**Bansilal Ramnath Agarwal Charitable Trust's**

# Vishwakarma Institute of Technology

*(An Autonomous Institute affiliated to Savitribai Phule Pune University)*

## Structure & Syllabus of

# B. Tech. (Production Engineering)

## Pattern 'B21/C21/D21'

## Effective from Academic Year 2021-22

**Prepared by: - Board of Studies in Industrial & Production Engineering**

| | | | | |
|---|---|---|---|---|
| **Title: Course Structure** | | | | **FF No.: 653** |

| **Branch: Production Engg** | **Year:** S.Y. | **Academic Year:** 2021-22 | **Semester:** I & II | **Module:** III & IV |
|---|---|---|---|---|
| **Pattern: B-21** | | | | |

# S. Y. B. Tech. Production Engineering AY 2021-22 (B21)

| Sr. No. | Subject Code | Subject Name | Teaching Scheme (Hrs/Week) | | | Examination scheme | | | | | | | Total | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Theory | Lab | Tut | CA | | | | MSE | ESA | | | |
| | | | | | | HA | Lab | Seminar | GD | MSE | ESE | CVV | | |
| S1 | MD2201 | Data Science | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S2 | CS2221 | Internet of Things | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 30 | 20 | 100 | 5 |
| S3 | CS2218 | Object Oriented Programming | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 30 | 20 | 100 | 5 |
| S4 | IT2201 | Computer Organization and Architecture | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 30 | 20 | 100 | 5 |
| | ME2205 | 3-D Printing | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 30 | 20 | 100 | |
| S5 | Dept | Engineering Design & Innovation – III | - | - | - | - | - | - | - | - | - | - | 100 | 4 |
| S6 | Dept | Software Development Project – I | - | - | - | - | - | - | - | - | - | - | 100 | 3 |
| **Total** | | | | | | | | | | | | | | **27** |
| S1 | PR2240 | Manufacturing Technology | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S2 | PR2241 | Kinematics & Thermo Fluid Machines | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S3 | PR2239 | Mechanical Design | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S4 | CS2218 | Object Oriented Programming | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S5 | PR2238 | Product Design & Modeling | 3 | 2 | - | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 4 |
| S6 | PR2286 | Engineering Design & Innovation - IV | - | - | - | | | | | | | | 100 | 4 |
| **Total** | | | | | | | | | | | | | | **28** |

# MD2201::DATA SCIENCE

## Course Prerequisites:

1. Linear Algebra Basics
2. Central Tendency & Measures of Dispersion – Mean, Mode, Median
3. Probability
4. Some exposure to programming environment – C programming; Python

## Course Objectives:

1. Understand data processing pipeline
2. Perform dimensionality reduction operations
3. Optimize the performance of functions
4. Apply descriptive statistics tools
5. Deduce meaningful statistical inferences
6. Use unsupervised classification algorithms
7. Use supervised classification algorithms
8. Utilize the data science principles for an entire project life cycle as a case study

**Credits: 5**

**Teaching Scheme Theory: 3 Hours/Week**
**Tut: 1 Hours/Week**
**Lab: 2 Hours/Week**

## Course Relevance:

The course is offered in S.Y. B.Tech. to all branches of Engineering

Data Science is a multidisciplinary field. It uses scientific approaches, procedures, algorithms and frameworks to extract knowledge and insight from a huge amount of data. Data Science uses concepts and methods which belong to fields like information technology, Mathematics, Statistics, Computer Science etc.

Data Science influences the growth and improvements of the product by providing a lot of intelligence about customers and operations, by using methods such as data mining and data analysis. The course is relevant to all branches of Engineering and beyond, since data is generated as an obvious outcome of many processes.

**SECTION-1**

- Introduction to Data Science, Role of data scientist, introduction to R, R studio; introduction to univariate and multivariate systems, understanding databases, Data Processing - Data collection; Data preparation; Data visualization techniques and inferences - scatter plot, scatter matrix, histogram, box plot. (6 Hours)
- Normal distribution, evaluating normal distribution, Binomial distribution, confidence Intervals, central limit Theorem, hypothesis testing, inference for numerical data – t-distribution, paired data, ANOVA (8 Hours)
- Vector norms, distances & projections, discriminants, Principal Component Analysis, Optimization: constrained and unconstrained, Gradient Descent (6 Hours)

**SECTION-2**

- Supervised Learning – line fitting, residuals, correlation; line fitting by least squares regression; outliers in linear regression; Inference for linear regression; Multiple regression; Model selection; Logistic regression, Nearest Neighbor Classification – Knn; Naïve Bayes Classification – Bayesian methods, Bayes algorithm; Classification using decision trees and learners (9 Hours)
- Unsupervised Clustering - K-means clustering; Evaluation of model performance – Confusion matrices, sensitivity, specificity, kappa statistics, precision, recall, F-measure, ROC curve etc.; Methods of cross-validation, Bootstrapping; Meta-learning through ensemble approach – Bagging, boosting, Random Forests strategies. (7 Hours)
- Classifier performance measurement metrics – Training & Testing strategies – Resubstitution, Hold-out, Cross validation, Bootstrap ; Confusion matrix, Performance measures – Accuracy, Error rate, Sensitivity, Specificity, Precision, Recall, F-Measure, Receiver Ope[rating Characteristics curves (4 Hours)

**List of Tutorials:**

1. Data Visualization
2. Distances and Projections
3. Singular Value Decomposition
4. Principal Component Analysis
5. Optimization
6. Normal & Binomial Distribution
7. Hypothesis Testing
8. ANOVA test
9. Linear Regression
10. Logistic Regression
11. Nearest Neighbor Classification
12. Decision Trees based classification
13. Naive Bayes classification
14. Clustering
15. Evaluation of model performance
16. Bagging & Boosting approaches

**List of Practicals: (Any Six)**

1. Data visualization
2. Unconstrained Optimization
3. Hypothesis Testing
4. Linear regression
5. Logistic Regression
6. Nearest Neighbor classification
7. Naive Bayes classification
8. Clustering
9. Classifier performance using Confusion matrix and other attributes
10. Cross Validation methods

**List of Course Projects:**

1. Movie recommendation system
2. Customer Segmentation using Machine Learning
3. Sentiment analysis
4. Uber Data analysis
5. Loan prediction
6. HVAC needs forecasting
7. Customer relationship management
8. Clinical decision support systems
9. Development of machine learning solutions using available data sets (multiple projects)
10. Fraud detection

**List of Course Seminar Topics:**

1. Data wrangling
2. Predictive modeling
3. Data analytics in life science (multiple topics)
4. Ensemble modeling techniques
5. Text pre-processing
6. Feature scaling for machine learning
7. Multivariate normal distribution applications
8. Distance metrics and their applications
9. Visualization techniques such as Chernoff's faces
10. Tree based algorithms
11. Ridge regression
12. LASSO

**List of Course Group Discussion Topics:**

1. PCA and ICA
2. Hierarchical and nonhierarchical systems
3. Linear - Non linear regression
4. Parametric-non parametric estimation
5. Overfitting and underfitting in the context of classification
6. Linear and Quadratic discriminant analysis
7. Regression v/s classification
8. Classifier performance measures
9. Supervised and unsupervised learning
10. Various clustering approaches
11. Classifiers and classifier combinations
12. Balancing errors in hypothesis testing
13. Standard sampling practices for a successful survey for reliable sample data

**List of Home Assignments:**

Case Study: A very large number of resources are available for data generated out of case study. Unique Home assignments will be set up for all groups

Surveys: Principles of surveying will be implemented by groups to demonstrate use of data science principles in home assignments

**Assessment Scheme:**

Mid Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks
Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
Comprehensive Viva Voce - 20 Marks

**Text Books:** ***(As per IEEE format)***

1. 'A Beginner's Guide to R' – Zuur, Leno, Meesters; Springer, 2009
2. 'Introduction to Data Science' – Igual, Segui; Springer, 2017
3. 'Mathematics for Machine Learning' – Diesenroth, Faisal, Ong; Cambridge University Press, 2017
4. 'Machine Learning with R' – Lantz, Packt Publishing, 2018

**Reference Books:** ***(As per IEEE format)***

1. 'Elements of Statistical Learning' - Hastie, Tibshirani, Friedman; Springer; 2011
2. 'Data Science from Scratch' - Grus; Google Books; 2015
3. 'The art of Data Science' - Matsui, Peng; 2016
4. 'Machine Learning for absolute beginners' - Theobald; Google Books; 2017

**Moocs Links and additional reading material:** **www.nptelvideos.in**

1. https://www.edx.org/course/machine-learning-fundamentals-2
2. https://www.edx.org/course/foundations-of-data-analysis-part-1-statistics-usi
3. https://www.coursera.org/learn/statistical-inference/home/welcome
4. https://www.coursera.org/learn/data-scientists-tools/home/welcome

**Course Outcomes:**

Upon completion of the course, student will be able to –

1. Apply Data processing & data visualization techniques - 3
2. Implement dimensionality reduction & optimization techniques for enhancing data suitability - 5
3. Perform Descriptive and Inferential statistical analysis for building reliable predictions - 4
4. Implement Supervised algorithms for classification and prediction - 4
5. Implement Unsupervised classification algorithms - 3
6. Evaluate the performance metrics of supervised and unsupervised algorithms - 2
7. Demonstrate complete Data Science life cycle with case studies - 4

**Future Courses Mapping:**

1. Deep Learning
2. Reinforcement Learning
3. DBMS
4. Big Data
5. Data Mining
6. Information Retrieval
7. Recommendation Systems
8. Cloud Computing – AWS
9. IOT
10. Artificial Intelligence
11. Pattern Recognition
12. Natural Language Processing
13. Computer Vision
14. Machine Vision
15. Fault Diagnosis
16. Optimization
17. Bioinformatics
18. Computational Biology
19. Econometrics
20. Supply Chain
21. Ergonomics
22. Operations Research
23. Nano-inform**atics**

**Job Mapping:**

*Job opportunities that one can get after learning this course*

1. Data Scientist
2. Data Analyst
3. AI Engineer
4. Data Architect.
5. Data Engineer.
6. Statistician.
7. Database Administrator.
8. Business Analyst
9. Business Intelligence Developer
10. Infrastructure Architect
11. Enterprise Architect
12. Machine Learning Engineering
13. Machine Learning Scientist

\

**FF No. : 654**

# CS2221::INTERNET OF THINGS

## Course Prerequisites:

Students should have a basic Understanding of the Internet, Cloud, Networking Concepts and Sensors

## Course Objectives:

The student will be able to

1. Understand IoT Architecture and framework.
2. Recognize and differentiate between the various use cases of different sensors, actuators, solenoid valve etc
3. Learn about fundamental concepts of networking and protocols.
4. Understand IoT Physical, Data link and Higher layer Protocols.
5. Apply theoretical knowledge for Cloud computing.
6. Implement an IoT solution practically

**Credits: 5**

**Teaching Scheme Theory: 3 Hours/Week**
**Tut: 1 Hours/Week**
**Lab: 2 Hours/Week**

**Course Relevance:**

The Internet of Things is transforming our physical world into a complex and dynamic system of connected devices on an unprecedented scale. Internet of Things is a system of interrelated computing and sensing devices and has the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Advances in technology are making possible a more widespread adoption of IoT, from pill-shaped micro-cameras that can pinpoint thousands of images within the body, to smart sensors that can assess crop conditions on a farm, to the smart home devices that are becoming increasingly popular.

IoT is highly relevant in this growing ecosystem of internet-enabled devices. IoT offers increasing opportunities to collect, exchange, analyse and interpret data in real-time. This robust access to data will result in opportunities to further enhance and improve operations. In a world which is moving towards an increasingly connected future, Internet of Things (IoT) is the next big thing. Right from our homes to our cars to our cities, everything is being connected and the technology of IoT is right in the middle of it.

| **SECTION-1** |
|---|
| **Introduction to IoT**<br>Physical Design of IOT, Logical Design of IOT, IOT Enabling Technologies, IOT Levels & Deployment Templates, IoT and M2M (6 Hours)<br>**IOT Platform Design Methodology** |

IoT Design Methodology Steps, Home Automation Case Study, Smart Cities, Health Care, Agriculture, Manufacturing and Logistics (7 Hours)

**IoT Devices**

IoT System Design Cycle, Sensors - Terminologies, Calibration, Types, Specification, Use, Actuators - Types and Use, Prototype Development Platform - Arduino / Raspberry pi / Node MCU, Interface with Embedded System (7 Hours)

**SECTION-1I**

**Introduction to Wireless Sensor Network**

Sensor Node, Smart Sensor Network, Wireless Sensor Network, RFID - Principles and Components, Node MCU (5 Hours)

**Connectivity Technologies**

Network Configuration in IoT, IoT Stack and Web Stack, IEEE 802.15.4 Standard, Zigbee, Bluetooth, Overview of IoT Protocols, MQTT, Cloud Architecture and Types, Cloud Service Providers (10 Hours)

**Case Studies (Any Three from following List to be coveredJ**

Smart lighting, Home Intrusion Detection, Smart Parking, Weather Monitoring System, Weather Report Bot, Air Pollution Monitoring, Forest fire Detection, Smart Irrigation, IoT Printer, IoT in Manufacturing Industry, IoT in Process Industry, IoT in Quality, Control Applications in Industry, IoT in Material Handling System in Industry, IoT in Automobile Industry, Navigation System, Connected Vehicles, Industry 4.0 (5 Hours)

**List of Practicals: (Minimum Six)**

**1**. Setting up Arduino / Raspberry Pi/ Node MCU ESP8266 : Basic handling , programming
2. LED Interfacing
3. Sensor interface to Node MCU/Arduino / Raspberry Pi Temperature measurement using LM35
4. Actuator interface to Node MCU /Arduino / Raspberry Pi Traffic Signal Control
5. Node MCU /Arduino / Raspberry Pi wireless communication Raspberry Pi as a web server
6. Node MCU/Arduino / Raspberry Pi Cloud interfacing and programming like Thingspeak Email alert using SMTP protocol
7. Sensor data acquisition on Mobile (Mobile APP) / Developing Application (WEB APP) with Django Text transfer using MQTT protocol
8. Home Automation using Cisco Packet Tracer

**List of Course Projects:**

1. Smart Agriculture System
2. Weather Reporting System
3. Home Automation System
4. Face Recognition Bot
5. Smart Garage Door
6. Smart Alarm Clock
7. Air Pollution Monitoring System
8. Smart Parking System

9. Smart Traffic Management System
10. Smart Cradle System
11. Smart Gas Leakage Detector Bot
12. Streetlight Monitoring System
13. Smart Anti-Theft System
14. Liquid Level Monitoring System
15. Night Patrol Robot
16. Health Monitoring System
17. Smart Irrigation System
18. Flood Detection System
19. Mining Worker Safety Helmet
20. Smart Energy Grid

**List of Course Seminar Topics:**

1. IoT Architecture
2. Sensor Characteristics
3. IoT for supply chain management and inventory systems
4. IoT Ethics
5. Security in IoT
6. Cloud Computing Platform
7. IoT Best Practices
8. 5G in IoT
9. Middleware Technology
10. M2M energy efficiency routing protocol
11. IoT based Biometric Implementation
12. Complete IoT solution using AWS
13. A smart patient health monitoring system
14. IoT for intelligent traffic monitoring
15. Home automation of lights and fan using IoT

**List of Group Discussion Topics:**

1. Role of Internet of Things in development of India .
2. Manufacturing industries should make efforts to limit contribution to IoT.
3. Should countries put a ban on IoT for children?
4. Should IoT pay more attention to security rather than just expanding its horizon to the extremes
5. IoT is the next big thing in technology.
6. IoT poses a huge risk to privacy, if they your system is hacked.
7. IoT is the next big thing for hackers trying to have access to your intimate data.
8. Pros and cons of over-usage of IoT at homes and offices.
9. IoT at battlefields will make life of soldiers safer and easier.
10. IoT will make way for robots to rule over humans one day.
11. IoT devices are making people lazier and obese.
12. IoT needs to be regulated before it goes out of limits and poses serious threat.

**List of Home Assignments**

**Design:**

1. Smart City
2. Smart Transportation
3. Smart Healthcare
4. Smart Industry using IoT
5. Design of IoT framework

**Case Study:**

1. Open Source in IoT
2. IoT solutions for automobile
3. Cloud Computing
4. AWS
5. Microsoft Azure

**Blog:**

1. Network Selection for IoT
2. Need of secure protocols
3. Future of IoT
4. IIoT
5. IoT and Industry 4.0

**Surveys:**

1. Autonomous Vehicles
2. List of Indian companies which offer IoT solutions for agriculture and farming. Describe the problem they are addressing and their solution.
3. Make a list of Indian companies which offer IoT solutions for healthcare. Describe the problem they are addressing and their solution.
4. Make an exhaustive list of everything inside, just outside (immediate surroundings) and on the auto body which must be “observed” for safe and comfortable driving using autonomous vehicles.
5. Compare different Cloud Service providers in the market.

**Text Books:** ***(As per IEEE format)***

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", (Universities Press)
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", (CRC Press)

**Reference Books:**

1. Adrian McEwen, Hakim Cassimally “Designing the Internet of Things”, Wiley
2. Ovidiu Vermesan & Peter Friess “Internet of Things Applications - From Research and Innovation to Market Deployment”, ISBN:987-87-93102-94-1, River Publishers
3. Joe Biron and Jonathan Follett, "Foundational Elements of an IoT Solution,"

**MOOCs Links and additional reading material:**
https://proed.stanford.edu/course/view.php?id=191
https://nptel.ac.in/courses/106/105/106105166/
https://create.arduino.cc/projecthub/electropeak/getting-started-w-nodemcu-esp8266-on-arduino-ide-28184f

**Course Outcomes**
1. Demonstrate fundamental concepts of Internet of Things (CO Attainment level: 2)
2. Recognize IoT Design Methodology Steps (CO Attainment level: 3)
3. Select sensors for different IoT applications (CO Attainment level: 3)
4. Analyze fundamentals of networking (CO Attainment level: 4)
5. Apply basic Protocols in IoT (CO Attainment level: 4)
6. Provide IoT solutions practically with the help of case study (CO Attainment level: 5)

**Future Courses Mapping:**
***Other courses that can be taken after completion of this course***
1. Ad-Hoc Networks
2. Cyber Security
3. Wireless Networks
4. Industry 4.0
5. Big Data

**Job Mapping:**
The Internet of Things (IoT) is the most emerging field in today's world. It is revolutionizing every industry, from home appliances to agriculture to space exploration. Since the advent of cloud computing, there has been an exponential growth in the number of sensor-enabled devices connected to the internet and expecting further growth accelerating in the coming years. There are diversified career opportunities in this field. The various career positions available as IoT Research Developer, IoT Design Engineer, IoT Product Manager, IoT Software Developer, IoT Solution Architect, IoT Service Manager and many more.

**Assessment Scheme:**
Mid Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks
Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
Comprehensive Viva Voce - 20 Marks

**FF No.: 654**

# CS2218::OBJECT ORIENTED PROGRAMMING

## Course Prerequisites:
Basic course on programming

## Course Objectives:
1. Understand Object Oriented programming concepts
2. Demonstrate Object Oriented programming concepts by writing suitable Java programs
3. Model a given computational problem in Object Oriented fashion
4. To develop problem solving ability using Object Oriented programming constructs like multithreading
5. Develop effective solutions using for real world problems using the concepts such as file handling and GUI
6. Implement applications using Java I/O and event-based GUI handling principles

**Credits: 5**

**Teaching Scheme Theory: 3 Hours/Week**
**Tut: 1 Hours/Week**
**Lab: 2 Hours/Week**

## Course Relevance:
This is an important course for engineering students. It develops computational problem solving and logic building capability of students. Acquiring programming skills has a high relevance in all branches of Engineering. Once the student gains expertise in coding, this course proves to be beneficial to them to excel in industry demanding coding in specific software.

| **SECTION-1** |
|---|
| Introduction:<br>What is Object Oriented Programming (OOP)? The need of OOP, Characteristics of OOP.<br>Java overview: Classes and Objects, Java object storage, Different ways to create objects in Java, Access Modifiers, this reference, main method, Static vs Instance block, Static methods vs Instance methods in Java, Object class, Static class in Java, operators, keywords in java.<br>Constructors: Constructors in Java, Default constructor, Parameterized constructor, Copy Constructor, Private Constructors and Singleton Classes. Garbage Collection: Garbage Collection, How to make object eligible for garbage collection in Java?<br>Input and Output: Byte Stream vs Character Stream, Command Line arguments, use of Scanner Class, Scanner vs BufferReader Class, Formatted output, Reading input from console.<br>Arrays in Java: Arrays in Java, initialization, Default Array values, multi dimensional array, passing array to a function, Jagged arrays, java.util.Arrays class, string class, string buffer, string builder. |

Methods in Java: Methods, Parameters passing, Returning Multiple values, Throwable fillInStackTrace() method in Java, Valid variants of main(), Variable Arguments (Varargs) method

Inheritance: Inheritance in Java, Types, Constructor in Inheritance, Using final with Inheritance, Accessing superclass member, Override private methods, Parent and Child classes having same data member, Base vs derived class reference. Polymorphism: Method Overloading, Overloading main(), Static vs Dynamic Binding, Method Hiding. Private and final methods, Passing and Returning Objects in Java

**SECTION-2**

Exception Handling: Exceptions, types, types of handling exception, Checked vs Unchecked Exceptions, Throw and Throws, User-defined Exception, Chained Exceptions.

Interfaces and Abstract Classes: Interface and its usage, Abstract Class and its usage, Difference between Abstract Class and Interface, Nested Interface, Nested Class, Inner class, Anonymous Inner class, Marker interface.

Java Packages: Packages Introduction, default access specifier use, dealing with package.

Collection in Java: Collections Class, Enumeration, Iterators and ListIterator, Using Iterators, Iterator vs Foreach, ArrayList, Vector, Map, Set.

Multithreading: Thread life Cycle, Thread Priority, Thread Methods, Inter-thread Communication, Synchronization, Method and Block Synchronization, Deadlock situation in threading.

File Handling & Database connectivity: File Processing, Primitive Data Processing, Object Data Processing, Wrapper classes, Connecting Java with database (JDBC/ODBC).

