancing problem, Computers & Industrial Engineering, 34, 451-461.

e. Gonçalves, J.F., Almeida, J.R., 2002, A hybrid genetic algorithm for assembly line balancing, Journal of Heuristics 8, 629-642.

f. Hackman, S.T., Magazine, M.J., Wee, T.S., 1989, Fast, effective algorithms for simple assembly line balancing problems, Operations Research 37, 916-924.

g. Helgeson, W., and Birnie, D., 1961, Assembly Line Balancing Using the Ranked Positional Weight Technique, Journal of Industrial Engineering 12, 394–398.

h. Malakooti, B., 1994, Assembly line balancing with buffers by multiple criteria optimization, International Journal of Production Research 32, 2159-2178.

i. Merengo, C., Nava, F., Pozetti, A., 1999, Balancing and sequencing manual mixed-model assembly lines. International Journal of Production Research 37, 2835-2860.

j. Scholl, A., Becker, C., 2006, State-of-the-art exact and heuristic solution procedures for simple assembly line balancing, EJOR, 168, 666 - 693.

k. N. Boysen, M. Fliedner, and A. Scholl, “A classification of assembly line balancing problems,” JenaerSchriftenzurWirtschaftswissenschaft, 12/06, University of Jena, 2006a.

l. N. Boysen, M. Fliedner, and A. Scholl, “Assembly line balancing: Which model to use when?,” JenaerSchriftenzurWirtschaftswissenschaft, 23/06, University of Jena, 2006

PEC-PL 515 DIGITAL MANUFACTURING (DM)

Relevance of course:

Manufacturing the product with shortest time is the aim of the today's industries to satisfy customers need so the related technologies are needed to be studied, this course teaches about digitization in manufacturing and to achieve the objectives of PLM.

Objectives:

1. To theorize the challenges faced by manufacturing
2. To exhibit the importance of digital manufacturing for business processes
3. To demonstrate the importance of DM in Product Lifecycle Management.
4. To make aware of developing the digital work environment.
5. To make competent in using computer-aided technology to support the above.

Course contents:

Unit I: Introduction to Digital Manufacturing: A Brief History of Manufacturing, Digital Manufacturing Today, Digital Design, Digital Materials, Digital Fabrication, Digital Products, Technology Development, Applications Development, People and Business, The Digital Economy, Transition from Industrial Manufacturing

Unit II: Process simulation and validation: Assembly and component manufacturing, process simulation and validation, Ergonomic/ human simulation, Robotic simulation and OLP

Unit III: Plant design, simulation & optimisation: Station / work-cell layout design, Throughput simulation, Discrete event simulation, Optimisation of material flow and logistic

Unit IV: Manufacturing process simulation solution customisation: Functionality enhancements as extensions of OOTB software solution, Reports customisation, User interface customisation

Unit V: Special Topics: Informatics platform for designing and deploying e-manufacturing systems, framework for integrated design of Mechatronic systems, Collaborative supplier integration for product design and development. Reconfigurable manufacturing systems design, Virtual Reality based platform for collaborative product review and customisation, managing collaborative process planning activities through extended enterprise, rapid product development, desktop assembly factories, Information sharing in digital manufacturing based on STEP and XML

Practical/ Lab work

At least six Practical assignments on above syllabus.

Course outcomes:

At the end of course, students will able to;

a. Graduate exhibits the use of various elements of digital manufacturing tools.
b. Selects proper procedure of validating practical work through digital validation.
c. Administer for installing, configuring, integrating digital manufacturing tools.
d. Analyse and optimise various practical manufacturing processes through digital simulation.

Text Books:

- Wang, Lihui; Nee, Andrew Y.C. (Eds.) Collaborative Design and Planning for Digital Manufacturing, Springer, 2009.

References:

Relevant recent technical articles, research papers, key note addresses, etc.