Java GUI: AWT, Swing, Components, design patterns. Layout Manager: Flow, Border, Grid and Card. Label, Button, Choice, List, Event Handling (mouse, key), Menus, Tables

**List of Course Seminar Topics:**

1. Introduction of Arrays and 1D Array programming examples
2. Multidimensional arrays
3. Variants of main() and command line arguments
4. Input and Output stream classes
5. String concepts and various methods of compairing strings
6. Methods in Java
7. Java String Methods
8. Passing array to a function and Jagged array examples
9. Reading input using Scanner and BufferReader Class
10. String, String buffer and String builder
11. Types of Inheritance in Java
12. Implementation of Types using Constructor in Inheritance
13. Using final with Inheritance
14. Base vs derived class reference in Inheritance
15. Using final with Inheritance, Accessing superclass member
16. Parent and Child classes having same data member
17. Overriding, Hiding Fields & Methods
18. Static vs Dynamic Binding & Hiding Methods
19. Private and final methods
20. Passing and Returning Objects in Java
21. Java Memory Management
22. File handling in Java vs C++
23. Data types used in Java vs C++
24. Java Object Serialization and Deserialization
25. Operator precedence
26. Use of Object Class Methods
27. Garbage collection in JAVA
28. Use of Static Blocks in various applications
29. Keywords used in JAVA
30. Types of Variables In JAVA

**List of Group Discussion Topics:**

1. Checked and unchecked exception, user defined and standard exception
2. Abstraction in Java and different ways to achieve Abstraction
3. Packages in Java – Types, Advantages & Techniques to Access Packages
4. Inner classes, nested interfaces in Java
5. Difference between Interfaces and abstract classes in Java
6. Exception Handling in Java Vs CPP
7. Difference between 1) throw and throws. 2) Final, finally and finalize in Java
8. Discuss Exception propagation and Discuss Exception handling with method overriding i
9. Discuss Packages, Access specifiers and Encapsulation in java.

10. Difference between abstraction and encapsulation in Java.
11. Daemon Threads Vs user threads
12. Preemptive scheduling Vs slicing
13. Is it possible to call the run()method directly to start a new thread? pls comment
14. Arraylist Vs Vector
15. Arrays Vs Collections
16. is Iterator a class or an Interface? what is its use?
17. List Vs Set
18. BufferedWriter and BufferedReader classes in java
19. BufferedReader Vs Scanner class in java
20. Buffered Reader Vs FileReader in java
21. Instanceofjava
22. Difference between CPP and JAVA
23. Difference between JDBC and ODBC connectivity
24. file processing in java
25. Difference between premitive data processing and object data processing
26. Creating GUI using swing
27. comparision between Swing, SWT, AWT, SwingX, JGoodies, JavaFX, Apache Pivot
28. Introduction To JFC And GUI Programming In Java
29. Introduction to wrapper classes
30. Why java uses Unicode System?

**List of Practicals:**

1. Implement Student class using following Concepts
   - All types of Constructors
   - Static variables and instance variables
   - Static blocks and instance blocks
   - Static methods and instance methods

2. There is a class Adder which has two data members of type 1D int array and int variable. It has two functions: getdata and numsum. Function getdata accepts non-empty array of distinct integers from user in 1D int array data member and a targetsum in another data member. The function numsum adds any two elements from an input array which is equal to targetsum and return an array of resulting two elements, in any order. If no two numbers sum up to the target sum, the function should return an empty array. Note that the target sum is to be obtained by summing two different integers in the array; you can't add a single integer to itself in order to obtain the target sum. You can assume that there will be at most one pair of numbers summing up to the target sum. Use constructor. Use extra variables if needed

   Input:
   Array=[3,5,-4,8,11,1,-1,7] targetsum=15
   **Output: [8,7]**
   Input:
   Array=[3,5,-4,8,11,1,-1,6] targetsum=15
   Output: []

3. Write Java program to calculate area of triangle, square & circle using function overloading. Function parameter accept from user (Use function Overloading concepts and Inheritance).
4. Write a program for following exception, develop a suitable scenario in which the following exceptions occur:
    1. divide by zero
    2. Array index out of bounds exception
    3. Null pointer Exception
5. Write a java program to solve producer-consumer problem where there are two producer threads and one consumer thread.
6. Implement various operations using JDBC Connectivity.
7. Display bank account information ( Use interface and inheritance using java)
8. Develop a GUI in java which reads, update the file.

**List of Course Projects:**

Topics of Course Project would be discussed in Lab session.

**List of Home Assignments:**

Blog:

1. Single and Multidimensional arrays in Java
2. Comparison Inheritance & Polymorphism
3. Need of abstract classes and interfaces in Java
4. Multithreading concept in Java
5. Signed & Unsigned arithmetic operations usin JAVA
6. Role of start() and run() methods in multithreading

Survey:

1. Strategies for Migration from C++ to Java
2. Product development using Inheritance and Polymorphism in Industry
3. on Java/OOP features popular amongst developers
4. Which other (non-JVM) languages does your application use?
5. How Java Impacted the Internet
6. How can a ArrayList be synchronised without using vector?

Design:

1. Implementation of Singleton design pattern in Java
2. Notes Repository System for Academic
3. Design for employee management system
4. Design for student management system
5. Inventory Management System
6. Write a program to delete duplicate numbers from the file

Case Study:

1. Java development milestones from 1.0 to 16.0
2. Implementation of Different Methods in Polymorphism
3. Real world systems which use java for its implementation
4. Drawing a flag using java
5. Use of different methods of Class object

| |
|---|
| 6. Drawing a flag using java |
| **Assessment Scheme:**<br>Mid Semester Examination - 10 Marks<br>Presentation - 15 Marks<br>Laboratory - 10 Marks<br>Course Project - 10 Marks<br>Home Assignment - 10 Marks<br>Group Discussion - 15 Marks<br>End Semester Examination - 10 Marks<br>Comprehensive Viva Voce - 20 Marks |
| **Text Books:**<br>*Herbert Schildt, "JAVA- The Complete Reference", , 11th Edition, McGraw Hill Education* |
| **Reference Books:**<br>1. Bruce Eckel, "Thinking In Java – The Definitive Introduction to Object-Oriented Programming in the Language of the World-Wide Web", Fourth Edition, Pearson Education, Inc.<br>2. R. Morelli and R. Walde, "Java, java, Java – Object-Oriented Problem Solving", 3rd edition, Pearson Education, Inc. |
| **Moocs Links and additional reading material:**<br>Programming using Java\| Java Tutorial \| By Infosys Technology<br>https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_01304972186110361645_shared/overview<br>An Introduction to Programming through C++ – Prof A.G. Ranade- NPTEL- computer science and engineering – NOC https://nptel.ac.in/courses/106/101/106101208/# |
| **Course Outcomes:**<br>The student will be able to –<br>1. Understand object-oriented programming features<br>2. Develop real world applications using class, inheritance and polymorphism<br>3. Adapt Best Practices of Class Design by using Standard Templates Library<br>4. Solve computing problems by applying the knowledge of Exception handling and Multithreading<br>5. Design solutions by choosing suitable data structures such as Array, Vector, Map etc<br>6. Implement applications using Java I/O and event-based GUI handling principles |
| **Future Courses Mapping:**<br>Advanced Data Structures, Advanced Java, Spring Frame Work, Grails Frame Work |
| **Job Mapping:**<br>Java Programmer, Application Developer, Design Engineer, Senior Software Developer |

**FF No.: 654**

## IT2201::COMPUTER ORGANIZATION AND ARCHITECTURE

**Course Prerequisites:** Basics of computer system and any programming language.

## Course Objectives:

1. To study the fundamental concepts of structural Computer system and Computer Arithmetic
2. To understand the basic concepts and functions of Microprocessor
3. To gain knowledge of Computer Memory System
4. To get familiar with GPU and CPU architecture
5. To identify solutions for real world design issues using processors.

**Credits: 5** **Teaching Scheme Theory: 3 Hours/Week**

**Tut: 1 Hours/Week**
**Lab: 2 Hours/Week**

## Course Relevance:

Modern computer technology requires an understanding of both hardware and software, since the interaction between the two offers a framework for mastering the fundamentals of computing.
The purpose of this course is to cultivate an understanding of modern computing technology through an in-depth study of the interface between hardware and software.
In this course, you will study the history of modern computing technology before learning about modern computer architecture and a number of its essential features, including instruction sets, processor arithmetic and control, the Von Neumann architecture, pipelining, memory management, storage, and other input/output topics.
The course will conclude with a look at the recent switch from sequential processing to parallel processing by looking at the parallel computing models and their programming implications.

| **SECTION I** |
| --- |
| Basic concepts of Digital Electronics, Organization and Architecture, Structure & Function, Brief History of computers, Von Neumann Architecture, Integer Representation: Fixed point & Signed numbers. Integer Arithmetic: 2's Complement arithmetic, multiplication, Booth's Algorithm, Division Restoring Algorithm, Non Restoring algorithm, Floating point representation: IEEE Standards for Floating point representations.<br>8086 Microprocessor Architecture, Register Organization, Instruction types, Types of operands, Instruction formats, addressing modes and address translation. Near & FAR procedure, Instruction cycles. RISC Processors: RISC- Features, CISC Features, Comparison of RISC & CISC Superscalar Processors. Case study of Processor.<br>Fundamental Concepts: Single Bus CPU organization, Register transfers, Performing an arithmetic/ logic operations, fetching a word from memory, storing a word in memory, Execution of a complete instruction. Micro-operations, Hardwired Control, Example- Multiplier CU. Micro-programmed Control: Microinstructions, Microinstruction- sequencing: Sequencing techniques, Micro-program sequencing |

**SECTION II**

Need, Hierarchical memory system, Characteristics, Size, Access time, Read Cycle time and address space. Main Memory Organization: ROM, RAM, EPROM, E 2 PROM, DRAM, Design examples on DRAM, SDRAM, DDR3, Cache memory Organization: Address mapping. Basic concepts: role of cache memory, Virtual Memory concept. Pipeline and its performance, Data hazards: operand forwarding, handling data hazards in software, side effects. Instruction hazards: unconditional branches, conditional branches and branch prediction.

Parallelism in Uniprocessor system, Evolution of parallel processors, Architectural Classification, Flynn's, Fengs, Handler's Classification, Multiprocessors architecture basics, Parallel Programming Models : Shared memory, Message passing, Performance considerations : Amdahl's law, performance indications.

Parallel computing architectures (multi-core CPUs, GPUs, traditional multi-processor system, Xeon-Phi, Jetson Kit, Kilocore processor), multiprocessor and multicomputer systems, interconnection networks, Modern GPU architecture (in brief), Performance comparison: Speedup, Gain time and scalability.

**List of Practical (Any Six)**

1. Study of 8086 Architecture and Execution of sample programs.
2. Write 8086 ALP to access marks of 5 subjects stored in array and find overall percentage and display grade according to it.
3. Write 8086 ALP to perform block transfer operation. (Don't use string operations) Data bytes in a block stored in one array transfer to another array. Use debugger to show execution of program.
4. Write 8086 ALP to find and count zeros, positive number and negative number from the array of signed number stored in memory and display magnitude of negative numbers.
5. Write 8086 ALP to convert 4-digit HEX number into equivalent 5-digit BCD number.
6. Write 8086 ALP to convert 5-digit BCD number into equivalent 4-digit HEX number.
7. Write 8086 ALP for following operations on the string entered by the user.
   a. String length
   b. Reverse of the String
   c. Palindrome
8. Write 8086 ALP for following operations on the string entered by the user (Use Extern Far Procedure).
   a. Concatenation of two strings
   b. Find number of words, lines.

c. Find number of occurrences of substring in the given string.

9. Write 8086 ALP to initialize in graphics mode and display following object on screen.

10. Write 8086 ALP to encrypt and decrypt the given message.

11. Write 8086 ALP to perform following operations on file

a. Open File

b. Write data in the file.

c. Delete data in the file.

d. Close the file.

**List of Course Projects:**

1. Combinational and Sequential circuits
2. Memory Management
3. Graphics Mode
4. IOT based projects.
5. IoT based atmospheric CO2 administration.
6. IoT based flood risk predictor.
7. Simulate modern traffic control system.
8. Online Parallel Examination.

**List of Course Seminar Topics:**

1. Computer Architecture VS Computer Organization
2. Evolution of Computing Devices
3. Instructions types , formats and execution
4. Interrupts in Microprocessor
5. Trends in computer architecture
6. RISC Vs CISC architecture : A Case Study
7. ARM processor architecture
8. Latest Technology in Embedded systems
9. Multiplier Control Unit
10. Booth's Encoding Pattern for Fast Scalar Point Multiplication in ECC for Wireless Sensor Networks
11. Internet of Things (IoT) in 5G Wireless Communications
12. State of the art parallel processor design.
13. Memory management in mobile OS.
14. Evolution of processors.
15. Ultra SPARC Processor Archi**tecture.**

**List of Course Group Discussion Topics:**

1. GPU computing: CUDA
2. Memory System
3. Replacement Algorithms
4. Pipelining
5. Cache Coherance
6. Virtural Memory

7. Hazards in pipelining
8. Super Computer
9. Modern computer generations
10. Parallel computing models

**List of Home Assignments:**

**Design:**

1. Write the sequence of control steps required for the single bus organization for each of the following instructions:

1. ADD the (immediate) number NUM to register R1
2. ADD the contents of memory location NUM to register R1

Assume that each instruction consists of two words. The first word specifies the operation and addressing mode, and second word contains the number NUM

2. Configure a 32 Mb DRAM chip. Consider cells to be organized in 8K X 4 array. Find out the number of address lines.
3. A set associative cache consists of 64 lines, or slots, divided into four-line sets. Main memory contains 4K blocks of 128 words each. Analyze the format of main memory addresses with proper explanation.
4. A one pipeline system takes 50 ns to process a task. The same task can be processed in 6 segment pipeline with a clock cycle of 10 ns. Determine the speedup ratio of pipeline for 100 tasks. What is maximum speedup ratio?

**Case Study:**

1. Micro-programmed Control Unit and Hardwired Control Unit.
2. Pipeline Hazards
3. Flynn's architectural classification scheme.
4. Modern Processor units

**Survey:**

1. New memory technologies and their potential impact on architecture
2. Virtual Memory
3. Simulation of a superscalar processor and analyzing impact of design tradeoffs
4. Cache Consistency Models in Modern Microprocessors

**Blog:**

1. Super Computer
2. Intel Journey
3. New Arm Interconnect technologies
4. Distributed Systems and Parallel Computing

**Assessment Scheme:**

**M**id Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks
Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
Comprehensive Viva Voce - 20 Marks

**Text Books:**

1. William Stallings, "Computer Organization and Architecture: Designing for Performance", 7th Edition, Pearson Prentice Hall Publication, ISBN 81-7758-9 93-8.
2. C. Hamacher, V. Zvonko, S. Zaky, "Computer Organization", 5th Edition, Tata McGraw Hill Publication, ISBN 007-120411-3.
3. Kai Hwang, "Advanced Computer Architecture", Tata McGraw-Hill ISBN 0-07-113342-9
4. Douglas Hall, "Microprocessors and Interfacing", 2nd Edition, Tata McGraw Hill Publications, ISBN 0-07-025742-6.
5. Peter Abel, "Assembly Language Programming," 5th Edition, Pearson Education Publications, ISBN 10:013030655.

**Reference Books:**

1. Hwang and Briggs,"Computer Architecture and Parallel Processing", Tata McGraw Hill Publication ISBN 13: 9780070315563.
2. A. Tanenbaum, "Structured Computer Organization", Prentice Hall Publication, ISBN 81 –203 – 1553 – 7, 4th Edition.

**MOOCs Links and additional reading material:**

1. www.nptelvideos.in
2. https://www.udemy.com/
3. https://learn.saylor.org/
4. https://www.coursera.org/
5. https://swayam.gov.in/

**Course Outcomes:**

Upon completion of the course, post graduates will be able to –

1. Demonstrate computer architecture concepts related to design of modern processors, memories and I/Os. (2)
2. Illustrate the micro operations sequencing. (3)
3. Evaluate various alternatives in processor organization. (3)
4. Understand concepts related to memory & IO organization (2)
5. Adapt the knowledge based on Pipeline and its performance (3)
6. Design real world applications using processors. (4)

**Future Courses Mapping:**

Advance Computer Architecture, Advance Operating Systems

**Job Mapping*:***

Application Developers, System programmer

**FF No.: 654**

# ME2205::3D PRINTING

## Course Prerequisites: Basic manufacturing, Materials

## Course Objectives:

Additive Manufacturing (AM) is a technology supporting the sustainable rapid development of personalized complex design in various disruptive applications, especially in manufacturing and medical.

**Credits: 5**

**Teaching Scheme Theory: 3 Hours/Week**
**Tut: 1 Hours/Week**
**Lab: 2 Hours/Week**

## Course Relevance:

This course aims to build student competence in AM and related technology.
The students will learn fundamental knowledge of Additive
Manufacturing and Reverse Engineering (RE) and their applications in manufacturing, medical and other sectors. Besides, the students will be proficient in practice design for additive manufacturing.

**SECTION-1**

**Unit-I Design Thinking (6 Hours)**

- Engineering Design, Product Development Process, Problem,
- Types of Design, Phases of Engineering design, Definition and Need Identification to Detailed Design,
- Ergonomic and Aesthetic Aspects in Design, Design for Manufacturing,
- Limits, fits and tolerancing I and
- Limits, fits and tolerancing I I
- Concept of Geometric dimensioning and tolerancing.

**Unit-II 3D Printing Materials (6 Hours)**

- Types of Materials, Properties of materials,
- Application of materials in mechanical, chemical, electronics and software industry,
- Selection of Materials,
- Smart materials
- Materials for 3D Printing
- Bio materials, composite materials etc.

**Unit-III Introduction to Manufacturing and 3D Printing (8 Hours)**

- Machining Processes
- Casting and Forming Process
- NC and CNC Machining and Automation

- Non-Conventional Manufacturing Processes
- Introduction Overview, Basic principle need and advantages of additive manufacturing,
- Procedure of product development in additive manufacturing,
- Classification of additive manufacturing processes,
- Challenges in Additive Manufacturing.

**SECTION-II**

**UNIT IV Pre-Processing in 3D Printing (3D Modeling and Design) (7 Hours)**

- Creation of 2D geometry using Auto CAD, 2D drawing space
- AutoCAD Modify commands.
- Construct orthographic sectional views of brackets with dimension in different layers.
- 3D solid Modeling Create 3D solid and edit solid.
- Create a new assembly, insert components into an assembly, add mates (degree of freedom) and perform components configuration in an assembly.
- Design for 3D printing
- Topology optimization

**Unit V Advance Thermal Manufacturing Processes (6 Hours)**

- Laser principles, Properties of Lasers, Types of Lasers,
- Laser Beam Machining Processes,
- Mechanics of material removal in Laser machining,
- Introduction to electron beam machining, Comparison of E-beam machining with other thermal processes, Setup for EBM, Power requirement in E-Beam,
- Mechanics of EBM process and Plasma Arc Machining,
- Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.

**Unit VI: Additive Manufacturing Processes (7 Hours)**

- Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM),
- Selective deposition lamination (SDL), Selective laser sintering (SLS), Direct Metal deposition (DMD),
- Hybrid manufacturing, In situ process monitoring and control, Large scale additive manufacturing.
- 3D Printing of Metals
- Post processing requirements & Techniques
- Applications of Additive Manufacturing Applications in Aerospace, Automotive, Tooling, Defense, Jewelry, Repair and Biomedical industries
- Micro- nano- and bio-additive manufacturing

Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies

**List of Tutorials: (Any Three)**

In tutorial students are expected to present technical seminar (PPT) relevant to 3D Printing and Design. Also, students (in a group of 4/5 students) are expected to discuss any technical novel topic related to 3D Printing and Design.

**List of Practical: (Any Six)**

1) Design & develop a CAD model of a product
2) Tension test on Mild Steel and Aluminum
3) Brinell hardness test on different materials
4) Study of different 3D Printing Machines
5) Demonstration of CNC Lathe Machine Operation
6) Laser Beam Machining
7) 3D Printing Machine
8) Design and 3D print a master part
9) Design and 3D print a non-demountable assembly
10) Reverse engineering of a mechanical part
11) Design and 3D print a complex part
12) Optimize the 3D printing parameters for the function of the product

**List of Projects: Students can do course projects on**

1. Reverse Engineering
2. 3D Printing Machine
3. Dynamics of Machinery
4. Smart Materials
5. Smart Manufacturing
6. Industrial Automation
7. 3D Printing for Electronics
8. Prototyping
9. Ergonomics
10. Design for Additive Manufacturing
11. Quality in Additive Manufacturing
12. Precision Engineering
13. Process Planning and Cost Estimation
14. Tool Design
15. Green Manufacturing

**List of Course Seminar Topics:**

1. High Performance Production line for small series metal parts
2. Additive Manufacturing Aiming Towards Zero Waste & Efficient Production of High- Tech Metal Products
3. Smart production of Microsystems
4. High-Precision micro-forming of complex 3D parts
5. Additive Manufacturing for Wear and Corrosion Applications
6. Flexible and on-demand manufacturing of customized Products
7. Manufacturing decision and supply chain management system for additive manufacturing
8. Toolless Manufacturing of Complex Structures
9. Computer Aided Technologies for Additive Manufacturing
10. Hybrid Additive Manufacturing
11. Laser-based Additive Manufacturing
12. Making our Workforce Fit for the Factory of the Future
13. Sensor package fabrication via additive manufacturing for automotive sector
14. Additive Manufacture of High Temperature Components
15. Dynamic Properties of Additive Manufacturing

16. Material characterization of additively manufactured part
17. Biomaterials and Additive Manufacturing
18. Materials for 3D Printing
19. Rapid Manufacturing of lightweight metal components
20. Additive Manufacturing and Nature-based solutions
21. Functionally Graded Materials to Extra-Large Structures
22. Additive Manufacturing technologies in the Aerospace sector
23. Additive Manufacturing technologies in the Medical sector
24. METAL ADDITIVE MANUFACTURING (AM)
25. Topology optimisation in Additive Manufacturing
26. Design against Distortion of metallic aerospace parts based on combination of numerical modelling activities and topology optimization
27. Comparison AM with a conventional manufacturing process
28. Assessment of additive manufacturing parts
29. New EDM electrodes manufactured with electrically conductive materials by Additive Manufacturing

**List of Course Group Discussion Topics:**

1. Methods of force measurement
2. Force sensing technology
3. Surface modification technology
4. Application and use of carbon fiber reinforced plastic
5. Use of simulation in manufacturing
6. Electro chemical machining
7. Electro beam machining
8. Water jet machining
9. Laser metrology
10. Virtual gauging
11. Design for inspection
12. Electronic gauges
13. Gauging automation
14. Use of nanotechnology in material science
15. Use of computers in design and development process. including CAE, CAM.
16. Use of highly reliable plastic materials in engineering.
17. 3D printing in industrial scale
18. Computer aided manufacturing
19. smart materials
20. Bio and composite materials
21. Conventional machining vs 3D printing
22. limitations of additive manufacturing
23. challenges for additive manufacturing
24. design for 3D printing
25. laser beam machining
26. EBM process
27. SLA
28. FDM
29. LOM SDL

30. SLS
31. DMD
32. 3D printing of metals
33. Micro 3D printing
34. Nano 3D printing
35. Bio 3D printing
36. Applications of 3D printing

**List of Home Assignments:**

1. Engineering materials and their properties
2. Alloys and Composite materials
3. Materials for various Engineering applications
4. Selection of material for various industrial applications
5. Heat treatment of engineering materials
6. Selection of manufacturing processes for various industrial applications
7. Conventional and non-conventional machining processes
8. Additive manufacturing: concept and applications
9. Geometric dimensioning and tolerancing
10. Industrial automation: History and development
11. Computer integrated manufacturing
12. Hybrid Additive Manufacturing
13. Laser-based Additive Manufacturing
14. Making our Workforce Fit for the Factory of the Future
15. Sensor package fabrication via additive manufacturing for automotive sector
16. Additive Manufacture of High Temperature Components
17. Dynamic Properties of Additive Manufacturing
18. Material characterization of additively manufactured part
19. Biomaterials and Additive Manufacturing
20. Materials for 3D Printing
21. Rapid Manufacturing of lightweight metal components
22. Additive Manufacturing and Nature-based solutions
23. Functionally Graded Materials to Extra-Large Structures
24. Additive Manufacturing technologies in the Aerospace sector
25. Additive Manufacturing technologies in the Medical sector
26. Metal Additive Manufacturing (AM)

**Survey/Design (Broad areas)**

1. Design of simple components for manufacturability
2. Materials for additive manufacturing
3. Design for Additive Manufacturing
4. Selection of additive manufacturing process
5. Hybrid additive manufacturing
6. Application of additive manufacturing
7. Optimization of 3D printing

**Design:**

1. Design of simple components for manufacturability
2. Materials for additive manufacturing
3. Design for Additive Manufacturing

4. Selection of additive manufacturing process
5. Hybrid additive manufacturing
6. Application of additive manufacturing
7. Optimization of 3D printing

**Case Study:**

1. Case study on material selection for electronic industry, chemical industry, aerospace and automobile industry etc.
2. Case study on selection of manufacturing process for given component
3. Difficult to cut materials and effective strategies to manufacture for the same
4. Design of simple components for manufacturability
5. Materials for additive manufacturing
6. Design for Additive Manufacturing
7. Selection of additive manufacturing process
8. Hybrid additive manufacturing
9. Application of additive manufacturing
10. Optimization of 3D printing

**Blog**

1. New materials for manufacturing industry
2. Materials for industry 4.0
3. Smart Materials
4. New product development
5. Micro Machining
6. Advance machining Processes
7. Optimization of 3D printing
8. 3 D Metal printing
9. Material characterization of additively manufactured part
10. Biomaterials and Additive Manufacturing
11. Materials for 3D Printing
12. Rapid Manufacturing of lightweight metal components
13. Additive Manufacturing and Nature-based solutions
14. Functionally Graded Materials to Extra-Large Structures
15. Additive Manufacturing technologies in the Aerospace sector
16. Additive Manufacturing technologies in the Medical sector

**Surveys**

1. New materials for manufacturing industry
2. Materials for industry 4.0
3. Smart Materials
4. New product development
5. Micro Machining
6. Advance machining Processes
7. Optimization of 3D printing
8. 3 D Metal printing
9. Material characterization of additively manufactured part
10. Biomaterials and Additive Manufacturing
11. Materials for 3D Printing
12. Rapid Manufacturing of lightweight metal components

13. Additive Manufacturing and Nature-based solutions
14. Functionally Graded Materials to Extra-Large Structures
15. Additive Manufacturing technologies in the Aerospace sector
16. Additive Manufacturing technologies in the Medical sector

**Assessment Scheme:**
Mid Semester Examination - 10 Marks
Presentation - 15 Marks
Laboratory - 10 Marks
Course Project - 10 Marks
Home Assignment - 10 Marks
Group Discussion - 15 Marks
End Semester Examination - 10 Marks
Comprehensive Viva Voce - 20 Marks

**Text Books:** ***(As per IEEE format)***
Textbook: No designated textbook, but class notes and handouts will be provided

**Reference Books:** ***(As per IEEE format)***
1. ISO/ ASTM DIS 52900:2018 (E), (2018), Additive manufacturing – General principles – Terminology, ISO/ ASTM International 2018.
2. Wohlers T., (2018), Wohlers Report 2018, 3D Printing and Additive Manufacturing State of the Industry: Annual Worldwide Progress Report, Wohlers Associates, ISBN ISBN 978-0-9913332-4-0.
3. Redwood B., Schöffer F., Garret B., (2017), The 3D Printing Handbook: Technologies, design and applications, Editura 3D Hubs, ISBN 978-90-827485-0-5.
4. Zhang J., Jung Y.G., (2018), Additive Manufacturing: Materials, Processes, Quantifications and Applications, Elsevier, ISBN 978-0-12-812155-9
5. Gibson I., Rosen D., Stucker B., (2015), Additive Manufacturing Technologies - 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Editura Springer, ISBN 978-1-4939-2112-6.

**MOOCs Links and additional reading material:**

**Course Outcomes:**
1. Apply design for additive manufacturing (DfAM) in practice for the development of new products (apply);
2. Select an appropriate material for AM technology based on mechanical, physical and thermal properties (Select);
3. Apply knowledge on manufacturing, additive manufacturing, and reverse engineering in a variety of domains (apply);
4. To develop an ability to design a system, component, or process to meet desired needs within realistic constraints (Develop)
5. Investigate process parameters for effective additive manufacturing (create);
6. Select an appropriate AM technology based on preset optimisation criteria (eg. cost, quality, time/ available resources) (evaluate)

**Future Courses Mapping:**
***Mention other courses that can be taken after completion of this course***

**Job Mapping:** ***What are the Job opportunities that one can get after learning this course***

**FF No. : 654**

# PR2236::MANUFACTURING TECHNOLOGY

**Course Prerequisites:** Basic maths, trigonometry, material science, chemistry, physics

## Course Objectives:

1.Acquire knowledge of various methods by which different industrial, household, agricultural products are made
2.Understand equipment ,tooling and other requirements of producing parts
3.To be able to decide material, processes and parameters for economical production of parts.

**Credits:.....5.**

**Teaching Scheme Theory: 3** Hours/Week
**Tut: 1** Hours/Week
Lab: **2** Hours/Week

## Course Relevance:

1.The course explains wide variety of processes that are used for making different parts that are used in industry and other places
2.It deals in details with technology aspects of production of various products
3.For Engineers to be able to work in any industry or to become entrepreneur this knowledge is essential

## SECTION-1

1. Casting processes:-Classification, applications and advantages and limitations of casting process, **Patterns and Molds,** Patterns: Pattern materials, allowances, types of pattern, pattern design, Pattern color codes. Types of molding sand, properties of molding sands sand mold, molding sand materials, composition of molding sand Green and dry sand molding process. hand molding,and machine molding, ramming methods, CO2 molding process, Core & Core making: Core sands, core sand composition, Functions of cores, types of cores and core boxes. Core making procedure, core prints, chaplets, Shell molding and core making, forces on cores and molds.melting furnaces.

2.welding Process:-Gas arc and resistance welding,equipment,HAZ,soldering and brazing, Special welding techniques: Ultrasonic welding, Explosive Welding, Friction welding,Thermit welding, Laser welding, Electron beam welding. Inspection and Testing of Welds,Weld Defects: Common Weld defects, Causes and remedies of defects

**3**.Machining and finishing Processes:Construction,working and application of lathe,drilling,milling,planing and grinding,honing and lapping machines,various operations performed on these machines,cutting speed ,feed ,depth of cut,tooling,attachments,coolants,high speed machining.

**Metrology**-Standards-line and end,Measurement of linear and angular dimensions using linear and angular measuring instruments-vernier calliper,micrometer,sine bar etc,form and surface roughness measurement,using various measuring instruments and CMM.,IS for measurement

## SECTION-1I

4. Gear and Thread Cutting:

Thread cutting - internal and external chasers, dies, thread rolling thread milling, lapping and grinding

Gear cutting - Forming & generation, gear cutting on milling, gear hobbing, gear shaping, gear shaving, lapping & grinding, various machines use for gear manufacturing. Thread cutting & processes. Measurement of thread and gear parameters.

5. Broaching Operations and Non-conventional machining processes: Definitions, types of broaching, machines cutters for broaching, materials for broach, cutting action, chip disposal, broaching speeds, application of broaching, Advantages and limitations of broaching operations

6.Basic and secondary metal and plastic forming processes:-

Fundamentals of hot and cold working, rolling, forging, extrusion, drawing processes, sheet metal processes-blanking,piercing,bending etc, simple, compound and progressive dies, presses, applications, materials, dies, defects, advantages and limitations.

Plastics-compression, transfer and injection moulding, thermoforming, blow moulding, applications, machines, dies.

**List of Tutorials: (Any Three)**

1. Linear measurements by precision measuring instruments
2. Angular measurements by sine bar
3. Calculations for gear ratios for thread cutting and setting angle for taper turning
4. Gear cutting on milling calculations
5- Solidification of metal in casting.
6 -Dies in extrusion and drawing
7-Calculations of rolling force, angle of bite.
8-Calculation of forces, dimensions of tools in sheet metal operations
9. Measurement of roundness using Johanson's comparator
10. Surface finish measurement
11 Use of interferometer for study of various surfaces.
12. Process sheet of machining component.

**List of Practicals: (Any Six)**

1. Preparation of green sand with additives.
2. To determine compatibility of Green sand Mould.
3. Permeability testing of green sand.
4. Grain size distribution and estimation of AFS no of system sand and silica sand.
5. To measure green compressive strength of sand.
6. To measure green shear strength of sand.
7. Mold hardness test of Green sand Mould.
8. Core hardness test of Shell sand or Oil sand core.
9. Moisture test of green sand mould.
10.- One composite job on lathe involving the various operations..
.11. Profile Projector for measurement of screw thread parameters and saw tooth parameter
12. Measurement of gear tooth parameters
13 Measurement of screw thread parameters using floating carriage micrometer
14.Measurement of dimensions and form on CMM.

**List of Projects:**

1. Design of cope, drag pattern and core box, gating ratio and casting yield for Cover casing casting.
2Case study of Aluminum casting manufactured by high pressure dies casting process. (Die design, Metal composition, Process parameters, gating system & Rejection analysis
3Design and manufacture of permanent mould..
4. Manufacturing of Cu-Zn-Al casting plate by permanent mould process
5 Manufacturing of Cu-Al-Mn casting plate by permanent mould process
6 Mechanical and metallurgical Characterization of welded samples.
7 Optimization of soldering gap for soldering metal sheets
8 Optimization of brazing of steel sheets.
9Welding of dissimilar metals

10.Optimisation of weld parameters using laser welding.
11.Design of gear box for lathe machine
12..Design of quick return mechanism for shaping machine
13.Alignment test on various machine tools.
14.Measurement of forces on lathe,milling machines.
15.Simulation Model for solex pneumatic comparator
16.Simulation Model for electrical comparator (visual gauging head)
17.Programming for CMM.
18.Measurement strategy for complex casting on CMM.
19.Process sheet design for complex round part
20.Process sheet design for milling of component.
21.simulation and modelling for rolling process
22.Simulation and model for extrusion process

**List of Course Group Discussion Topics:**

1.Cutting speed feed depth of cut and economics of machining
2.Machining of Aluminium
3.Selection of appropriate grade of carbide tool for machining
4.Machining of square pocket
5.Extrusion Vs Drawing process
6.Elimination of defects in rolling process
7.Die design for various materials in drawing process
8.Measurement strategy for complex part on CMM
9.Measurement of roundness.
10.Selection of appropriate welding process for various types of jobs
11.NTM processes for die manufacturing
12.comparison of NTM finishing processes

**List of Course Seminar Topics:**

1 Cutting tool materials and coatings
2 Grinding wheel marking system
3 Super finishing processes
4 5-S Principles
5 Cutting tool signature
6 Total Productive maintenance
7 Speed-feed mechanisms in machine-tools
8 Computer integrated manufacturing
9 Surface treatment processes after machining
10 Machine-tool erection & alignment tests
11 Jigs & fixtures
12 Industry 4.0
13 Non conventional machining processes
14 Flexible manufacturing system
15. Automation in Foundry
16. support of IT to Foundry
17. Expert system for casting defects
18. Pollution and safety in foundry

19. Japanese Investment Casting Technology
20. Rail welding technology
21 Robot welding technology
22. Friction stir welding
23. Laser Welding
24. Ultrasonic Welding

**List of Course Group Discussion Topics:**

1.Cutting speed feed depth of cut and economics of machining
2.Machining of Aluminium
3.Selection of appropriate grade of carbide tool for machining
4.Machining of square pocket
5.Extrusion Vs Drawing process
6.Elimination of defects in rolling process
7.Die design for various materials in drawing process
8.Measurement strategy for complex part on CMM
9.Measurement of roundness.
10.Selection of appropriate welding process for various types of jobs
11.NTM processes for die manufacturing
12.comparison of NTM finishing processes

**List of Course Seminar Topics:**

1 Cutting tool materials and coatings
2 Grinding wheel marking system
3 Super finishing processes
4 5-S Principles
5 Cutting tool signature
6 Total Productive maintenance
7 Speed-feed mechanisms in machine-tools
8 Computer integrated manufacturing
9 Surface treatment processes after machining
10 Machine-tool erection & alignment tests
11 Jigs & fixtures
12 Industry 4.0
13 Non conventional machining processes
14 Flexible manufacturing system
15. Automation in Foundry
16. support of IT to Foundry
17. Expert system for casting defects
18. Pollution and safety in foundry
19. Japanese Investment Casting Technology

20. Rail welding technology
21 Robot welding technology
22. Friction stir welding
23. Laser Welding
24. Ultrasonic Welding

**List of Home Assignments:**

**Design:**

1.Design optimum shape of riser for casting a component.
2.Design an experimental method for measuring only the force required for forging the flash
3.Design of dies for products having constant curvature
4.Design of titanium ball joint for hip replacement
5.Machining parameters for titanium machining

**Case Study:**

1.Manufacture of *Baseplate for a Household Steam Iron*
2.Forging of turbine blades.
3. *Fabrication of a One-Piece Brass Flashlight Case*
4. *Fabrication of Lavatory Wash Basins*
5.Machining of cast steel body valve
6. *Estimating the Machining Time for Turning*

**Blog**

1.Automated casting line
3.High speed machining
4.Manufacturing in competitive environment
5.Design for manufacturing
6.Green manufacturing.
7.Modular fixturing

**Surveys**

1.Survey of different die and mould materials used in various casting processes
2. Survey of different rolling mill stands
3.Manufacturing steps involved in making long metallic hypodermic needles.
4.Process capabilities of various machining processes
5.Applications of various NTM processes.

**Suggest an assessment Scheme:**

***Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Bloom's Taxonomy.***
***MSE-30,ESE-30,viva-40,practical -100***

**Text Books:** ***(As per IEEE format)***

1. P. N. Rao; Manufacturing Technology I,II: Foundry, Forming & Welding; Tata McGraw Hil
2. P. L. Jain; Principles of Metal casting; Tata McGraw Hill
3. O. P. Khanna; Foundry Technology; Khanna Publisher
4. O. P. Khanna; Welding Technology; Khanna Publisher
5. Chapman, Workshop Technology vol 1,2,3 ELBS
6 Hazra Choudhary, Manufacturing Processes: Vol. 1 and 2,New Delhi 2010

**Reference Books:** ***(As per IEEE format)***

1. R.L. Timings, Manufacturing Technology, Vol I&II, 3/e, Pearson Education
2. W.A.J Chapman, Workshop Technology: Volume I, II, III: ELBS.
3. Hazra Choudhary S. K. Bose S. K., Elements of Workshop Technology: Volume I, II.Asia Publishing House:
4. Begeman, Manufacturing Processes.
5. Production Technology, HMT: TMH Publishing Co., New Delhi, 1985..
6 T. V. Ramana Rao; Metal Casting: Principles & Practice; New Age International Pvt. Ltd.
7 P. C. Mukharjee; Fundamentals of Metal Casting; Oxford & IBH Publishing Co.
8. Heine, Loper, Rosenthal; Principles of Metal Casting; Tata McGraw Hill.
9. Richard Little; Welding & Welding Technology, Tata McGraw Hill.
10. Dr. R.S. Parmar; Welding Processes and Technology; Khanna Publisher.

**Moocs Links and additional reading material:** www.nptelvideos.in
https://www.edx.org/course/fundamentals-of-manufacturing-processes

**Course Outcomes:**

1) Select and design and perform different pattern and mould making to manufacture castings.
2) Apply fundamentals of gas welding, soldering and brazing techniques for joining of appropriate material and job
3) Understand basic construction and working of various Machine tools used for metal removal processes
4) Illustrate conventional and unconventional machining processes performed on various machines
5)Understand various methods of producing gears and threads
6)Select appropriate processes from hot and cold metal deformation processes.

**CO PO Map-All COS map to PO1,PO2,PO3,PSO14 and PSO 15 to level 3**

**CO attainment levels-CO1-5,CO2-3,CO3-2,CO4-3,CO5-4,CO6-5**

***Future Courses Mapping:***
*1.Software applications in manufacturing.*
*2.Additive manufacturing*
*3Process engineering*
*4.Die and mould design*

***Job Mapping:***
*Student may get jobs in any type of manufacturing industry.*

**FF No. : 654**

## PR2237::KINEMATICS & THERMO-FLUID MACHINES

**Course Prerequisites:** Engineering Mechanics, Applied Physics, Applied Thermodynamics

## Course Objectives:

1. To develop the ability to analyze and understand the dynamic (position, velocity, acceleration, force and torque) characteristics of mechanisms such as linkages and cams.
2. To familiarise with basics of Spur gear and gear trains.
3. To familiarize application of the concepts of thermodynamics in gas power cycles and the latest technological developments in engine technology.
4. Explain Refrigeration and Air-Conditioning Processes and their application.
5. To understand Boilers and steam generation process and their application in different process industries.
6. To study Fluid statics and Fluid machinery and fluid flow measurement techniques.

**Credits:5** **Teaching Scheme Theory: 3** Hours/Week

**Tut: 1** Hours/Week

Lab: **2** Hours/Week

## Course Relevance:

- The course provides students with instruction in the fundamentals of theory of machines. The Theory of Machines and Mechanisms provides the foundation for the study of displacements, velocities, accelerations, and static and dynamic forces required for the proper design of mechanical linkages, cams, and geared systems.
- Thermal engineering is controlling heating or cooling processes in an enclosed or open environment using various equipment. It involves the science of thermodynamics, Fluid mechanics, heat and mass transfer.

**SECTION-1**

**1. Simple Mechanism:** Kinematic link, types of link, machine, structure, types of constrained motion, kinematic pair, classification of kinematic pairs, degrees of freedom, kinematic chain, mechanism, inversion, four bar chain and its inversion, single slider crank chain and its inversion and double slider crank chain and its inversions. Ackerman steering mechanism, Hooke's joint

**2. Kinematic Analysis of Mechanisms:** Introduction, Motion of a link, velocity of a point on a link by relative velocity method, velocity in a slider crank mechanism, introduction, acceleration diagram for a link, acceleration of a point on a link by relative acceleration method, Klein's construction

**3. Cams and Followers:** Introduction, applications, types of cams and followers, terms used in radial cams, analysis of motion of follower, displacement, velocity, and acceleration diagrams for various types of follower motions: uniform velocity, SHM, uniform acceleration and retardation, cycloidal motion, construction of cam profile for roller, knife edge, flat faced followers and oscillating follower.

**4. Spur Gear:** Advantages and disadvantages of gear drive, classification of toothed wheel, terms used in gears, involute and cycloidal profile, condition for constant velocity ratio-law of gearing, length of path of contact, length of arc of contact, interference in involute gears.

**5. Gear Trains:** Types of gear trains- simple gear trains, compound gear trains, reverted gear trains, epicyclic gear train

**SECTION-1I**

**1. I.C. Engines:** Classification of I.C. Engines, construction and working of two stroke, four stroke, S.I. and C.I. Engines, terms used in air cycles, thermodynamic air cycles- Otto, Diesel combustion cycles, cooling and lubrication systems of I.C.engines.,Supercharging and turbo charging methods, applications of I.C. Engines, hybrid vehicles.Introduction to electric vehicles.

**2. Steam Generators:** Introduction, formation of a steam at a constant pressure, temperature versus total heat graph during steam formation, steam properties, boiler performance, boiler efficiency, equivalent of evaporation.

**3. Refrigeration and Air conditioning:** Air refrigeration working on Bell Coleman cycle, Simple vapour compression cycle, vapour absorption cycle, types and properties of refrigerants, p-h and T-s diagram, Air conditioning: window, split, central, and industrial air conditioning systems

**4.Properties of Fluid:** Definition of fluid, Newton's law of viscosity, classification of fluid: Newtonian & Non-Newtonian fluids, ideal & real fluids, fluid properties: viscosity, compressibility, cohesion, adhesion, surface tension, capillarity, vapour pressure, types of flow, Pascal's law, continuity equation, Bernoulli's equation, applications of Bernoulli's equation, orifice meter, venturimeter, pitot tube

**5. Fluid Machinery:** Construction, working and applications of centrifugal pumps and reciprocating pumps. Construction, working and applications of hydraulic turbines – Impulse-Pelton turbine, Reaction turbines- Francis and Kaplan turbine, draft tubes, governing of turbines.