PEC-PL 516 CUSTOMIZATION OF CAD/CAM SOFTWARE (CCS)

Objectives:

1. Impart rapid development concepts, SDLC and prototyping
2. Add more features and function to the existing command, CAD template designing, CAE analysis template customization.
3. To make aware Interface customization, e. g icon/menu, naming and arrangement.
4. Comprehend AutoCAD/CATIA and VBA customization techniques.
5. Inculcate the API in UG/NX

Course Content:

Unit I: Introduction To Customization: Customization, Application Programming Interface (API), macros, scripts

Unit II: Tools For Customization: Object Oriented Programming (OOP), OLE interfaces in CAD/CAM software; Use of General programming interfaces like VB, VBS, VC++, OpenGL programming and System dependent programming interfaces like Visual LISP (AutoCAD), GRIP (Unigraphics), Pro-Programming (Pro/Engineer)

Unit III: Computer-Based System Engineering: System Engineering process, Software product development life cycle, software processes, software development project management, software prototyping.

Unit IV: Rapid Development: Core issues in rapid development, rapid development languages, lifecycle planning and customer-oriented development.

Unit V: Solid Modeling Algorithms: Euler operations, basic solid modeling algorithms

Unit VI: Automated Solid Modeling Using Customization: Creating 2D, 3D and solid entities through API, editing 2D, 3D and solid entities through API, Design and development of user interfaces - icons, menus, dialog boxes, integrating databases with CAD; creating BOM or part lists, Automated Assembly modeling through customization, Automated drafting and dimensioning using customization, Creating Automated Animations using API and animation software.

Course outcomes:

At the end of course, students will able to;

a. Identify custom software development requirements related to CAD, CAM applications
b. Design and develop the following for custom tool development in CAD software like NX, CATIA, AutoCAD, AIP, etc.
    a. User friendly and complete UIs
    b. Algorithms and programs for modeling and drafting parts, assemblies
c. Design and develop custom software for CAM applications using DBMS like MS access, VFP, Oracle.

Reference Books

d. 1. Rapid development; **Steve McConnel**, Microsoft Press
e. 2. Software Engineering; **Ian Sommerville**, Pearson Education
f. 3. Computer graphics; **Foley, van Dam, et al**, Pearson Education
g. 4. OpenGL Programming guide; **Mason Woo, et al**;
h. 5. Advanced AutoCAD; **George Omura**
i. 6. Customizing AutoCAD; **Sham Tickoo**, Thomson learning
j. 7. Solid Modeling; **Martti Mantilya**; Computer Science Press
k. 8. Solid Works API using VB and C++; Custom Programming Unlimited LLC
l. 9. GRIP programming manuals for Unigraphics (Vol. 1 and 2)
m. 10. User Function Programming manuals for Unigraphics (Vol. 1, 2, 3)

PEC-PL 517 WEB AND NETWORKING TECHNOLOGIES (W&NT)

Relevance to industry:

Collaborative product design and concurrent engineering is a reality today due to the availability of networking environment. Internet usage is increasing day by day and Web based engineering tools are a part of everyone's desktops now-a-days.

Objectives of the course:

1. To impart the importance web engineering skills
2. Provide opportunity to enhance skills in networking, web programming.
3. To inculcate the web developing tools like XML, HTML, and J2EE technologies

Course contents:
Web: History of Web application, W3C, Introduction to various web building technologies.

Mark up languages: Use of mark-up languages in building web applications, Hypertext Mark-up language (HTML), Extensible mark-up Language (XML),

XML Parsers: What is parsing, Types of parsers, benefits and limitations of each parser.

RMI and networking: Introduction to Remote Method Invocation (RMI), Importance of RMI in web applications

J2EE technologies:

JSP- What is JSP, JSP architecture, Session in JSP, Cookies and use of cookies. Servlet- Introduction to Servlet technology, web container, Methods of Servlet, Lifecycle of a servlet, advantages of servlet, HTTP session listener and filters in servlet.

EJB3- Introduction to Application server, Features of enterprise beans, benefits of EJB, Annotations, Introduction to POJO, stateless and stateful session beans.

Ajax- Introduction to framework, rule of ajax in enhancing user experience, ajax examples.