**List of Tutorials ( Any three)**

1. Graphical solution of problems on velocity in mechanisms by relative velocity method.
2. Graphical solution of problems on acceleration in mechanisms by relative acceleration method.
3. Graphical solution of problems on velocity and acceleration in mechanisms by Kleins construction method.
4. Motion analysis and plotting of displacement–time, velocity-time and acceleration-time, of cam profiles.
5. Develop and build mechanisms to provide specific motion.
6. Calculate boiler efficiency and assess boiler performance.
7. To study controls and applications of refrigeration and air conditioning.
8. Analytical method to find velocity and acceleration in a single slider mechanism.
9. Determination of boiler efficiency, equivalent evaporation and assess boiler performance.
10. Determination of engine efficiency,work done, mean effective pressure and pressure and temperature at salient points in the otto cycle.
11. Determination of engine efficiency,work done, mean effective pressure and pressure and temperature at salient points in the diesel cycle.

**List of Practicals: (Any Six)**

1. Determination of moment of inertia of rigid body by bifilar suspension method.
2. Determination of moment of inertia of rigid body by trifilar suspension method.
3. To draw a cam profile for specific follower motion.
4. Determination of radius of gyration of a connecting rod using theory of compound pendulum.
5. Verification of cam jump phenomenon.
6. To perform experiment on Watt Governors and to find speed, height of a Watt governor and obtaining the graph of governor speed V s height of governor.
7. Verification of Bernoulli's equation.
8. Trial on multi cylinder four stroke petrol engine.
9. Trial on single cylinder four stroke diesel engine.
10. Trial on reciprocating air compressor.
11. Study and demonstration onPelton wheel.
12. Study and demonstration on Francis turbine.
13. Study and demonstration of engine systems

**List of Projects:**

1. Automatic bar feeding mechanism
2. Gear indicator for two wheelers
3. Peddling washing machine
4. Material handling system
5. Peddling pump
6. Sheet metal bend removing machine
7. Power generation using Speed breaker
8. Automated material transferring system
9. Foot step pressure electrical power generator
10. Automatic rain activated wiper
11. Cam operated expanding mandrel
12. Hydraulic forklift
13. Pedaling dress washing machine
14. Pedal controlled mobile charger cum emergency light
15. Automatic fuel tank filling system
16. Automatic speed breaking systems
17. Digital vehicle fuel level indicator
18. Automatic rain operated wiper
19. Pneumatic pick & placement robot
20. Automatic packaging and stamping systems
21. Automatic gear display
22. Automatic brake failure indicator
23. Automatic soap rapping machine.
24. Automatic bottle filling system
25. Mechanical four wheels steering
26. Speed control governor
27. Conveyor using geneva mechanism.
28. Cam operated punching machine.
29. Pentograph
30. Cam operated hammer

**List of Course Seminar Topics:**

1. Four wheel independent suspension
2. Advanced materials in automobile
3. Speed controlled governors
4. Automatic gear changer
5. Four wheel drive
6. Crisis in the automobile industry
7. Magnetic gears
8. Ackerman steering mechanism
9. Regenerative brakes
10. Hybrid vehicles

**List of Course Group Discussion Topics:**

1.Electric vehicles in India
2.Automation in automobile
3.Ecofriendly refrigerant
4.Best alternatives to petrol and diesel
5.Micro hydraulics
6.Breakthrough in I C engine efficiency
7.Smart pneumatics
8.I C engine combustion and environment
9.High speed precise gear boxes
10.Use of renewable energy in Industrial sector

**List of Home Assignments:**

**Design:**

1.Desing of solar air dryer
2.Desing of solar air conditioner
3.Desing of Cam followers Mechanism to suit the given input data.
4.Design of four wheel drive
5.Desing of A/C by peltier effect
6.LPG kit design for two wheelers
7. Turbocharge for two wheelers
8.Design of LPG Refrigeration system with zero operating cost

**Case Study:**

1.Thermal power plant exhaust gases and environment
2.Gear technology in automobile sector
3.Advances in steering Mechanism
4.Recent development in pump technology
5.Crises in automobile industry

**Blog**

1.Electronic fuel injectors
2.Hybrid vehicles
3.Dynamic speed governors
4.Intillegent reverse braking system
5.Vapour absorption cooling system

**Surveys**

1.Speed controlled governors -today's need
2.Automatic versus manual transmission
3.Need of electric vehicles
4.Compressed air production from speed breakers
5.Air driven engines

**Suggest an assessment Scheme:**
Mid semester exam-15 marks
End semester exam-15 marks
Lab assignments - 10 marks
Tutorial - 5 marks
Home assignment - 5 marks
Course project - 10 marks
Seminar/Group discussion - 10 marks
Orals - 10 marks

**Text Books:** ***(As per IEEE format)***

1.S. S. Ratan Theory of Machines 11th Tata McGraw Hill 2008
2. R. S. Khurmi, K. Gupta Theory of Machines 14th S Chand Co. Delhi 2005
3. Ballaney P. L., Khanna Theory of Machines and 3rd Khanna Publisher 1999
Sadhu Singh Theory of Machines and Mechanism 5th Pearson Education 2009
5. Ghosh Amitabh and Malik Ashok Theory of Machines and Mechanisms
5th Affiliated East-West Press 1998
6. V.P. Singh Theory of Machines 8th Dhanpat Rai Publishing 2004
7.Bansal R.K Fluid Mechanics and Hydraulic Machines 9th Laxmi Publication (P) Ltd. 2005
8.S.C. Gupta Fluid Mechanics and Hydraulic Machines 5th Pearson Education India, 2006
9.Jain A.K Fluid Mechanics and Hydraulic Machines 6th Tata Mcgraw Hill 1998
10.R K Rajput Thermal Engineering 8th Laxmi Publication (P) Ltd. 2010
11.P.K.Nag Engineering Thermodynamics 5th Tata McGraw-Hill Education 2005

**Reference Books:** ***(As per IEEE format)***

1.Shigley Joseph Edward and Vicker John Joseph Theory of Machines and Mechanisms 5th Oxford University Press 2016
2. Thomas Bevan Theory of Machines 1st Pearson Education Ltd. 2016
3. Abdullah Shariff Howard L. Harrison Theory of Machines 3rd Dhanpat Rai Publishing 1981
4. V.K.Bansal Theory of Machines 3rd Laxmi Publications Pvt Limited 2006
5.Modi P. N. and Seth S. M Hydraulics and Fluid Mechanics
14th Standard Book House, New Delhi 2002
6.Khurmi R. S. and Gupta J. K Thermal Engineering 15th S. Chand & Company Ltd, 2015
7.Kumar Vasant Adani Thermal Engineering 4th Metropolitan Book Co., Delhi. 2006
8.P.L. Ballaney Thermal Engineering 20th Khanna Publisher 2009

**Moocs Links and additional reading material:** www.nptelvideos.in

**Course Outcomes**

1. Classify different types of links and mechanisms and draw velocity and acceleration diagrams of various mechanisms.
2. Construct cam profile for the specific follower motion.
3. Understand the mechanism of spur gear, types of gears and gear trains.
4. Understand basic concepts of fluids, thermodynamics, refrigeration and air conditioning principles and classification of flows
5. Analyze performance of boilers.
6. Distinguish various types of hydraulic turbines and pumps

**CO PO Map**

**CO attainment levels:**

CO 1- 5
CO 2 - 5
CO 3 - 4
CO 4 - 4
CO 5 - 5
CO 6 - 5

**Future Courses Mapping:**

Dynamics of machines
Robotics
Renewable Energy
Mechatronics
Computational Fluid dynamics
Advances in heating and refrigeration
Autonomous and electric vehicles
3D/4D Printing
Advanced gas turbine technology
Nanotechnology
Steam power engineering

**Job Mapping:**

Manufacturing Industry
Power Industry
Research and development Industry
Automobile Industry
Defence Industry
Marine Industry
Consumer goods Industry
Metal and mining Industry

**FF No. : 654**

# PR2239::MECHANICAL DESIGN

**Course Prerequisites:** Basic Idea of Mechanical, Material related information

## Course Objectives:

1. Understanding of Simple Stresses and Strains concept
2. Understanding of Beams and axially loaded columns
3. Understanding of torsional and shear stresses
4. Understanding of Shafts, Keys and Couplings
5. Understanding of Fluctuating Loads and Flywheel

**Credits:** 05 **Teaching Scheme Theory:** 03 **Hours/Week**

**Tut:** 01 **Hours/Week**

**Lab:** 02 **Hours/Week**

**Course Relevance:** Basic concept of strength of materials and design of material elements

**SECTION-1**

**1. Simple Stresses and Strains:**

Types of stresses and strains, Hooke's law, Poisson ratio, modulus of elasticity, modulus of rigidity, stress-strain diagrams for ductile and brittle materials, factor of safety, working stress, bulk modulus, interrelation between elastic constants. Introduction to principal stresses, principal planes and methods for determination of its position

***2.*** **Stresses in Beams & Axially Loaded Columns:**

Theory of simple bending, assumptions, flexural formula, second moment of area of common cross sections with respect to centroidal and parallel axes. Bending stress distribution diagrams, moment of resistance and section modulus calculations.

Shear Force and Bending Moment Diagrams: SF and BM in determinate beams due to concentrated loads, uniformly distributed loads, uniformly varying loads and couples. SF and BM diagrams for cantilevers, simple and compound, cantilever beams

Buckling of columns, Uses and limitations of Euler's and Rankine's formulae for buckling of columns under various end conditions, equivalent length for various end conditions.

***3.*** **Concepts of torsional and shear stresses:**

Theory of pure torsion, torsional moment of resistance, polar modulus, torsional rigidity, cases of stepped and composite shafts with circular and non circular sections, polar moment of inertia, shear and torsional resilience,

Shear Stresses, shear stress distribution diagrams for common symmetrical sections, maximum and average shear stress, shear connection between flange and web

**SECTION-1I**

**1. Design of Shafts, Keys and Couplings:** Design of solid and hollow shafts based on strength, rigidity, ASME code for shaft design. Keys, Types of keys, Design of keys and key ways Couplings, Types of Couplings, Design of muff coupling, Design of rigid and flexible couplings.
**2 Design for Fluctuating Loads and Flywheel:** Design for Fluctuating Loads- Fluctuating stresses, Fatigue failure, fatigue strength and endurance limit, Introduction to S-N diagram,Low cycle and High cycle fatigue, Stress concentration factor and Notch sensitivity. Factors affecting fatigue strength. Goodman and Soderberg diagram, Modified Goodman's diagrams for fatigue design. Cumulative fatigue damage
**3. Rolling Contact Bearings:** Types, Static and Dynamic load Capacity, Stribeck's Equation, Concept of equivalent load, Load life Relationship, Selection of bearing from Manufacturer's Catalogue, Design forbearing for variable loads and Speeds, Bearings with Probability of Survival other than 90%. Lubrication and Mounting of bearings, oil Seals and packing used for bearings.
**4. Design of Threaded, Welded Joints and Power Screw:** Design of Power Screw - Types, materials used, thread forms and their applications; types of stresses induced, overhauling and self-locking properties, design of nuts. Design of bolted joints subjected to transverse and eccentric loads. Design of welded joints for various loading conditions
**5. Design of Springs:** Types, Application and materials of springs, Stress and deflection equation for Helical springs, Styles of ends, Design of helical springs, Helical Springs in Parallel and Series, Design of Helical Springs for Variable Load

**List of Tutorials: (Any Three)**
1) Calculations of simple stresses & strains
2) Shear Force & Bending Moment Calculations
3). Principal planes and Principal stresses
4). Buckling of columns and struts
5) calculations of shaft design
6) calculations of coupling
7) calculations of power screw jack
8) calculations of bearings
9) calculations of Welded Joints
10) Calculations on springs

**List of Practicals: (Any Six)**

1. To study the Brinell Hardness testing machine and the Brinell hardness test
2. To study the Rockwell Hardness testing machine and perform the Rockwell hardness test
3. To study the Impact Testing machine and Perform Izod impact test
4. To study the Impact Testing machine and Perform charpy impact test
5. To study the UTM and perform the tensile, compression test
6. To Perform compression test on UTM
7. Buckling of columns and struts
8. Design of shaft.
9. Design and sheet drawing of coupling
10. Design of spur gear

**List of Projects:**

1. Models for different types of loadings of columns
2. Representation models of SFD and BMD for concentrated loaded beams
3. Representation models of SFD and BMD cantilever beam
4. Representation models of SFD and BMD for UDL beam
5. Representation models of SFD and BMD for UVL beam
6. Design and drawing of shaft subjected under static and dynamic loads.
7. Design and drawing of rigid flange coupling for any industrial application
8. Design and drawing of flexible flange coupling for any industrial application.
9. Design and drawing of levers used in industry
10. Design and drawing of helical spring for any industrial application

**List of Course Seminar Topics:**

1. Torsion of Shafts Cylinders
2. Torsion of Thin Cylinders
3. Deflection of Beams
4. McCauley's method for simply supported beams
5. Graphical solution using Mohr's circle of stresses
6. Rolling Contact Bearings
7. Design of Threaded jobs,
8. Design of Welded Joints
9. Design of Power Screw
10. Two stage Gear box.

**List of Course Group Discussion Topics:**

1.Torsional models of shafts
2. Moment of Inertia models
3. Models of Principal planes and stresses
4. Design Two stage Gear box used for any industrial applications
5. Design Three stage Gear box used for any industrial applications
6. Design of break in any automobile
7. Design of spring used in two wheeler
8. Design of spur gear used for any industrial applications
9. Design of screw jack assembly used in daily life.
10. Design of threaded joint used in real life application

**List of Home Assignments:**

**Design:**

1.Design of welded joint
2. Design of power screw
3. Design and sheet drawing of screw jack assembly
4. Design of spring
5. Design of helical gear

**Case Study:**

1.Testing on mild steel rod
2. Shear Force & Bending Moment Calculations
3. Principal planes and Principal stresses
4. Design under variable load
5. Design of flywheel

**Blog**

1. Design of bearings
2. Stress and strains analysis
3. Bending moment analysis
4. Design of any product
5. Design of threaded joint

**Surveys**

1. Stress analysis based practical analysis
2. Bending moment based practical analysis
3. Material Testing based
4. Design of plastic products
5. Design Of other type of material

**Suggest an assessment Scheme:**

Mid semester - theory - 15
End semester theory - 15
Lab assignments - 10 marks
Tutorial - 5 marks
Home assignment - 5 marks
Course project - 10 marks
Seminar/Group discussion - 20 marks

Orals - 20 marks

**Text Books:** ***(As per IEEE format)***

1. Beer and Johnston – Mechanics of Materials – Tata McGraw Hill Publication
2. Timoshenko and Young – Strength of Materials, CBS Publisher
3. A Text book of machine design – R. S. Khurmi & J. K. Gupta, S Chand
4. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publications,
5. R. K. Jain, Machine Design, Khanna Publication,
6. Pandya and Shah Machine Design, Charotar Publication,
7. Hall, Holowenko Laughlin Machine Design, Tata McGraw Hill Publication,
8. J.F. Shigley Design of Machine Element, McGraw Hill Publication
9. M. F. Spotts Design of Machine Element, Pearson Education Publication,
10. PSG Design data Book

**Reference Books:** ***(As per IEEE format)***

1. U.C. Jindal, Design of Machine Elements, Pearson Education
2. E.P. Popov – Introduction to Mechanics of Solids, Prentice Hall Publication.
3. Singer and Pytel – Strength of materials, Harper and Row Publication.
4. P. Kannaiah, Design of Machine Elements Scitech Publication,
5. H. Burr and Cheatam, Mechanical Analysis and Design, Prentice Hall Publication,
6. P. Kannaiah, Design of Transmission Systems, Scitech Publication,
7 R. L. Norton Machine Design An Integrated Pearson Education
8 S. S. Wadhwa and S. S. Jolly Machine Design A Basic ApproachDhanapat Rai and Sons

**Moocs Links and additional reading material:** www.nptelvideos.in

**Course Outcomes:**

1. Calculate normal stress, shear stress, and deformation and applications of the analysis and design of members subjected to an axial load or direct shear
2. Analyze and design circular determinate shafts subjected to torsional loading for its shear stress distribution and angle of twist.
3. Establish the shear force and bending moment diagrams for a beam
4. Select different types of rolling contact bearings from manufacturer's catalogue for various industrial applications.
5. Analyze the stress and strain in power Screw and design the same for various industrial applications.
6. Analyze the stress and strain in threaded and welded joints and design the same for various

**CO PO Map**

**CO attainment levels**

CO 1 - 3
CO 2 - 3

CO 3 - 4
CO 4 - 4
CO 5 - 4

**Future Courses Mapping:**
*CAD/CAM*

**Job Mapping:**

*Design and analysis field, Manufacturing sector industries*

# PR2238::PRODUCT DESIGN & MODELING

**Course Prerequisites:** Basics of Engineering Drawing, Need of Visualization, Orthographic and Isometric Views, Concepts of Missing views, etc.

## Course Objectives:

1. To understand the Process of product design and development, with emphasis on creativity and the systematic planning of subsequent manufacturing processes.
2. To study and apply the innovative problem solving techniques like TRIZ, lean and value engineering for better solutions to the Engg. problems.
3. Understanding the concepts of limits, fits and tolerances with GD & T dimensions and standards with their applications to actual machine parts.
4. Learn the 2D CAD software for sketching and dimensioning along with all its features.
5. Learn the 3D modeling software for part, assembly, surface and sheet metal modeling along with mechanism simulation.

**Credits:..4** **Teaching Scheme Theory: 3** Hours/Week

**Tut: --** Hours/Week

Lab: **02** Hours/Week

**Course Relevance:** The course will provide students with the most important skills needed to conceptualize and design new products, make and interpret drawings of design and production as well as develop skills on CAD softwares, which are very important from the career point of view.

### SECTION-1

**Introduction to product design and development process -** Key concepts, processes and methods, including product classification / specifications, Generic product development process, Product life cycle. Product mix. Proof of concept, Value Engineering / Value Analysis. Ergonomics / Aesthetics, Intro. To TRIZ- axiomatic design, Concurrent Engg., Rapid prototyping,

**Conceptual Design -** Innovative / Creative thinking. Concept generation, selection & embodiment of concept, Design morphology. Engineering drawings, Design for prototyping, and manufacturing. Product architecture. Designing to codes and standards, DFX. Product costing. Legal, ethical and social issues in design.

**Sketching and Engg. Drawing techniques, standards and Conventions :** Freehand drawing, perspective, sketching and editing. Dimensioning technique for machine components, Conventional representation of machine components as per IS code: SP-46 such as screw threads, springs, gears, bearing, tapped holes, knurling, splined shafts, tapers, chamfers, countersunk and counter bores, keys, & welded joints,

**Standard Machine components and Fasteners -** Rivets - forms & proportions of rivet heads, types of riveted joints. Thread terminology, thread forms, designations, single and multi-start threads, right and left hand threads, types of screws , bolts and nuts, nut locking arrangements using pins, washers & screws. Std. components - Bearings, Seals, retaining rings, etc

**SECTION-1I**

**Surface Roughness -** Introduction, terminology, machining symbol with all parameters, roughness values (Ra) and roughness grade numbers, indicating surface roughness on drawing.

**Tolerances, Fits, GD&T -** Definitions applied to tolerances, types of tolerance, types of fits, fit system. Geometrical tolerances – Nomenclature, tolerance frame, types of geometrical tolerances & their symbols, indicating geometric tolerances on drawing,

**Assembly & Details of Machine Parts -** Introduction to assembly & part drawing ,examples- Revolving Centers, Machine Vice, Tool post, Screw Jack, jigs & fixtures, tailstock, Cotter Joint, Knuckle Joint, Flange Joint, Rigid and Flexible Coupling, Drawing reading. – Title block, part list / bill of material, revision block etc.

**Basics of computer graphics & CAD -** Software configurations, functions of CAD package, constructing the geometry, various graphics elements such as line, circle, rectangle, ellipse, arc, spline etc. Geometric transformations, translations, rotation, mirror, concatenations, etc. Examples in Typical CAD software like AutoCAD,

**List of Practicals: (Any Six)**

1. On Full Imperial Sheets - Conventional representation of machine components as perIS Code: SP 46
2. On Full Imperial Sheets - Types of screws, Bolts and nuts, Nut locking arrangement.
3, 4, 5.On Full Imperial Sheets - Assembly and details of any 3 of machine Assembly :Cotter joint, Knuckle joint, Flange joint, Rigid and flexible coupling, Stop valve, Non returnvalve, Revolving centers, Machine vice, Tool holder.
6. 2D / 3D CAD modeling assignments on min. 6 drawings / parts
7,8,9. on 2D CAD - Assembly and details of any 3 of machine Assembly :Cotter joint, Knuckle joint, Flange joint, Rigid and flexible coupling, Stop valve, Non return valve, Revolving centers, Machine vice, Tool holder.
10,11,12 - on 3D CAD - Assembly and details of any 3 of machine Assembly :Cotter joint, Knuckle joint, Flange joint, Rigid and flexible coupling, Stop valve, Non return valve, Revolving centers, Machine vice, Tool holder. (Using Solid, surface and assembly modeling)

**List of Project Areas:**

1. Blueprint reading and comprehension
2. Assembly modeling and animation
3. Programs on parametric programming involving: Programming for standard machine components, Programming involving decision making and looping.
4. Use of Standard part libraries
5. Use of script files and CAD customization

6. Special CAD modeling assignments

**Suggest an assessment Scheme:**
***Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.***

**Text Books:** ***(As per IEEE format)***

1. Gill P. S., A Text book of Machine Drawing, Revised Edition K. Kataria and Sons, NewDelhi, 2008,
2. Farazdak Haideri, Machine Drawing and Computer Graphics, NiraliPrakashan, Pune,1998.
3. George Omura, ABC's of Autolisp, BPB Publications, 2002.
4. Zeid Ibrahim, Mastering CAD/CAM, Tata McGraw Hill.
5. Xiang Z. & Roy P., Computer Graphics, 2nd Edition, McGraw-Hill International Edition,2001,
6. Sham Tickoo, Catia V5-6r15 for Designers, 13th Edition, Dreamtech Press, 2016
7. Ajit Singh, Machine Drawing, Tata McGraw Hill,

**Reference Books:** ***(As per IEEE format)***

1. Narayana K. L., Kannaiah P., Venkatata Readdy K., Machine Drawing, 2nd Edition, New Age international Publishers, Delhi, 2008, ISBN 81-224-1917-8.
2. Bhat N. D., Panchal, Machine Drawing, Charotar Pub. House, 2000.ISBN: 9380358466
3. John Hood D., Using AutoCAD with Auto LISP, McGraw Hill Book Company 1990. ISBN:0070297487 2.

**Moocs Links and additional reading material:** www.nptelvideos.in

**CO PO Map**

**CO attainment levels**

**Future Courses Mapping:**
*Mention other courses that can be taken after completion of this course*

| **Title: Course Structure** | | | | **FF No.: 653** |
|---|---|---|---|---|
| **Branch:** Production Engg | **Year:** T.Y. | **Academic Year:** 2021-22 | **Semester:** I & II | **Module:** V & VI |
| | | | | **Pattern: C-21** |

# T. Y. B. Tech. Production Engineering AY 2021-22 (C21)

| Sr. No. | Subject Code | Subject Name | Teaching Scheme (Hrs/Week) | | | Examination scheme | | | | | | | Total | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Theory | Lab | Tut | CA | | | | MSE | ESA | | | |
| | | | | | | HA | Lab | Seminar | GD | MSE | ESE | CVV | | |
| S1 | PR3203 | Production Metallurgy | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S2 | PR3238 | Metal Cutting & Machine Tool Design | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S3 | PR3211 | Metrology & Quality Control | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S4 | PR3206 | Software Applications In Manufacturing Engineering | 3 | 2 | - | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 4 |
| H2 (AM) | PR3210 | Additive Manufacturing | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| H1 (RA) | IE3210 | Automated Manufacturing Systems | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S6 | PR3273 | Engineering Design and Innovation - V | - | - | - | | | | | | | | 100 | 4 |
| **Total** | | | | | | | | | | | | | | **28** |
| S1 | PR3241 | Manufacturing Automation | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S2 | PR3237 | Advanced Manufacturing Processes | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S3 | PR3201 | Forming Technologies & Tool Design | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S4 | PR3209 | Computer Aided Engineering Analysis | 3 | 2 | - | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 4 |
| H2 (AM) | PRXXXX | DFX and PLM | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| H2 (RA) | IEXXXX | Mechatronic & Industrial Robotics | 3 | 2 | 1 | 10 | 20 | 15 | 15 | 10 | 10 | 20 | 100 | 5 |
| S5 | PR3286 | Engineering Design and Innovation-VI | - | - | - | - | - | - | - | - | - | - | 100 | 4 |
| **Total** | | | | | | | | | | | | | | **28** |

**FF No. : 654**

## IE2240::PRODUCT DESIGN & MODELING

**Course Prerequisites:** Basics of Engineering Drawing, Need of Visualization, Orthographic and Isometric Views, Concepts of Missing views, etc.

## Course Objectives:

6. To understand the Process of product design and development, with emphasis on creativity and the systematic planning of subsequent manufacturing processes.
7. To study and apply the innovative problem solving techniques like TRIZ, lean and value engineering for better solutions to the Engg. problems.
8. Understanding the concepts of limits, fits and tolerances with GD & T dimensions and standards with their applications to actual machine parts.
9. Learn the 2D CAD software for sketching and dimensioning along with all its features.
10. Learn the 3D modeling software for part, assembly, surface and sheet metal modeling along with mechanism simulation.

**Credits:..4** **Teaching Scheme Theory: 3** Hours/Week

**Tut:** -- Hours/Week

Lab: **02** Hours/Week

**Course Relevance:** The course will provide students with the most important skills needed to conceptualize and design new products, make and interpret drawings of design and production as well as develop skills on CAD softwares, which are very important from the career point of view.

| **SECTION-1** |
|---|
| **Introduction to product design and development process -** Key concepts, processes and methods, including product classification / specifications, Generic product development process, Product life cycle. Product mix. Proof of concept, Value Engineering / Value Analysis. Ergonomics / Aesthetics, Intro. To TRIZ- axiomatic design, Concurrent Engg., Rapid prototyping,<br>**Conceptual Design -** Innovative / Creative thinking. Concept generation, selection & embodiment of concept, Design morphology. Engineering drawings, Design for prototyping, and manufacturing. Product architecture. Designing to codes and standards, DFX. Product costing. Legal, ethical and social issues in design.<br>**Sketching and Engg. Drawing techniques, standards and Conventions :** Freehand drawing, perspective, sketching and editing. Dimensioning technique for machine components, Conventional representation of machine components as per IS code: SP-46 such as screw threads, springs, gears, bearing, tapped holes, knurling, splined shafts, tapers, chamfers, countersunk and counter bores, keys, & welded joints,<br>**Standard Machine components and Fasteners -** Rivets - forms & proportions of rivet heads, types of riveted joints. Thread terminology, thread forms, designations, single and multi-start threads, right and left hand threads, types of screws , bolts and nuts, nut locking arrangements using pins, washers & screws. Std. components - Bearings, Seals, retaining rings, etc |
| |
| **SECTION-1I** |
| **Surface Roughness -** Introduction, terminology, machining symbol with all parameters, roughness values (Ra) and roughness grade numbers, indicating surface roughness on drawing.<br>**Tolerances, Fits, GD&T -** Definitions applied to tolerances, types of tolerance, types of fits, fit system. Geometrical tolerances – Nomenclature, tolerance frame, types of geometrical tolerances & their symbols, indicating geometric tolerances on drawing,<br>**Assembly & Details of Machine Parts -** Introduction to assembly & part drawing ,examples- Revolving Centers, Machine Vice, Tool post, Screw Jack, jigs & fixtures, tailstock, Cotter Joint, Knuckle Joint, Flange Joint, Rigid and Flexible Coupling, Drawing reading. – Title block, part list / bill of material, revision block etc.<br>**Basics of computer graphics & CAD -** Software configurations, functions of CAD package, constructing the geometry, various graphics elements such as line, circle, rectangle, ellipse, arc, spline etc. Geometric transformations, translations, rotation, mirror, concatenations, etc. Examples in Typical CAD software like AutoCAD, |

**List of Practicals: (Any Six)**

1. On Full Imperial Sheets - Conventional representation of machine components as perIS Code: SP 46
2. On Full Imperial Sheets - Types of screws, Bolts and nuts, Nut locking arrangement.
3, 4, 5.On Full Imperial Sheets - Assembly and details of any 3 of machine Assembly :Cotter joint, Knuckle joint, Flange joint, Rigid and flexible coupling, Stop valve, Non returnvalve, Revolving centers, Machine vice, Tool holder.
6. 2D / 3D CAD modeling assignments on min. 6 drawings / parts
7,8,9. on 2D CAD - Assembly and details of any 3 of machine Assembly :Cotter joint, Knuckle joint, Flange joint, Rigid and flexible coupling, Stop valve, Non return valve, Revolving centers, Machine vice, Tool holder.
10,11,12 - on 3D CAD - Assembly and details of any 3 of machine Assembly :Cotter joint, Knuckle joint, Flange joint, Rigid and flexible coupling, Stop valve, Non return valve, Revolving centers, Machine vice, Tool holder. (Using Solid, surface and assembly modeling)

**List of Project Areas:**

1. Blueprint reading and comprehension
2. Assembly modeling and animation
3. Programs on parametric programming involving: Programming for standard machine components, Programming involving decision making and looping.
4. Use of Standard part libraries
5. Use of script files and CAD customization
6. Special CAD modeling assignments

**Suggest an assessment Scheme:**

***Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.***

**Text Books:** ***(As per IEEE format)***

1. Gill P. S., A Text book of Machine Drawing, Revised Edition K. Kataria and Sons, NewDelhi, 2008,
2. Farazdak Haideri, Machine Drawing and Computer Graphics, NiraliPrakashan, Pune,1998.
3. George Omura, ABC's of Autolisp, BPB Publications, 2002.
4. Zeid Ibrahim, Mastering CAD/CAM, Tata McGraw Hill.
5. Xiang Z. & Roy P., Computer Graphics, 2nd Edition, McGraw-Hill International Edition,2001,
6. Sham Tickoo, Catia V5-6r15 for Designers, 13th Edition, Dreamtech Press, 2016
7. Ajit Singh, Machine Drawing, Tata McGraw Hill,

| |
|---|
| |
| **Reference Books:** ***(As per IEEE format)*** |
| 1. Narayana K. L., Kannaiah P., Venkatata Readdy K., Machine Drawing, 2nd Edition, New Age international Publishers, Delhi, 2008, ISBN 81-224-1917-8.<br>2. Bhat N. D., Panchal, Machine Drawing, Charotar Pub. House, 2000.ISBN: 9380358466<br>3. John Hood D., Using AutoCAD with Auto LISP, McGraw Hill Book Company 1990.ISBN:0070297487 2. |
| |
| **Moocs Links and additional reading material:** www.nptelvideos.in |
| **Future Courses Mapping:**<br>*Mention other courses that can be taken after completion of this course* |
| **Job Mapping:**<br>*What are the Job opportunities that one can get after learning this course* |

**FF No. : 654**

## PR3203::PRODUCTION METALLURGY

**Course Prerequisites:** Material Science

## Course Objectives:

1.To understand the significance of microstructures & properties in materials.
2. To understand various ferrous materials, compositions, properties and applications.
3. To learn the mechanism of phase transformations and application of heat treatment process to achieve required mechanical properties of materials.
4.To understand process of surface heat treatments and its applications
5.To explore different non ferrous materials,its compositions, properties and applications

**Credits: 5** **Teaching Scheme Theory: 3** Hours/Week

**Tut: 1** Hours/Week

**Lab**: **2** Hours/Week

**Course Relevance:** Knowledge of ferrous and non ferrous materials is essential for understanding properties of materials for appropriate applications or new product

development.Heat treat process objective to achieve required mechanical properties of the products.

| **SECTION-1** |
|---|
| **1) Microstructure & Metallography**: Micro and macro examination, Specimen preparation for micro & macro examination. Optical metallurgical microscope, Etching technique.<br>**2) Iron-Iron carbide equilibrium diagram**: Critical temperatures, Allotropy, cooling curve and volume changes of pure iron. Microstructure, non-equilibrium cooling of steel, widmanstatten structure, structure property relationship. Classification and applications of plain carbon steels, specifications of some commonly used steels like BIS, EN, AISI, SAE.<br>**3)Cast irons -** Differences between steels and cast irons. Classification of cast irons, Gray cast iron, White cast iron, Malleable cast iron, Ductile Iron, Chilled and alloy cast irons. Effects of various parameters on structures and properties of cast irons, Different alloy cast irons. Applications of cast irons for different components of machine<br>tool, automobiles, pumps etc.<br>**4)Steels:** Classification of steels, Alloy Steels, Effects of alloying elements on properties of plain carbon steels, classification of alloying elements. Typical examples of alloy steels like HSLA, Dual phase steels, Maraging steels, Stainless Steels, Sensitization of stainless steel, weld decay of stainless steel. Tool steels and tool materials, Heat treatment of high-speed steel. Special purpose steels with applications. Special cutting materials like Stellites, Ceramics, Cermets etc. |
| |
| **SECTION-1I** |
| **5)Phase Transformation:** Transformation products of austenite,bainite,martensite Time-temperature- transformation diagrams, Critical cooling rate,Continuous cooling Transformation diagrams. Heat treatment of steels,Quenching media<br>**6)Heat Treatment Processes**: Annealing, Normalizing, Hardening, Tempering. Retention of austenite. Effects of retained austenite. Elimination of retained austenite, Tempering. Secondary hardening, Temper embrittlement, Hardenability testing. Defects due to heat treatment, causes and remedial measure.Heat treatments of cast iron.<br>**7)Surface hardening and Isothermal treatments**: Process details, applications modifications in these treatments. Isothermal treatments like Austempering, Patenting, Isoforming, Ausforming etc. procedures of these treatments, applications.Introduction to heat treatment furnaces and Furnace atmospheres.<br>**8)Nonferrous alloys:** Copper alloys like Brasses, Bronzes (Tin, Aluminium, Beryllium,Silicon bronzes) Copper nickel alloys, Nickel - Silver, Aluminium and aluminium alloys. Solders, Bearing materials and their properties and applications, Precipitation hardening alloys. High Temperature materials such as Nimonics, Super alloys, Ti-alloys, Nickel alloys,Bio materials etc. Properties of these alloys and typical applications. |
| |

**List of Tutorials: (Any Three)**
1)Calculation of Grain Size
2)Calculation of Amount of Phases
3) Charge calculation for desired composition of Cast Iron
4)Graphical representation of Heat treatment cycles
5) Interpretation of Material grade
6) Calculation of austenite and ferrite stabilizing equivalents in stainless steel

**List of Practicals: (Any Six)**
1. Specimen preparation for micro examination.
2. Macro examination of prepared samples.
3. Microstructure analysis of plain carbon steels.
4. Analysis of microstructures of heat treated steels.
5. Phase analysis of microstructures of Cast Irons.
6. Microstructures analysis of non ferrous alloys.
7. Hardenability testing
8. Study and drawing microstructures of annealed & normalized steels.
9. Study the effect of carbon content on hardness of hardened steel.
10. Study the effect of tempering temperature on hardness of hardened steel.
11. Study the effect of alloying elements on hardness of hardened steel.
12. Comparison of Hardenability of plain carbon steel and alloy steel.
13) Measurement of Case depth and case hardness of surface hardened samples.

**List of Projects:**
1. Effect of carbon percentage on hardness after hardening.
2. Effect of tempering temperature on hardness.
3. Use of macro examination in Metallography.
4. Hardenability testing of different steels and co relating results with composition of Steel.
5. Study the effect of tempering on the hardness of steel.
6. Study Carburizing steel.
7. Study Carbonitriding of steel.
8. Measurement of case depths.
9. Study of the effect of Carburizing time on case depth.
10. Study of tempering of tool steel
11. Study & comparison of different bearing materials.
12. Sorting of plain carbon steels by observing their microstructures.

**List of Course Seminar Topics:**
1.Characterization of Microstructures
2.Production of Grey Cast Iron
3.Methodology of S.G Iron Production
4.Steel Making Process
5.Effect of surface hardening processes and applications
6.Cutting Tool materials and manufacturing
7.Phase transformations and cooling rate of steels
8.Heat treatment of Cast Iron
9.Aluminum Grades properties and applications
10.Nimonics microstructures and Mechanical properties

**List of Course Group Discussion Topics:**
1. Correlation of microstructures and mechanical Properties.
2. Aluminum 6000 series potential applications and characteristics
3. Titanium as an emerging material in Automotive applications
4. Potential applications of Magnesium castings and characteristics
5.Sensitization of stainless steel and weld decay.
6. Mechanical properties and microstructures of pure titanium
7. Cast Iron applications in components Car assembly and functional requirements.
8. Potential applications of Al components in Electric Car
9. Heat treatment of connecting rod and functional requirements.
10.Bearing materials and its characteristics and functional requirement as a bearing material.

**List of Home Assignments:**
**Design:**
1.Design charge for cast Irons composition
2.Design of Heat treatment cycle for crankshaft
3.Design of phase percentage in steels
4.Design of austenite and ferrite phases in stainless steels
5.Design heat treatment cycle for Aluminum 6061 components.
**Case Study:**
1.Car engine block material grades and manufacturing technology
2. Flywheel material and manufacturing process
3. Aeroplane landing gear material and processing technique
4. Gear heat treatment process and required properties
5.Single point cutting tool materials and manufacturing technology of tool
**Blog**
1Titanium as a.Bio Medical Material for implants
2.Lightweighting Mg for automotive applications
3 Super alloy classification, properties and applications
4.S.G. Iron manufacturing technology
5. Stainless steel Production capacity in India
**Surveys**
1.Steel requirements for construction applications, production, requirement, Number of companies, Total world wide volume and Indian market requirement

2.Cast Iron foundries in India state wise and tonnage capacities.
3.Aluminum Production capacity of India with major plant capacity
4.Ti materials potential in India.
5.Copper extraction plants in India and Production capacity.

**Suggest an assessment Scheme:**

- Midsem 20 Marks
- End sem 20 Marks
- Home Assignment 10 marks
- Lab work 10 Marks
- Course Project 10 Marks
- Tutorial 10 Marks
- Viva 10 marks
- GD/PPT 10 marks

**Text Books:** ***(As per IEEE format)***

1. Dr. V. D. Kodgire, Material Science and Metallurgy for Engineers, Everest Publishing House, Pune.
2. Raymond A. Higgins, Engineering Metallurgy, Part 1: Applied Physical Metallurgy, 5th Edition, English Language Book Society.
3. K.G. Budinski, M. K. Budinski, Engineering Materials, Prentice –Hall India Pvt. Ltd.
4. Sidney H. Avner, An Introduction to PhysicalMetallurgy, Indian Edition

**Reference Books:** ***(As per IEEE format)***

1. E.C. Rollason, Metallurgy for Engineers, English Language Book Society
2. Donald Clark and Wilbur Varney, Physical Metallurgy for Engineers, East- West Press Pvt. Ltd. New Delhi.
3. Donald. Askeland and P.P. Phule, The science and engineering of materials, 4th edition, Thomson learning Inc.
4. A.S.M. Metals Handbook Volume 4, Heat Treatments.

**Moocs Links and additional reading material:** www.nptelvideos.in
http://nptel.ac.in/courses/113105024/
http://nptel.ac.in/courses/113105024/1
http://nptel.ac.in/courses/113105024/2
http://nptel.ac.in/courses/113105024/3
http://nptel.ac.in/courses/113105024/4
http://nptel.ac.in/courses/113105024/5
http://nptel.ac.in/courses/113105024/6
https://www.youtube.com/watch?v=PVnftOMxl6w&list=PLbMVogVj5nJQbjE_u2KZhUmCypfLunjG4
https://www.youtube.com/watch?v=FrhvKcjKdPo&index=5&list=PLbMVogVj5nJQbjE_u2KZhUmCypfLunjG4

**Course Outcomes:**
The student will be able to –
1. Interpret Fe-$Fe_3C$ equilibrium diagram, microstructures & correlate structure-properties relationship of steels & cast irons.
2. Select appropriate Cast Irons for different engineering applications.
3. Select appropriate alloy steel and tool steel for different engineering applications
4. Use the concept of TTT, CCT diagrams & apply the heat treatment techniques to enhance mechanical properties of steels.
5. Apply the surface hardening & isothermal heat treatment techniques to enhance mechanical properties of steels.
6. Select appropriate nonferrous material for different engineering applications.

**CO PO Map**

| PO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PS1 | PS2 | PS3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO 2 | 3 | 2 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO 3 | 2 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO 4 | 3 | 2 | 2 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO 5 | 3 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO 6 | 2 | 2 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |

**CO attainment levels**

| CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|---|---|---|---|---|---|
| 3 | 4 | 4 | 5 | 3 | 3 |

**Future Courses Mapping:**
Metal Forming Technologies & Tool Design, Die and Mould Design, Engineering Design and Innovations, Advanced Manufacturing Processes

**Job Mapping:**
1) Job Scope in Manufacturing Industry: Heat Treatment shop, Research and Development, Material Procurement, Product Design.Foundry Industry, Quality Assurance.
2) IT Consultancy, Projects and Service Industries, IOT:Functional knowledge of materials properties and applications for specific applications. modelling and simulation of process and materials.

**FF No. : 654**

## PR3238::METAL CUTTING & MACHINE TOOL DESIGN

**Course Prerequisites:** Manufacturing Technology

## Course Objectives:

1. To understand tool designation systems and its applications and mechanism of chip formation
2. To explore performance characteristics of machining in terms of tool life, tool wear, cutting forces..
3. To perform design calculations of single and multi point cutting tools
4. To design and draw jigs and fixtures

5. To explore machine tool design elements like gear box, spindle set ups, feed box etc

**Credits: 05** **Teaching Scheme Theory: 03** Hours/Week

**Tut: 01** Hours/Week

Lab: **02** Hours/Week

**Course Relevance:** Theory of metal cutting covers all machining aspects and principles of machining regime for performance improvement. Economy and productivity improvement is sought by designing jigs and fixtures. Whereas knowledge of analysis of machine tool parts helps to understand machine tools in better way.

| **SECTION-1** |
|---|
| **Analytical approach to Theory of Metal Cutting**<br>Mechanics of chips formation, types of chips, determination of shear angle, chip reduction factor, velocity relationship, merchant force circle, estimation of cutting forces, Tool dynamometer. Heat generation & tool life<br>Heat generation in cutting, functions of cutting fluid, characteristics of cutting fluid, types of cutting fluid, Tool wear, Tool life, modified Taylor's equation, Tool dynamometers.<br>Novel considerations in metal cutting: Minimum quality lubrication (MQL), vortex flow cooling, cryogenic machining, high temperature machining<br>**Economics and selection of Tooling**<br>Performance analysis of machine tools, economics of machining, selection of cutting tools,<br>Tool materials, design features and selection criteria for single and multi point cutting tools like form tools, drills, reamers, milling cutters, broaches<br>**Design of jig & fixtures**<br>Introduction to jig & fixture, difference between jig & fixtures. Classification of jig & fixtures. Principle of location, types of locators. Principle of guiding elements Types of guiding elements, Principle of clamping elements, Types of clamps. Types of Jigs & Fixtures<br>Concept of modular fixtures. General guide lines & procedures for design of jig & fixtures, Bodies, bases & frame, Design of locators, Design of guiding elements, Analysis of number of clamping forces required & their magnitude |
| |
| **SECTION-1I** |

**Machine Tool Drives & mechanisms**

Stepped regulation of speed, laws of stepped regulation, arithmetic, harmonic, logarithmic & geometric progression, relation between range ratio, number of speed steps, design of stepped drives: Break up of speed steps, structural formulae, structural diagram, selection of best structural diagram, ray diagram, speed chart, general recommendations for Developing the gearing diagram, determining the number of teeth of gears. speed/feed gear box: Limiting Transmission Ratio of Speed/Feed Gear Box.