Distributed Computing Concepts of Client-Server Architecture (2-Tier, 4-Tier, n-Tier), Design aspects, Technologies (.NET, J2EE)

Security: Computer network security, data security, issues, techniques involved, known practices, multisite configurations, issues,

Introduction to Hibernate and JSF

Text Books:

- David Hunter et al, 'Beginning XML'
- XML - O'Reilly Media
- Achyut S. Godbole and Atul Kahate, ' Web Technologies' **Edition:** 3

Reference Book:

- Jennifer Niederst, Learning Web Design 2nd Edition
- Elizabeth Castro, HTML for the World Wide Web
- Rod Johnson, Expert One-on-One J2EE Design and Development

MCC-590 RESEARCH METHODOLOGY AND IPR

Syllabus Contents:

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2: Effective literature studies approaches, analysis Plagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2 nd Edition , "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall , "Industrial Design", McGraw Hill, 1992.
6. Niebel , "Product Design", McGraw Hill, 1974.
7. Asimov , "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

SEM-PL 518 MINI PROJECT & SEMINAR

Relevance of the course:

Seminar and Mini Project gives opportunity to students to learn/study topics in the area of their interest, probably that will show them the way towards project work in second part.

Objectives of the course:

1. To motivate for using recent technical research papers and articles.
2. To promote for improving learning, presenting and documentation skills.

Evaluation scheme:

Sr. No.	Component	Weightage (%)
1	Mid Term Evaluation	50
2	End Term Evaluation	50

Course contents:

The Seminar and Mini Project shall consist of few particulars amongst **literature review** based on a sizable number of publications. **Design / Development / Synthesis** related to a particular area. Implementation of existing theory for applications, pilot experiments etc. Each student is required to prepare a report and deliver a talk based on the work carried out as mini-project under the guidance of a faculty member(s). The work carried out should be preferable related to his/her dissertation topic

Course Outcomes:

a. Apply effective strategies in literature searches using available resources.
b. Build programs, software tool, interface for automating PLM system issues.
c. Document properly according to a specific style.

From above course run at institute level and student have to appeared for that.

DIS-PL 601 DISSERTATION PHASE - I

Relevance of the course:

The dissertation of the M. Tech. project will enhance the research qualities of the students,

This results in better projects and research. In this way they can contribute to industries and society.

Objectives of the course:

1. To motivate for doing research development activities.
2. To find solutions to realistic industrial problems.
3. To comprehend the skill for report writing, presenting and documentation.

Evaluation scheme:

Sr. No.	Component	Weightage (%)	Remark
1	Part Implementation	50	Regular evaluation by guide and a panel of internal examiners.
2	End term dissertation I.	50	Evaluation based on presentation and demonstration before examiner.
Note: A separate schedule will be displayed for the different activities under Dissertation Phase- I			

Course contents:

The dissertation Part – I include the following component:

Part Implementation, progress work of the main project.

Course Outcomes:

a. Recognize the importance of planning and preparation required to undertake a research project.
b. Develop a thorough understanding of the chosen subject area.
c. Demonstrate the ability to collate and critically assess/interpret data.
d. Develop an ability to effectively communicate knowledge in a scientific manner.

DIS-PL 602DISSERTATION PHASE- II

Relevance of the course:

The dissertation of project will enhance the research qualities of the students, this results in better projects and research. In this way they can contribute to industries and society.

Objectives of the course:

1. To motivate for doing research development activities.
2. To find solutions to realistic industrial problems.
3. To comprehend the skill for report writing, presenting and documentation.

Evaluation scheme:

Sr. No.	Component	Weightage (%)	Remark
1	Part Implementation	50	Regular evaluation by guide and a panel of internal examiners.
2	End term dissertation II.	50	Evaluation based on presentation and demonstration before examiners.
Note: A separate schedule will be displayed for the different activities under Dissertation Phase-II			

Contents:

The dissertation work shall consist of an extensive work, study or analysis of field / industrial problems with appropriate solutions or remedies. The bonafide work carried out for Dissertation Part – II should be potentially rich in terms of academics.

Dissertation Report

The project report shall be hard bound. It is a report on the work done by the student. It should have literature review, problem definition and formulation, adopted methodology, experimentation plan if any, results, conclusions, discussion and its relevance to the further work.

Examination

The viva-voce examination of the Dissertation Part – II shall consist of a presentation by the candidate and demonstration of the work carried out.

Course Outcomes:

a. Recognize the importance of planning and preparation required to undertake a research project.
b. Extend the research work to a standardized level that can give solutions to real life issues.
c. Demonstrate the ability to collate and critically assess/interpret data.
d. Develop an ability to effectively communicate knowledge in a scientific manner.