**Design of Spindle**

Function & Requirements of Spindle Units, their Materials, Effect of Machine Tool Compliance on Machining accuracy Design of Spindle for Bending Stiffness: Deflection of Spindle Axis due to a) Bending, b) - due to Compliance of Spindle Supports, c) - due to Compliance of the Tapered Joint. Optimum Spacing between Spindle Supports, Permissible Deflection & Design for stiffness: Additional Check for Strength like Additional Supports, Location of Bearings and Drive elements

**Design of Machine Tool Structure**

Function & Requirement of Machine Tool Structure, Design Criteria from Strength & Stiffness considerations, Concept of Unit Rigidity, Unit Strength under Tension, Unit Strength under Torsion & Unit Strength under Bending for Material of Machine Tool Structures, Compare Steel & Cast Iron on the basis of Material Properties, Manufacturing Problems and Economy, Role of Static & Dynamic Stiffness in the design of elements of machine tools, Profiles of Machine Tool Structures, Factors affecting stiffness of machine tool structures & methods of improving it, Basic Design procedure of machine tool structures

**List of Practicals: (Any Six)**

1. Experiment on chip formation.
2. Measurement of shear angle using chip thickness ratio criteria.
3. Study of influence of cutting parameters on surface roughness in turning.
4. Measurement of cutting forces in turning using lathe tool dynamometer.
5. Verification of metal cutting theories.
6. Tool life study on a single point turning tool.
7. Design & working drawing of one drilling jig.
8. Design & working drawing of one Fixture.
9. Design & working drawing of one Form tool.
10. Design & working drawing of any two of following cutting tools.
11. SPCT, Reamer, Broach, Plain milling cutter
12. Industrial visit report.

**List of Projects:**

1. Mechanics of Chip Formation
2. Preparation of Cutting Tool Models
3. Design of Drilling Jigs
4. Design of Milling Fixtures
5. Measurement of Cutting Forces using Multi Axis Tool Dynamometers
6. Machinability study of difficult-to-cut materials
7. Machining performance under different machining environments
8. Parametric study of cutting parameters on response parameters
9. Challenges in machining of composites
10. Variation in cutting forces during machining of Composites using Tool Dynamometer
11. Design and Manufacturing of Cutting Tools

**List of Course Seminar Topics:**

1. Different types of coating on cutting tools
2. Minimum Quantity Lubrication
3. Performance enhancement of natural oils as cutting fluids in detrimental cutting conditions
4. Study of hazards related to cutting fluids and remedies
5. State of the art in Dynamometry
6. Simulations in heat generation and tool life
7. Thermal monitoring in cutting zone
8. Modular fixtures: Concept, roles and applications
9. Nano-Cutting Fluid for Enhancement of Metal Cutting Performance.
10. Machining challenges faced in processing of metal matrix composition
11. Methods of Tool Wear Measurement in machining of Superalloys
12. Application of soft computing in optimization of machining process parameters

**List of Course Group Discussion Topics:**

1. Function and requirements of spindle units and their materials
2. Influence of structure components on machine tool accuracy
3. Function & Requirement of Machine Tool Structure
4. Cryogenic Machining
5. Comparison between Vertical machining center and Horizontal machining center
6. Modular v/s conventional fixtures.
7. Machine tool design and operating strategies for green manufacturing
8. The Analysis of Key Technologies for Sustainable Machine Tools Design
9. Back gear mechanism in lathe
10. Classification of jig and fixtures
11. Conventional & Advanced finishing processes for Gear manufacturing
12. Conventional vs Additive Manufacturing of Jigs and Fixtures
13. Economics and selection of tooling

**List of Home Assignments:**

**Design:**

1. Design of spindle
2. Hybrid machine tool design
3. Design and Fabrication of Jigs and Fixture for Radial Drilling Machine in Automotive Industry to Improve Productivity
4. Design of Drill jig 3D model

**Case Study:**

1. Multi-spindle drill machine
2. Design of Part locating Pin
3. Machine tools and noise pollution
4. Selection of cutting tools
5. Deflection of spindle axis due to a) Bending, b) due to Compliance of Spindle Supports,
6. Compliance of the Tapered Joint.

**Blog:**

1. Tool failure criteria in case of SPCT, Milling cutter, Broaches, Drill
2. Nanocomposites in Machining Tool
3. various types of cutting tools
4. artificial intelligence for accurate metal cutting
5. MACHINE LEARNING IN MANUFACTURING ENGINEERING

**Surveys:**

1. Function and requirements of spindle unit
2. Recycling of Cutting Tool inserts

**Suggest an assessment Scheme:**

- Midsem 20 Marks
- End sem 20 Marks
- Home Assignment 10 marks
- Lab work 10 Marks
- Course Project 10 Marks
- Tutorial 10 Marks
- Viva 10 marks
- GD/PPT 10 marks

**Text Books:** ***(As per IEEE format)***

1. P C Sharma, Production Engg., Khanna publishers.
2. M.H.A. Kempster, Introduction to Jigs and fixtures design

**Reference Books:** ***(As per IEEE format)***

1. Tool Engg by Nagpal
2. Dolalson, Lecain and Goold, Tool design, Tata McGrawhill.
3. Hoffman, Introduction to Jigs and fixtures.
4. Tool Engineering Handbook, A.S.T.M.E.
5. Basu, Mukherjee and Mishra, Fundamentals of tool engineering and design.
6. R. K. Jain, Production Technology, Khanna Publishers
7. Milton Shaw, Metal cutting principle

**Moocs Links and additional reading material:**
www.nptelvideos.in

**Course Outcomes:**

1. Understand and represent cutting tools using designation systems
2. Apply metal cutting theories to estimate and represent cutting forces
3. Analyze cutting environment and cutting parameters
4. Understand design principles of location, clamping for jigs and fixtures
5. Design and draw jigs and fixtures by following design principles
6. Design and draw single and multi-point cutting tools

**CO PO Map**

COURSE LIST

| CO/PO | PO:1 | PO:2 | PO:3 | PO:4 | PO:5 | PO:6 | PO:7 | PO:8 | PO:9 | PO:10 | PO:11 | PO:12 | PSO:13 | PSO:14 | PSO:15 | PSO:16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO:1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 |
| CO:2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 |
| CO:3 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 |
| CO:4 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 |
| CO:5 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 |
| CO:6 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 |

Freezed...

**CO attainment levels**
**CO1-4; CO2-3; CO3-2; CO4-3; CO5-5; CO6-5**

**Future Courses Mapping:**

**Job Mapping:**
*Design Engineer, Production manager, Shop supervisor, Manufacturing Engineer*

# PR3211::Metrology & Quality Management

## Course Prerequisites:

Course Prerequisites:

1. Fundamental Physics
2. Engineering drawing
3. Machine Drawing

## Course Objectives:

1. To make students understand and appreciate the significance of measurements.
2. To make students understand various types of measuring processes and instruments.
3. To make students capable of designing measurement processes for various parameters.
4. To make students understand the concept of Quality in engineering works.
5. To make students measure quality parameters and apply quality inspection methods to decide the quality of the product and also the process capabilities.

**Credits:5**

**Teaching Scheme Theory: 03 Hours/Week**

**Tut: 01 Hours/Week**

**Lab: 02 Hours/Week**

Course Relevance: Metrology and quality Management is the heart of Engineering. Engineers cannot work without quantification of anything. Quantification involves measurements. Metrology fundamentals enable Engineers to implement their ideas right from concepts, design, and manufacturing to ensuring quality results of the ideas.

**SECTION-1**

**Topics and Contents**

1) **Introduction to Metrology :** Introduction to Metrology, Precision, Accuracy, Errors in Measurement, Calibration. Linear Measurement: Standards, Line Standard, End Standard, Wavelength Standard, Classification of Standards, Precision and Non Precision Measuring instruments, Slip Gauges. Manufacture of slip gauges.

2) **Angular Measurement :** Sine bar, Sine Center, Uses of sine bars, Clinometer, Angle gauges, Angle Dekkor, vernier bevel protractor, Auto Collimator, Standard balls and rollers for angle measurement.

3) **Comparators:** Uses, Need of Comparators, Types, Advantages and Disadvantages of mechanical comparators- Dial Indicator, Johansson Mikrokator, Sigma Comparator, Electrical, Electronic Comparator, Free flow and back pressure flow Pneumatic Comparators, Optical Comparator.

4) **Limits, Fits and Tolerances:** Meaning of limits, fits and tolerances, Indian standards system for limits fits and tolerances, Cost – Tolerance relationship, concept of Interchangeability, Indian Standard System. Design of limits Gauges: Types, Uses, Taylor's Principle, Design of Limit Gauges.

**SECTION-1I**

**Topics and Contents**

5) **Interferometry:** Introduction, Flatness testing by interferometry, NPL Flatness Interferometer.

6) **Screw Thread Metrology:** External Screw Thread terminology, Floating Carriage Instruments, Pitch and flank Measurement of External Screw Thread.

7) **Gear Metrology:** Spur Gear Parameters and their Inspection Methods pitch & Tooth thickness measurement by various methods. Measurement of pitch – Internal Thread, Measurement of gear tooth profile, Profile projector.

8) **Computer Aided Inspection:** In-process Inspection and On-line Sensing, Automated Inspection Techniques, Coordinate Measuring Machine (CMM), Need, merits and demerits of CMM, types - manual CMMs, CNC CMMs, multi-sensor CMMs, modes of operation, types of probes, Image processing and its application in Metrology.

9) **Quality Control:** Concept of Quality, Quality control and quality assurance, Specification of quality, Factors controlling quality of design and conformance, Cost of quality, Balance between cost and quality and value of quality, Seven QC tools.

**List of Tutorials: (Any Three)**

1) Method of measurement with slip gauges
2) Measurement with Vernier Calliper and Micrometer, Bore gauge
3) Measurement with Autocollimator
4) Use of surface finish softwares.
5) Applications of Flatness interferometer
6) Applications of Gauge length interferometer
7) Study of Nano technology instrumentation
8) Deming's cycles and 14 points
9) Sampling plans, calculations of sampling size
10) OC curves and its characteristics

**List of Practicals: (Any Six)**

1) 1. Linear measurements by precision measuring instruments

2. Angular measurements by sine bar

3. Dial Gauge calibration

4. Design of limit gauge

5. Measurement of roundness using Johanson's comparator

6. Surface finish measurement

7. Use of interferometer for study of various surfaces

8. Profile Projector for measurement of screw thread parameters and saw tooth parameter

9. Measurement of gear tooth parameters

10. Measurement of screw thread parameters using floating carriage micrometer

11. Machine tool metrology- Alignment tests on Lathe Machine

12. Study of Toolmakers Microscope

**List of Projects:**

1. . Laser based measuring systems

2. Machine vision system

3. In process gauging system

4. Image analysis for measurement

5. Case study – coordinate Measuring Machine

6. Pneumatic gauge

7. Model for solex pneumatic comparator

8. Model for electrical comparator (visual gauging head)

9. Models for

– Force measurement

– Torque measurement

– Speed measurement

– Measurement of temperature at the Furnace

– Laser beam machining / Turning

10. Design and manufacturing of gauges for particular application

11. Calibration set up for – Slip gauges – Micrometer – Vernier Caliper, etc.

12. Measurement of micro components and micro features

13. Set up for measurement of – Roundness – Straightness – Squareness – Flatness

14. Remote measurement of

– Temperature

– Pressure

15. Test set up for measurement of

– Pitch of screw thread

– Involute profile of Gear teeth

16. Gear Roller Tester setup

17. Development of camera based systems for micro-coordinate metrology

18. Color based product sorting system using PLC

19. PLC based sorting system using metal detection

20. Pneumatic displacement gauge

21. Dimension sensing probe

22. Air Gauging

– C Jet Air Gauge

– E Jet Air Gauge

– Accessories Filter Sets

23. Electronic Gauging

– Electronic Column Gauging

– Electronic Display Unit

– Four Channel LCD Display Unit

– Air Electronic Gauging

24. Air Probes

– Air Plug Gauges

– Air Ring Gauges

– Air Snap Gauges

– Special Air Probes

25. Contact Type Plug

– Contact Type Plug for Bore Measurement

26. Multi Gauging Fixtures for

– Con Rod Pneumatic Measurement

– Con Rod contact type

– Con Rod contact type for Matching Rod & Cap

– Crank Shaft pneumatic measurement

– Contact type snap for Crankshaft

– Spline Shaft measurement

– Camshaft

– Camshaft profile measurement

– Cylinder Block measurement

– Piston

– Axle & Axle flange measurement

– Pump body

– Cylinder liner measurement

27. Auto Gauging Fixtures for

– Con Rod sorting system

– Con Rod marking and sorting system

– Crankshaft and crankcase

– Crankshaft auto gauging with grading and marking

– Cylinder Block

– Bombshell online measurement

– Cylinder Liner

28. Calibration set up

29. Product sorting systems [eg colour based]

30. Electronic gauging systems

31. To check the flatness of given surface plate by spirit level.

**List of Course Seminar Topics:**

1. 1. Machine vision systems

2. CMM case study

3. In process gauging system

4. Image analysis for measurement

5. Coating Design

6. Lens Design

7. Juran trilogy approach

8. Quality circle

9. Criteria for Quality award

10. ISO certification

**List of Course Group Discussion Topics:**

1. Concept of Accuracy, Precision and error
2. Concept of Calibration
3. Industrial applications of Metrology
4. Use of metrology in Research
5. Metrology in Manufacturing
6. Metrology in Quality Control
7. Concept of Quality
8. Quality in Design
9. Non engineering Applications of Metrology.
10. Sensitivity and uncertainty in measurements

**List of Home Assignments:**

**Design:**

1. Design of Gauges
2. Designing methods for measuring tapers
3. Designing methods for measuring angles
4. Designing methods for testing of parts
5. Designing methods for testing of process parameters

**Case Study:**

1. 5S

2. Kaizen

3. QMS

4. Six sigma

5. Testing of operational parameters of gears

**Blog:**

1. Sigma Comparators

2. Pneumatic Comparators

3. Electrical Comparators

4. LVDT

5. Kanban

**Surveys**

1. JIT

2. Quality Audit

3. Determination of process capability

4. Fault finding in given batch of specimen

5. ISO 14000

**Suggest an assessment Scheme:**
***Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Bloom's Taxonomy.***

Mid Semester Examination - 10 Marks

Presentation - 15 Marks

Laboratory - 10 Marks

Course Project - 10 Marks

Home Assignment - 10 Marks

Group Discussion - 15 Marks

End Semester Examination - 10 Marks

Comprehensive Viva Voce - 20 Marks

**Text Books:** ***(As per IEEE format)***

**Text Books:**

1. R. K. Jain Engineering Metrology Khanna publishers 1975

2. I. C. Gupta A textbook of engineering metrology Dhanpat rai and sons 2013

3. Hume K.J., Engineering Metrology, Macdonald Publications

4. Juran J. M. Quality Handbook, McGraw Hill Publications

5. D. Montogomery Introduction to SQC, John Wiley & Sons

**Reference Books:** ***(As per IEEE format)***

1. K. W. Sharp Practical Engineering Metrology, Sir Isaac Pitman & Sons, London, 1966

2. ASTME Handbook of Industrial Metrology, Prentice Hall of India Ltd, 1992

3. G.N.Galyer F.W and C.R.Shotbolt Metrology for Engineers, ELBS Edition 1990

4. Judge A.W., Engineering Precision Measurements, Chapman & Hall 5. Francis T. Farago, Mark. A. Curtis, Handbook of Dimensional Measurement

**Moocs Links and additional reading material:** www.nptelvideos.in

**Course Outcomes:** Student will able

1) Measure length using line-graduated instruments, i.e. vernier calipers, micrometers etc.

2) Measure angle precisely using precision angular measuring instruments like vernier bevel protractor, sine bar, clinometers, angle dekkor and auto collimator.

3) Design Go and No Go gauges based on principles of limits, fits and tolerance and use of comparators of various types.

4) Apply knowledge of various instruments and methods to determine geometry and surface finish and dimensions of industrial components.

5) Use effective methods of measuring screw threads and gear teeth parameters.

6) Understand and apply principles of quality management

**Future Courses Mapping:**

1) Product Life-cycle Engineering
2) Advanced Reliability Engineering
3) Quality Management systems (QMS)
4) Reliability Engineering
5) Quality Management Systems
6) Robotics Manufacturing Automation

**Job Mapping:**

The course is going to be in demand as it is required in industries more in the quality control and inspection of products, processes and after sell services. The companies are looking for appointing agencies to carry out quality control measurements. Also calibration of measuring instruments can be a good option for students interested in entrepreneurship.

**FF No. : 654**

## PR3206::SOFTWARE APPLICATIONS IN MANUFACTURING ENGINEERING

### Course Prerequisites:

Manufacturing processes,product design,autocad

## Course Objectives:

1. To Introduce the students to the standard terminologies, conventions, processes, operations, design and operational characteristics of key hardware components, programming techniques, applications, merits and demerits of Computer Numerical Controlled (CNC) machines.
2. To provide the students with an understanding of the basic fundamentals of rapid prototyping, its fabrication techniques, materials and various areas of defects and improvements in Rapid Prototyping.
3.To introduce to CAD/CAM systems and applications of these softwares in manufacturing engineering.

**Credits:....5....** **Teaching Scheme Theory:3...** Hours/Week
**Tut:…1** Hours/Week
Lab:**2...** Hours/Week

## Course Relevance:...

For today's high technology driven industry, softwares are used for efficient application of machinery, tools and labour to produce finished goods for end users. This course provides students, knowledge of intelligent manufacturing, automation, simulation, production modelling, monitoring and product development by application of softwares in manufacturing**.**

**SECTION-1**

**A)INTRODUCTION**

Introduction to CAD, CAM, Evolution, definition, integration within the scope of CIM
Components of CAD systems, Fundamentals of CAD, Automation and CAD, Product Cycle &CAD, Introduction to Computer Hardware, Introduction to computer software and their applications. Introduction to Automation, need & future of NC systems and CAM, Advantages & disadvantages. Hardware components and configurations

B)Creation od part 2d /3 d solid model--

by using autocad/SIMCAM/Fusion 360 softwares:-Commands for creation of models using line,arc,circle,mirroring,setting of UCS ,MCS,creations of features,dimensioning,use of layers,conversion to various viwes.Database-product data,data management attributes, production data,operational data,resourses dataData exchange-IGES,PDES,STEP.Benefits of CAD/CAM system

*c)Additive manufacturing-*

*Various additive manufacturing processes***,**

Introduction: Classification of manufacturing processes, Different manufacturing systems, Introduction to Rapid Prototyping (RP), Need of RP in context of batch production, FMS and CIM and its application; Basic Principles of RP, Steps in RP, Process chain in RP in integrated CAD-CAM environment, Advantages of RP. Classifications of Different RP Techniques: Based on raw material, Based on layering technique (2D or 3D) and energy sources. Process Technology in RP: Comparative study of stereo-lithography (SL) with photopolymerization, Solid foil polymerization, Selective laser sintering, Selective laser melting, Ballastic particle manufacturing, Fused deposition modeling, Shape melting, Laminated object manufacturing, Solid ground curing, Repetitive masking and deposition, Beam inference solidification, Laser engineered net shaping (LENS), 3D Printing, CAD Data and Programming Techniques for RP: Transformations, Solid modeling for RP, Surface modeling, STL file generation, Defects in STL files and repairing algorithms, Interface formats, Slicing methods, Design of support structures, Internal hatching and surface skin fills.

**SECTION-1I**

**D)Computer Aided Manufacturing-**

Scope-Manufacturing Planning and Manufacturing Control, CAD/CAM, Process definition and manufacturing planning – Structures of a process plan – CAD based process planning – Coding systems – Methods of CAPP – Process planning systems., Nature of the CIM system– ERP software,

NC & CNC Machine tools Basics

1) CNC MACHINE TOOLS -Evolution of CNC Technology,principles, features, advantages, applications, CNC and DNC concept, classification of CNC

Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, programming,characteristics, interpolators–

2)STRUCTURE OF CNC MACHINE TOOL CNC, structural details,configuration and design, guide ways – Friction, Anti friction and other types of guide ways, , recirculating roller screw, rack and pinion, spindle assembly, Driving units,feedback units.

**E**)**Application of Softwares for machining on CNC machines**-

:Creation of CAM database for modelled component-CNC Program generation from CAD models,**Use of SIMCAM /Fusion 360 softwares** for creation of CAM model for component-Setting of cutting speed,feed,DOC,coolant,tool path generation,simulation of machining and validation.

**F)Application of softwares**

-for industrial robots ,manufacturing planning and machining-Siemens-NX software,simulation softwares for simulation of solidification in casting process –solid cast,procast,mould flow for injection moulding etc.

**List of Tutorials: (Any Three)**

1) 2D transformations of geometric entities

2. 3D transformations of geometric entities

2) Example of programming-liner interpolation.

8. Example of programming-circular interpolation clockwise

9. Example of programming-circular interpolation anti clockwise

10. Example of programming-Automatic canned cycle-turning

11. Example of programming- Automatic canned cycle-facing, threading, grooving

12. Example of programming-Cutter diameter, tool nose radius compensation, tool length offsets.

13)Exercises in tool presetting and workpiece referencing on CNC machine tools, , 14Automatic Cutter location data generation from CAD Models in APT format

15.post-processing for machining on CNC machines using standard CAD/CAM software.

**List of Practicals: (Any Six)**

1) Comparison of properties of 3D Printing Materials
2. Study of fill patterns
3. Logic behind "stl" file generation
4. 3D Modeling using "123D Catch"
5. Experimental Investigation on 3D Printing parameters
6. G-Code file generation of Object
7. Study of slicing software
8) Methodology of 3D printed objects
9. Comparative assessment of FDM and DLP Techniques
10. Shape optimization using DFAM approach
11. Manual Programming for CNC Turning center
12.Manual Programming for CNC milling machine
13.CNC Parametric Part programming
14.Program generation using CAM software
15.Free form surface modeling and tool path generation
16.Programming for 5-axis machining
17.CNC tool path verification and optimization
18.CNC full machine simulation and verification

**List of Projects:**

1. Modeling of part using CAD
2. Manufacturing of Part on CNC lathe
3. Manufacturing of Part on Vertical machining centre
4 Manufacturing of Part on Horizontal machining centre
5. Manufacturing of Part on turning centre
6. Optimization of tool path (to reduce machining time) using any CAM software
7. Generation of G and M code using CAM software for turned component
8 Generation of G and M code using CAM software for milled component.
9. Creation of input files for 3D Model and logic behind it
10. Analysis and modeling of different slicing strategies
11. Blending and G Code generation
12 3D Printing of objects
13. 3D printing defects and methods to avoid/overcome them
14. Shape optimization
15 Printing of assemblies
16. Assessment of different fill patterns.
17. Parametric assessment on VAT Photopolymerisation
18. Parametric assessment on Fused Deposition Modeling

**Suggest an assessment Scheme:**
***Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.***
***MSE-30,ESE-30,CVV-40,practical-100***

**Text Books:** ***(As per IEEE format)***

1. Chua, C.K., Leong, K.F., Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley and Sons Inc., 2000.
2. Pham, D.T., Demov, S.S., Rapid Manufacturing: The Technologies and Applications 87th Senate approved Courses Scheme & Syllabus for M.E. CAD/CAM Engg. (2015) of Rapid Prototyping and Rapid Tooling, Springer-Verlag London Limited, 2001.
3. Noorani, R., Rapid Prototyping: Principles and Applications, John Wiley & Sons, Inc., New Jersey, 2006.
4. Patri, K. V., Weiyin, Ma, Rapid Prototyping - Laser-based and Other Technologies, Kluwer Academic Publishers, U.S.A., 2003.
5. Saxena, A., Sahay, B., Computer Aided Engineering Design, Anamaya Publishers, New Dehi, 2005.
6. Zeid, I., Mastering CAD/CAM, Tata McCraw Hill, 2006*Name(s) of author(s); Title of the book; Edition No., Publisher*
7. Groover, Zimmer-CAD/CAM: Computer-aided Design & Manufacturing 7th Edition Pearson Education 2010

**Reference Books:** ***(As per IEEE format)***

1. Rao P N Introduction to CAD/CAM Tata McGraw Hill Publishing Co.2011
2 *Suh Suk-Hwan, Kang Seong-Kyoon, Chung Dae-Hyuk, Stroud Ian., Theory and Design of CNC Systems, 2008, Springer-Verlag London Limited*
*3. Smith Peter, CNC programming handbook, 2003, Industrial Press Inc*
*4. Hood-Daniel P., and Kelly J.F., Build Your Own CNC Machine, 2009, Springer-Verlag New York*
*5. Manuals of CAD/CAM Software Package on CAM Module and CNC Machines*

**Moocs Links and additional reading material:** www.nptelvideos.in,mitsubhishi ecnc, EDX-CNC programming. https://www.edx.org/course/introduction-to-computer-numerical-control

**Course Outcomes:**

1) Apply solid modeling concepts and techniques in RP.
2. Analyze and implement the different algorithms associated with STL file errors
3) Identify, characterize and select the ideal materials for a given Rapid Prototyping system.
4). Describe construction and working of CNC machines.
5) Write programme for CNC lathe and miiling machine
6)Simulate CNC machining by CAD/CAM system

**CO PO Map**
**All COS map to PO1,PO2,PO3,PSO14 and PSO 15 to level 3**

**CO attainment levels-CO-1-5,CO2-5,CO3-4,CO4-3,CO5-5,CO6-5**

**Future Courses Mapping:**
Product design and modeling,mechatronics and robotics,cad-cam,FEM

**Job Mapping:**
*In CAD/CAM and prototyping,product design areas.*

**FF No. : 654**

# PR3210::ADDITIVE MANUFACTURING

## Course Prerequisites:

Product design & Modelling

## Course Objectives:

- To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering techniques.
- To familiarize students with different processes in rapid prototyping systems.
- To teach students about mechanical properties and geometric issues relating to specific rapid prototyping applications.

**Credits:....5....** **Teaching Scheme Theory:3...** Hours/Week
**Tut:…1** Hours/Week
Lab:**2...** Hours/Week

## Course Relevance:...

Additive Manufacturing (AM) is an economically viable alternative to conventional manufacturing technologies for producing highly complex parts. The main objective of this course is to acquaint students with the concept of AM, various AM technologies, selection of materials for AM, modeling of AM processes, and their applications in various fields. The course will also cover AM process plan including building strategies and post-processing.

| **SECTION-1** |
|---|
| **INTRODUCTION**<br>Overview – History – Need-Classification -Additive Manufacturing Technology in product development - Materials for Additive Manufacturing Technology – Tooling – Applications<br>**CAD & REVERSE ENGINEERING**<br>Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation – Softwares for Additive Manufacturing Technology: MIMICS, MAGICS<br>**LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS**<br>Classification – Liquid based system – Stereolithography Apparatus (SLA) - Principle, process, advantages and applications – Solid based system –Fused Deposition Modeling – Principle, process, advantages and applications, Laminated Object Manufacturing |
| |
| **SECTION-1I** |

**POWDER BASED ADDITIVE MANUFACTURING SYSTEMS**

Selective Laser Sintering – Principles of SLS process – Process, advantages and applications, Three Dimensional Printing – Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting

**MEDICAL AND BIO-ADDITIVE MANUFACTURING**

Customized implants and prosthesis: Design and production, Bio-Additive Manufacturing - Computer Aided Tissue Engineering (CATE) – Case studies

**DESIGN FOR ADDITIVE MANUFACTURING PROCESSES**

Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.

**List of Practicals: (Any Six)**

1. Properties of 3D Printing Materials
2. Features of Slicing Softwares
3. Reverse Engineering using image capturing apps
4. G-Code file generation of Object
5. Study of fill patterns
6. Logic behind “stl” file generation
7. Identification of causes and remedies of printing defects in components
8. Postprocessing operations required in FDM 3D Printing
9. Geometrical tolerancing during 3D printing
10. Case study using DFAM

**List of Course Projects**

1. Creation of input files for 3D Model and logic behind it
2. Analysis and modeling of different slicing strategies
3. Blending and G Code generation
4 3D Printing of objects
5. 3D printing defects and methods to avoid/overcome them
6. Shape optimization
7 Printing of assemblies
8. Assessment of different fill patterns.
9. Parametric assessment on VAT Photopolymerisation
10. Parametric assessment on Fused Deposition Modeling

**Suggest an assessment Scheme:**

- Midsem 20 Marks
- End sem 20 Marks
- Home Assignment 10 marks
- Lab work 10 Marks
- Course Project 10 Marks
- Tutorial 10 Marks
- Viva 10 marks
- GD/PPT 10 marks

**Text Books:** ***(As per IEEE format)***

1. Chua, C.K., Leong, K.F., Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley and Sons Inc., 2000.
2. Pham, D.T., Demov, S.S., Rapid Manufacturing: The Technologies and Applications 87th Senate approved Courses Scheme & Syllabus for M.E. CAD/CAM Engg. (2015) of Rapid Prototyping and Rapid Tooling, Springer-Verlag London Limited, 2001.

**Reference Books:** ***(As per IEEE format)***

1. Noorani, R., Rapid Prototyping: Principles and Applications, John Wiley & Sons, Inc., New Jersey, 2006.
2. Patri, K. V., Weiyin, Ma, Rapid Prototyping - Laser-based and Other Technologies, Kluwer Academic Publishers, U.S.A., 2003.

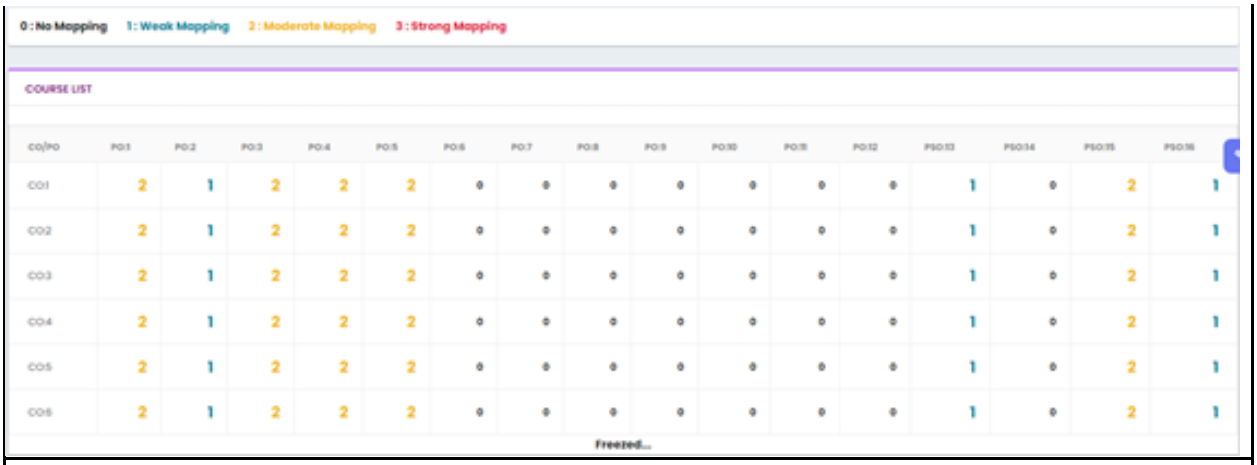
**Moocs Links and additional reading material:**

https://www.coursera.org/learn/additive-manufacturing-3d-printing
https://learn-xpro.mit.edu/additive-manufacturing
https://www.udemy.com/course/learn-3d-printing-additive-manufacturing/
https://alison.com/course/the-future-of-additive-manufacturing-technologies

**Course Outcomes:**

1. Understand various additive manufacturing processes for different applications
2. Use correct CAD file formats in 3D printed parts manufacturing
3. Select appropriate 3D printing parameters considering shape features, part quality and printer specifications
4. Apply AM concepts for Bio medical and medical fields
5. Perform reverse engineering steps to prepare virtual model
6. Operate 3D printer machine to manufacture desired 3D objects

**CO PO Map**




**CO attainment levels-CO-1-5, CO2-5, CO3-4, CO4-3, CO5-5, CO6-5**

# PR3241::MANUFACTURING AUTOMATION

## Course Prerequisites:

Manufacturing processes, fluid mechanics

## Course Objectives:

1. To understand the importance of automation in the of field machine tool based manufacturing
2. To get the knowledge of various elements of manufacturing automation – CAD/CAM,sensors, pneumatics, hydraulics and CNC
3. To understand the basics of product design and the role of manufacturing automation
4. To understand the principle of automatic control and real time motion control systems, with the help of hydraulic and pneumatic drives and actuators
5.To familiarize with the basic concepts of industrial automation.-assembly,inspection and material handling
6. To acquaint with the concept of low cost automation with electro pneumatic and elecrtro hydraulic systems.

**Credits:.....** **Teaching Scheme Theory: ……..** Hours/Week

**Tut: ……..** Hours/Week

Lab: **……..** Hours/Week

## Course Relevance:

Automation is technology concerned with performing a process by means of programmed commands combined with automatic feedback control to ensure proper execution of the instructions.. The development of this technology has become increasingly dependent on the use of computers and computer-related technologies. Consequently, automated systems have become increasingly sophisticated and complex. Automation provides higher production rates and increased productivity, more efficient use of materials, better product quality, improved safety, shorter workweeks for labour, and reduced factory lead times.

| **SECTION-1** |
| --- |
| ***1)Hard automation***<br>***Capstan Turret lathes,*** *SPMs, automats –Single spindle and multi spindle automats, Tool layouts, Cam design Transfer lines, types, work part transfer mechanisms, control of production line, transfer line performance*<br>***2)Soft Automation-***<br>*Introduction, types, major elements and optimization of FMS, Group technology, cellular manufacturing, Group technology – part families formation, classification and codification systems (DCLASS, MICLASS, OPITZ), Operational elements in a typical FMC – Typical FMS layout, Integration and Implementation issues in CAD/CAM/CIM – Introduction – Requirements for integrated* |

*manufacturing systems – Economic justification of CAD/CAM/CIM technologies – Steps to implement CIM. Conceptual understanding of Lean manufacturing, Agile manufacturing*

***3)Automatic material handling and inspection***

*Automatic material handling and inspection, Automated guided vehicles systems, conveyor systems, automated inspection, Analysis, carousel storage systems, automatic gauging system*

***Factory automation, Assembly systems***

*Factory automation, Assembly systems, automated assembly, design for automated assembly, vibratory bowl feeders, hopper feeders, rotary disc feeders. Synchronous and non synchronous material transfer, centrifugal, revolving feeders*

**SECTION-1I**

Automation technologies in manufacturing-
Fluid Power Engineering:-

4)Fluid Power-Basics and Hydraulic Pumps

Pascal's Law, properties of fluid, laminar and turbulent flow, Pressure drop in hoses/pipes,Power units and accessories, Types of hydraulic fluids - petroleum based, synthetic and water based, selection of fluids, additives, effect of temperature and pressure on hydraulic fluid.Seals, sealing materials, compatibility of seal with fluids, Types of pipes, hoses, material,quick acting couplings, Fluid conditioning through filters, strainers, sources of contamination and contamination control.

Pumps: Types, classification, principle of working and constructional details of vane pumps,gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, characteristics curves, selection of pumps for hydraulic power transmission

5)Actuators,Valves and Industrial hydraulic circuits

Actuators: (i) Linear and Rotary. (ii) Hydraulic motors- Types- Vane, gear, piston types,radial piston. (iii) Methods of control of acceleration, deceleration. (iv) Types of cylinders and mountings. (v) Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads. (vi) Design considerations for cylinders

Control of Fluid Power

Symbols for hydraulic and pneumatic circuits, Control of fluid power: (i) Necessity of fluid control through pressure control, directional control, flow control valves. (ii) Principle of pressure control valves, direct operated and pilot operated relief valves, pressure reducing valve, sequence valve. (iii) Principle of flow control valves, pressure compensated,temperature compensated flow control valves, meter in circuit, meter out circuits, flow through restrictor. (iv) Types of directional control valves: two way two position, four way three position, four way two positions valves. Open centre, close centre, tandem centre valves. Introduction to Cartridge valves, proportion control and servo valves- Manually operated, solenoid operated, pilot operated, direction control valves, check valve

Industrial Circuits & System Design

Industrial circuits 1 - Simple reciprocating, Regenerative, Speed control(Meter in, meter out & bleed off), Sequencing, Synchronization, transverse & feed, circuit for rivetting machine,automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit, motor breaking circuit
Design of hydraulic/pneumatic circuit for practical application, Selection of different components such as reservoir, various valves, actuators, filters, pumps based on design.(Students are advised to refer manufacturer's catalogues.)
6) Pneumatics
Principle of Pneumatics: (i) Laws of compression, types of compressors, selection of compr essors. (ii) Comparison of Pneumatics with Hydraulic power transmissions. (iii) Types of filters, regulators, lubricators, mufflers, dryers. (iv) Pressure regulating valves, (v) Direction control valves, two way, three way, four way valves. Solenoid operated valves, push button, lever control valves. (vi) Speed regulating – Methods used in Pneumatics. (vii) Pneumatic actuators- rotary, reciprocating,
Air motors- radial piston, vane, axial piston (ix) Basic pneumatic circuit, selection of components(x) Principle of fluid Logic control, Basic fluidic devices - Fluid sensors Application of pneumatics in low cost Automation and in industrial automation

**List of Tutorials: (Any Three)**
1)1. Tool lay -out of Turret lathe
2. Cam design of single spindle automat
3. Analysis of transfer lines with no internal storage
4. Analysis of AGVs
5. Conveyor system analysis
6.Tool layout of single spindle automat
7. Assembly line balancing-ranked position weight method
8. Survey of softwares for assembly line balancing
9. Classification and coding problem
10. Production flow analysis problem Cell formation approaches
11. AS/RS design.
12. In process inspection

**List of Practicals: (Any Six)**
1. Drawing of various hydraulic and pneumatic symbols from book 'Industrial Hydraulics – by pipenger
2. Demonstration of different parts of hydraulic trainer, quick acting coupling, hoses and seals
3. Study of a circuit using accumulator
4. Experiment on operating characteristics of gear pump
5. Study of direction control valves & pilot operated check valves & circuits
6. Study, simulation and testing of sequencing circuit
7. Study, simulation and testing of meter in, meter out and bleed off circuits

8. Drawing and study of Power Steering mechanism circuit
9. Study of Compressed air generation and distribution systems
10. Construct and test various circuits using H-simulator software
11. Control of D/A cylinder with one 3/2 and one 5/2 single solenoid valve
12. Design, simulation and testing of pneumatic circuit for control of d/a cylinder with two
13. 3/2 DCV and one 5/2 DCV

**List of Projects:**

**1.** Design a mechatronics system- e.g System to accept different type of coins.
2. Mechatronics design of robotic walking machine
3. Mechanism for feeding stock from coil
4. Magazine feeding device
5. Determination losses in hydraulic systems
6. Selection of pumps for hydraulic system
7. Selection of valves for hydraulic system
8. Selection of cylinders for hydraulic system
9. Selection of pumps for motors hydraulic system
10. Design of hydraulic circuits of JCB
11. Design of hydraulic circuits of lawn cutting machine
12. Project on simulation and testing various circuits using e4 training.com website software

**List of Course Seminar Topics:**

1. CIM - Hostile and remote environments.
2. product cycle and automation in CAD/CAM,
3.Hydraulic circuits for machine tools
4.Pneumatic exavator
5.Fluid contamination and control
6.selection of pumps
7.Selection of compressors
8.Accumulators
9.Intensifiers
10.Low cost automation and pneumatics

**List of Course Group Discussion Topics:**

.1. Automated guided vehicle systems
2. Spool Vs Poppet valves
3. Need of Accumulators
4.Applications of intensifiers
5.Hydraulics Vs Pneumatics
6.proportion control valves
7.Servo valves
8.synchronisation circuits
9.contamination control
10.Control of cylinder

**List of Home Assignments:**

**Design:**

0. Interfacing handling & storage with manufacturing.
1. Determination losses in hydraulic systems
2. Selection of pumps for hydraulic system
3. Selection of valves for hydraulic system
4. Selection of cylinders for hydraulic system
5. Selection of pumps for motors hydraulic system
6. Design of hydraulic circuit for hydraulic planning machine
7. Design of hydraulic circuit for hydraulic grinding machine
8. Design of hydraulic circuit for hydraulic presses
9. Design of hydraulic circuit for hydraulic injection moulding machine
10. Design of hydraulic circuits of JCB
11. Design of hydraulic circuits of lawn cutting machine

**Case Study:**

1.application of DNC
2.Case study of adaptive control in machining
3. tool management and workpiece handling system In FMS
4.Winch application
5.Vehicle transmission hydrostatic

**Blog**

1.Strategies of Automation
2.Automation for machining operations design & Fabrication consideration
3.Automated inspection-principles and methods,
4. parts placing mechanisms
5.Blog on pneumatic systems

**Surveys**

1. Survey of hopper feeding devices
2. Vibratory bowl feeder
3 Survey of chucking devices
4. Survey of turning devices in transfer machines
5.survey of animation softwares in hydraulic and pneumatics

**Suggest an assessment Scheme:**

***Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.***

MSE-30,ESE-30,Viva-40,practical-100

**Text Books:** ***(As per IEEE format)***

1. Mikell P. Grover, Automation, Production Systems and Computer-Integrated Manufacturing, Pearson Education, New Delhi. ISBN: 0132393212 2. N. Viswanandham, Y. Narhari, Performance Modeling of Automated Manufacturing System, Prentice-Hall. ISBN: 0136588247
3. P. C. Sharma, Production Engineering, S. Chand and Co. New Delhi, ISBN-81-2190111-1
2 Esposito – 'Fluid Power with application', Pearson,7 th edition, ISBN 10:1-292-02387-2

**Reference Books:** ***(As per IEEE format)***

1. W Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Prentice-Hall. ISBN: 0131216333
2. C D Johnson, Process Control Instrumentation Technology, Prentice Hall of India, New Delhi. ISBN: 8120309871.
*3.* J. J. Pipenger – 'Industrial Hydraulics', McGraw Hill 1. H. L. Stewart – 'Hydraulics and Pneumatics', Industrial Press
4. A. Lall – 'Oil Hydraulics', International Literature Association 3. Yeaple – 'Fluid Power Design Handbook'
5. Vickers Manual on Industrial Hydraulics
6. Festo's Manual on Pneumatic Principle, applications
7. ISO – 1219, Fluid Systems and components, Graphic Symbols
8. Majumadar, "Oil Hydraulics- Principle & Maintenance", Tata McGraw Hill,1998

**Moocs Links and additional reading material:** www.nptelvideos.in

**Course Outcomes:**
1) Analyze performance of automated transfer systems
2) Able to classify jobs according to group technology and Understand concepts FMS
3) Understand principles of automated assembly systems
4 Select appropriate pumps, for hydraulic systems
5. Select appropriate motors, cylinders and valves and construct circuits for hydraulic systems
6)Apply principles of pneumatic systems for automation systems

**CO PO Map**
**All COS map to PO1,PO2,PO3,PSO14 and PSO 15 to level 3**

**CO attainment levels**
**Co1-4**
**Co2-3**
**Co3-2**
**Co4-5**
**Co5-5**
**co6-5**

**Future Courses Mapping:**
*Advanced hydraulic and pneumatic systems,mechatronics and robotics,CIM*

**Job Mapping:**
*As a designer for Industrial fluid power systems,maintenance of machines and management of automation technologies in manufacturing organisation*

# PR3237::ADVANCED MANUFACTURING PROCESSES

**Course Prerequisites:** Machine Tools & Processes, Mathematics

## Course Objectives:

1. Identify the characteristics and need for advanced manufacturing processes
2. Describe the basic mechanism of material removal and working principle of processes
3. Identify the process parameters and manufacturing characteristics of processes
4. Analyse the effect of process input parameters on process output parameters
5. Develop mathematical model relate process input and output parameters

**Credits: 5.** **Teaching Scheme Theory: 3** Hours/Week

**Tut: 1** Hours/Week

Lab: **2** Hours/Week

## Course Relevance:.....

| **SECTION-1** |
|---|
| **Introduction**<br>Introduction to nontraditional machining methods - Need for non - traditional machining - Sources of metal removal - Classification on the basis of energy sources - Parameters influencing selection of process<br>**Mechanical Processes**<br>Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining. (AJM, WJM and AWJM). Operating principles -Equipment -Parameters influencing metal removal - Applications -Advantages and Limitations. Ultrasonic Machining, Operating Principle and Process characteristics<br>**Thermo Electrical Energy Techniques Electrical Discharge Machining (EDM)**<br>Fundamental principle of EDM, Equipment's required for EDM process parameters, process capabilities. Application example troubleshooting, Introduction to wire EDM, Process principle and parameters, process capacities and its applications.EDM tool design, Machine tool selection, EDM accessories / applications, electrical discharge grinding. |
| |
| **SECTION-1I** |

**Thermal Energy Techniques**

Operating principles - Equipment and sub systems - Parameters influencing metal removal- Benefits - Applications - Advantages and limitations of Electron beam machining (EBM), Plasma ARC Machining (PAM) and laser beam machining (LBM). Electron Beam Machining, EBM Principle and process characteristics

**Electro Chemical Machining (ECM)**

Background of ECM process, Classification of ECM processes. Electrochemistry of ECM, Equipment required in ECM. Process capabilities and processes parameters. Evaluation of MRR. Parameters influencing metal removal- Applications - Advantages and limitations. Electro Chemical Grinding: Process principles, process parameters, Applications

**Chemical Machining (CHM)**

Introduction, Elements of process Chemical blanking process:-Preparation of workpiece. Preparation of masters, masking with photo resists, etching for blanking, applications of chemical blanking, chemical milling (Contour machining):- Process steps – masking, Etching, process characteristics of CHM :-material removal rate accuracy, surface finish, Advantages & application of CHM. Electro-chemical Drilling and Deburring operations.

**List of Tutorials: (Any Three)**

1. Calculations of MRR in USM
2. Calculations of MRR in AWJM
3. Calculations of MRR and TWR in EDM
4. Calculations of MRR and TWR in ECM
5. Energy calculation in EDM process

**List of Practicals: (Any Six)**

1. Student will do experiment and process modeling of following processes in order to predict MRR, Surface roughness etc. and also they will study parametric correlations of the process.
    a. Laser Beam Machining
    b. Electro Discharge Machining
    c. Electro Chemical machining
    d. Wire Electro discharge Machining
    e. Abrasive Water Jet Machining
2. Experiment on Ultrasonic machining (USM), Abrasive Jet Machining (AJM) and Abrasive water jet machining (AWJM)
3. Experiment on MRR and surface roughness modeling of EDM process and wire-EDM process.
4. Experiment on Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining (EBM)
5. Experiment on Electro Chemical Machining (ECM) and Chemical Metal removal process
6. Case study on Hybrid material Removal process (ECDM, ECG, EDG etc.)

**List of Projects:**

1. Some Experimental Investigation of Laser Cutting of Thin Copper sheets
2. Parametric study of Gas Laser Cutting of thick SS Sheets
3. Parametric study of Abrasive Water Jet Cutting of thick SS Sheets
4. Electro discharge machining of superalloys using copper electrode
5. Electro discharge machining of superalloys using graphite electrode
6. Parametric study of Wire Electro discharge cutting of superalloy sheets
7. Slicing of Hastelloy, Inconel718 and Ti6Al4V using WEDM
8. Laser Surface texturing of various materials
9. Surface texturing of various materials using Electro Discharge Machining
10. Profile cutting of various materials using WEDM

**List of Course Seminar Topics:**

1. Focused ion beam machining
2. Nanolithography
3. Process capabilities of abrasives based processes
4. Process capabilities of thermoelectric energy based processes
5. Process capabilities of chemical energy based processes
6. Joining of dissimilar metals using ultrasonic welding

**List of Course Group Discussion Topics:**

1. Use of Water Jet Machining
2. Surface Treatment using Lasers
3. Electron Beam Welding
4. Electron Beam Drilling
5. Incremental Forming
6. Use and Developments in Abrasive Water Jet Machining
7. Laser cladding
8. Use of USM for Biomedical Applications

**List of Home Assignments:**

**Design:**

1. Material removal models by Shaw in USM
2. Analysis and modeling of abrasive flow in AJM
3. Spark generators in EDM
4. Tool design for ECM process
5. Anode shape prediction in ECM

**Case Study:**

1. Laser texturing and its applications
2. Laser welding, brazing and cladding
3. Abrasive flow finishing
4. Performance analysis comparison of LBM and EBM
5. Performance analysis comparison of ECM and EDM

**Blog**

1. Electrostream drilling

2. Electrochemical deburring
3. Shaped tube electrolytic machining
4. Maskants in Chemical machining
5. Near-Dry EDM

**Surveys**

1. Developments in Water Jet and Abrasive Water Jet Machining
2. Microlaser beam machining application
3. Use of USM biomedical applications
4. Use of Water Jet Machining
5. Use of waterjet machining in industries

**Suggest an assessment Scheme:**
HA-10, Lab-20, GD-10, Seminar-10, MSE-15, ESE-15, Viva-20

**Text Books:** ***(As per IEEE format)***

1. V. K. Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd., 2007
2. P. K. Mishra, Non-Conventional Machining, The Institution of Engineers (India), 1997
3. P. C. Pandey and H. S. Shan, Modern Machining Processes, Tata McGraw-Hill. 2007

**Reference Books:** ***(As per IEEE format)***

1. G. F. Benedict, Unconventional Machining Processes, Marcel Dekker Publication, New York, 1987
2. McGeough, Advanced Methods of Machining, Chapman and Hall, London, 1998
3. P. DeGarmo, J. T. Black, and R. A. Kohser, Material & Processes in Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 20014

**Moocs Links and additional reading material:** www.nptelvideos.in
https://nptel.ac.in/courses/112/107/112107078/
https://nptel.ac.in/courses/112/103/112103202/
https://nptel.ac.in/courses/112/104/112104028/

**Course Outcomes:**

1. Understand need of advanced machining processes and select process for any industrial job based on its complexity, cost and specifications required.
2. Apply the working principles and processing characteristics of mechanical type advanced machining processes such as USM, AJM, WJM and Develop experimental, regression based, mathematical and physics based models for the advanced machining processes and predict MRR and surface roughness.
3. Apply the working principles and processing characteristics of electro-thermal type advanced machining processes such as EDM, wire-EDM and Develop experimental,

regression based, mathematical and physics based models for the advanced machining processes and predict MRR and surface roughness.

4. Apply the working principles and processing characteristics of thermal type advanced machining processes such as PAM, LBM, EBM machining to the production of precision components.
5. Apply the working principles and processing characteristics of chemical type advanced machining processes such as Electrochemical Machining to the production of precision micro and macro components.
6. Apply the working principles and processing characteristics of chemical type advanced machining process for production of precision components.

**CO PO Map**

**CO attainment levels**
CO1-2, CO2-3, CO3-4, CO4-4, COg-4, CO-4

**Future Courses Mapping:**
*Mention other courses that can be taken after completion of this course*

**Job Mapping:**
Manufacturing Engineer, Production Manager, Production Supervisor, Researcher

**FF No. : 654**

# PR3201::FORMING TECHNOLOGIES & TOOL DESIGN

**Course Prerequisites:**Production Metallurgy, Manufacturing Technology

## Course Objectives:

1.To Understand different metal forming processes and mechanics of deformation systems

2. To learn different forming tools and techniques.

3. To understand the processing parameters of metal forming techniques

4. To learn defects, causes and remedies of the forming processes.

5.To analyse force and energy requirements for metal forming

**Credits: 5** **Teaching Scheme Theory: 3** Hours/Week

**Tut: 1** Hours/Week

Lab: **2** Hours/Week

**Course Relevance:.**Metal forming is a near and net shaping process widely used as a secondary manufacturing process after casting process.This course is useful to understand the deformation mechanics,tools, techniques and material behavior under thermomechanical conditions.

**SECTION-1**

1) **Theory of Elasticity & Plasticity :**Elastic and Plastic Behavior, Types of stresses and strains, State of stress in three dimensions, Stress tensor, 3D Principal stresses in, Mohr's Circle-3D,Hydrostatic and Deviator Components of stress, Octahedral stress, Ductile and brittle behavior, Tensile deformation, Elastic & Plastic Work done in tensile deformation, Deformation under Compression test. (5h)

2) **Theory of Yielding of Metals**: Flow stress concept, factors affecting flow stress, Methods of flow stress measurements, Temperature rise during plastic deformation, Theories of Plastic yielding: Maximum distortion Energy Criteria, Maximum Shear stress Criteria, Effects of mechanical work on structure of metal, Effect of hot and cold working of metals, Strain hardening Classification of forming processes, Materials and their structures. (5h)

**3) Forging Processes**: Comparison of forging with other manufacturing processes, Structure and Properties of forging, Classification of forging processes-open die and closed die forging, Hot and cold forging, Basic forging operations such as drawing, fullering, edging, blocking etc, Forging equipment- Hammers and presses, construction working capacities and selection of

equipment. Special forging techniques: Isothermal forging, Rotary swaging, Orbital forging, Liquid forging and Powder forging, Forgeability: Concept of forge ability and forgeability tests, Analysis of forging load considering friction, Forging defects and remedies. (5h)

**4) Forging Die Design**:Design of forging die for multi-impression die-: selection of parting line, drafts, fillet & comer radii, ribs & webs, stock size calculation, flash & gutter, design of fullering, edging, blocking, finishing impressions, trimming dies, Die block dimensions, die inserts.Design of Upset forging dies and Punches. (5h)

**SECTION-1I**

**5)Rolling of Metals** :Rolling of Metals Scope and importance of rolling. Cold rolling and Hot rolling Types of Rolling Mills- Construction and working. Analysis of Rolling load: Friction in rolling, Roll bite, reduction, elongation and spread.Deformation in rolling and determination forces required.Rolling Process variables: redundant deformation. Roll flattening, Roll camber - its effect on rolling process, mill spring. Automatic gauge control- Lubrication in rolling, Defects in rolling. (6h)

**6)Wire drawing, Rod drawing & Tube drawing** :Rod, Wire and tube drawing Introduction rod and wire drawing machines - construction and working. Preparation of stock for wire drawing. Wire drawing dies, material and design.Variables in wire drawing, Maximum reduction in wire in one pass, forces analysis in wire drawing and strip drawing Multiple drawing, work hardening, lubrication in wire drawing.Tube drawing: Methods, stock preparation. Lubrication in tube drawing. Force analysis in Tube drawing. (6h)

**7)E**x**trusion of Metals:** Types of Extrusion process: direct, reverse, impact and hydrostatic extrusion. Dies for extrusion, Extrusion ratio, Extrusion Force equipment (with and without friction), types of metal flow in extrusion, Extrusion load analysis, Extrusion dies Extrusion defects and remedies. Design of Extrusion Die set. (5h)

**8)Forming techniques:** HERF: Explosive forming- Confined and unconfined techniques, High velocity forming- principles, comparison of high velocity and conventional Forming processes. Magnetic pulse forming, Electro hydraulic forming: principal and process .Dies and tool material requirements. (3h)

**List of Tutorials: (Any Three)**

1)Engineering stress-strain & True stress Strain
2) Yield Criteria analysis
3)Forging load calculation
4)Rolling Load calculations
5)Power calculations in wire,rod, and tube drawing
6)Extrusion load analysis

**List of Practicals: (Any Six)**

1.Estimation of amount total work done in tensile deformation of MS/Al/ Brass
2. Estimation of amount of total work done in compressive deformation of MS/Al/ Brass.
3. Design of edging die profile for lever forged component.
4. Rolls pass design for box pass.
5. Estimation of extrusion ratio, shape factor and circumscribing circle diameter for structural section of aluminum.
6. Forgeability test of notched surface of low C steel.
7. Microstructural analysis of super plastically deformed samples.
8. Study of Industry practices in any metal forming industry.
9. Measurement of plastic strain ratio of sheet metal.
10. Study the effect of strain rate on flow stress of metal.
11. Cold Rolling of aluminum strip and optimization of rolling passes.
12. Hot Rolling of steel plates and to study its texture.
13. Severe plastic deformation for strengthening of metals.

**List of Projects:**

1) To study the effect of strain rate in tensile deformation at room temperature.
2) To study the effect of strain rate in Compressive deformation at room temperature.
3) Estimation of flow stress at high temperature in tensile deformation.
4) Estimation of flow stress in compressive deformation.
5) Estimation of anisotropic behavior of sheet metals.
6) Severe plastic deformation and characterization of mechanical and microstructures.
7) Forgeability analysis of various metals.
8) Texture analysis of metals after mechanical working.
9) Design and manufacture mini wire drawing set up.
10) Design and manufacture mini extrusion set up.
11) To determine forming limit curves for single pass deep drawing.
12) To study the effect of processing temperature on plastic deformation.
13) Simulation of forged components.

**List of Course Seminar Topics:**

1. Equal Channel Angular Pressing
2. Isothermal Forging
3. Orbital Forging
4. Automatic Gauge control in Rolling
5. Tandem Rolling mill process
6. Impact Extrusion
7. Seamless tube manufacturing
8. Effect of anisotropic materials and measure of anisotropy of materials
9. Friction and lubricants in bulk forming
10. Ti Forging for aerospace components

**List of Course Group Discussion Topics:**

1. Forgeability of materials
2. Industry 4.0 for Forging Industry
3. Extrusion flow patterns and defects
4. Finite Element analysis in Metal forming
5. Incremental Forming
7. Laser Peen Forming
8. Powder Forming
9. Biaxial tensile test
10. Expert System for Metal Forming

**List of Home Assignments:**

**Design:**

1. Design of Edging tool for Connecting rod
2. Design of Upset forging tools for Stainless steel bolt
3. Design Profile of wire drawing dies for 3 mm wire from 16 mm Al bar.
4. Roll pass design from 50x 50 sq bar to dia 12 mm bar
5. Design of Extrusion profile for copper H section of 5 mm thick and height of 30 mm

**Case Study:**

1. Manufacturing of crankshaft for Marine Engine
2. Manufacturing of AISI304 stainless steel sheet of 1mm thick
3. Manufacturing of brass pipes and tubes
4. Manufacturing of copper wire of 1 mm
5. Manufacturing of beverage cans

**Blog**

1. Severe Plastic deformation
2. Incremental Forming
3. Isothermal Forging
4. Electromagnetic Forming
5. High Energy Rate Forming

**Surveys**

1.Forging Plants and production capacity in India
2. Steel Rolling Plants in India and production capacity
3. Copper Wire drawing Plants in India and annual Production capacity
4. Aluminum Extrusion plants in India and Production capacity
5. Seamless tube manufacturing plants and capacities in India

**Suggest an assessment Scheme:**

- Midsem 20 Marks
- End sem 20 Marks
- Lab work 10 Marks
- Course Project 10 Marks
- Home Assignment 10 marks
- Tutorial 10Marks
- GD/PPT 10 marks
- Viva 10 marks

**Text Books:** ***(As per IEEE format)***

1. Dieter G.E., "MechanicalMetallurgy", McGraw Hill, Co., S.I. Edition, 2001
2. P. N. Rao, Manufacturing Technology, Tata McGraw Hill
3 .S Kalpakjian and S R Schmid, Manufacturing Processes for Engineering Materials, Pearson education, 2009.
4. E. Paul Degarmo, J T Black, Ronald A Kohser, Materials and processes in manufacturing, John wiley and sons, 8th edition, 1999

**Reference Books:** ***(As per IEEE format)***

1. Dr. R. Narayanswamy, Metal Forming Technology, Ahuja Book Co.
2. Surender Kumar, Principles of Metal Working, Oxford & IBH Publishing Company, 1985, Edition 2.
3. ASM Metal handbook, Metalworking –Bulk Forming, Vol: 14A, ASM International
4. J. N. Harris, Mechanical working of metals
5. G. W. Rowe, Principles of industrial metalworking process, Edward Arnold
6. Nagpal G.R., Metal forming processes, Khanna publishers, New Delhi, 2004

**Moocs Links and additional reading material:** www.nptelvideos.in
NPTEL Web Course: https://nptel.ac.in/courses/112105182/.
NPTEL Video Course: https://nptel.ac.in/courses/112105182/1

**Course Outcomes:**
Students will be able to
1 understand.state of stress systems and behavior of metals
2. understand fundamentals of elastic and plastic deformation of metals.
3. select appropriate forging process, equipment, tools and analysis of forging load..
4. classify rolling processes, equipment and analysis of rolling forces and defects.
5. understand wire and tube drawing machines, tools and analyze wire and tube drawing forces.
6. understand types of extrusion process and analysis of extrusion load and metal flow.

**CO PO Map**

| PO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PS1 | PS2 | PS3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO2 | 3 | 2 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO3 | 2 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO4 | 3 | 2 | 2 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO5 | 3 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO6 | 2 | 2 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |

**CO attainment levels**

| CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|---|---|---|---|---|---|
| 3 | 4 | 4 | 5 | 3 | 3 |

**Future Courses Mapping:**
*Die and Mould Design, Process Engineering & Technology Management*

**Job Mapping:**
*Material Procurement, Forging Industry, Steel Plants, Wire and tube drawing Industries, Rolling Plants,Materials Processing Research, Quality, Operations.*

**FF No. : 654**

# PR3209::COMPUTER AIDED ENGINEERING ANALYSIS

**Course Prerequisites:** Strength of Materials, Matrices, Design of Machine Elements

## Course Objectives:

1. To introduce the concepts of Mathematical Modeling of Engineering Problems.
2. To appreciate the use of FEM to a range of Engineering Problems
3. To learn basic principles of finite element analysis procedure.
4. To learn the theory and characteristics of finite elements that represent engineering structures.
5. To learn and apply finite element solutions to structural, thermal, dynamic problems to develop the knowledge and skills needed to effectively evaluate finite element analyses.

**Credits: 05** **Teaching Scheme Theory: 03** Hours/Week

**Tut: 01** Hours/Week

**Lab: 02** Hours/Week

## Course Relevance:.....

**SECTION-1**

**Fundamentals Concepts of FEA**

Introduction– Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads & constraints) General FEM procedure, Applications of FEM in various fields, P & h formulation, Advantages and disadvantages of FEM. Consistent units system. Review of Solid Mechanics Stress equilibrium equations, Strain-Displacement equations, Stress-Strain, Temperature Relations, Plane stress, plane strain and axi-symmetric problems, Strain energy, Total potential energy. Essential and natural boundary conditions Review of Matrix Algebra (Vectors, Matrices, Symmetric banded matrix, Determinants, Inverses), banded skyline solutions. Introduction to solvers (Sparse solver, iterative solver, PCG, block Lanczos). Introduction to different approaches used in FEA such as direct approach, Variational approach, weighted residual, energy approach, Galerkin and Rayleigh Ritz approach.

**1D Elements**

Types of 1D elements. Displacement function, Global and local coordinate systems, Order of element, primary and secondary variables, shape functions and its properties. Formulation of elemental stiffness matrix and load vector for spring, bar, beam, truss and Plane frame. Transformation matrix for truss and plane frame, Assembly of global stiffness matrix and load vector, Properties of stiffness matrix, half bandwidth, Boundary conditions elimination method and penalty approach, Symmetric boundary conditions, Stress calculations.

**SECTION-1I**

**2D Elements**
Types of 2D elements, Formulation of elemental stiffness matrix and load vector for Plane stress/strain such as Linear Strain Rectangle (LSR), Constant Strain Triangles (CST), Pascal's triangle, primary and secondary variables, properties of shape functions. Assembly of global stiffness matrix and load vector, Boundary conditions, solving for primary variables (displacement), Overview of axi-symmetric elements

**Isoparametric Formulation**
Natural coordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

**List of Practicals: (Any Six)**
1. Introduction to analytical methods
2. Elements and their properties
3. Steps in stress analyses
4. Introduction to analysis software
5. Stress analysis of beams (Cantilever, Simply supported & Fixed ends)
6. Stress analysis of a plate with a circular hole.
7. Stress analysis of rectangular L bracket
8. Stress analysis of 3D objects
9. 1D FEA Problems
10. 1D FEA Problems
11. 2D FEA Problems
12. 2D FEA Problems
13. 3D FEA Problems
14. 3D FEA Problems

**List of Projects:**

1. Finite Element Analysis Of Composite Leaf Spring For Automotive Vehicle
2. A Project on Modeling And Structural Analysis Of a Cam Shaft
3. A Project on Bending stress and fatigue analysis of connecting rod of Mahindra tractor through finite element method (ANSYS)
4. A Project on Design & Analysis of Coil Spring with different materials for automotive applications
5. Design And Analysis Of Piston By Composite Materials
6. A Project on Finite Element Analysis Of Connecting Rod
7. A Project on FEA Analysis Of Disc Brake
8. Design And Analysis Of New Model Wheel Rim For A Four Wheeler
9. Stresses Analysis Of Helical Gear Using Finite Element Analysis
10. A Project on Design & Analysis of rocker arm
11. Design & Analysis of Fins with Various Configuration
12. Heat transfer enhancement techniques
13. A Project on Design & Analysis of machine tool spindle

**List of Course Seminar Topics:**

1. Sensitivity Analysis
2. Optimized Mesh Density
3. Dynamic Meshing
4. Element Killing
5. New Elements in Element Library
6. Specialty & Difference between different commercial softwares – ABAQUS, ANSYS Mechanical, ANSYS APDL, COMSOL, NASTRAN, LS DYNA, HYPERWORKS, ASTRIX, ADAMS, COSMOS, Sinda
7. Advances in Multiphysics

**List of Course Group Discussion Topics:**

1. Necessity of Approximation methods like FDM, FEM, FVM etc for Engineering problems
2. Importance of shape functions in finite elements
3. Selection criteria for element types for given applications
4. Advantage of Potential Energy Approach over other FEA methods
5. Elimination and penalty approaches for solving stiffness matrices
6. Importance of isoparametrisation for solving FEA problems
7. Classic mechanics vs Numerical methods- Which one best?
8. Properties of Global Stiffness Matrix - Its effect on accuracy of solutions
9. Role of solvers in Finite Element Analysis
10. Benefits of axisymmetry approach in FEA

**List of Home Assignments:**
**Case Study:**
1. Simulation and Modeling of Metal Turning Process
2. Simulation and Modeling of Milling Process

**Blog**
1. Application of FEA in Bio-technology
2. Role of CAE in Additive Manufacturing

**Suggest an assessment Scheme:**

- Midsem 20 Marks
- End sem 20 Marks
- Lab work 10 Marks
- Course Project 10 Marks
- Home Assignment 10 marks
- Tutorial 10Marks
- GD/PPT 10 marks
- Viva 10 marks

**Text Books:** ***(As per IEEE format)***

1. Chandrupatla T. R. and Belegundu A. D., Introduction to Finite Elements in Engineering, Prentice Hall India
2. Seshu P., Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010
3. Bathe K. J., Finite Element Procedures, Prentice-Hall of India (P) Ltd., New Delhi

**Reference Books:** ***(As per IEEE format)***

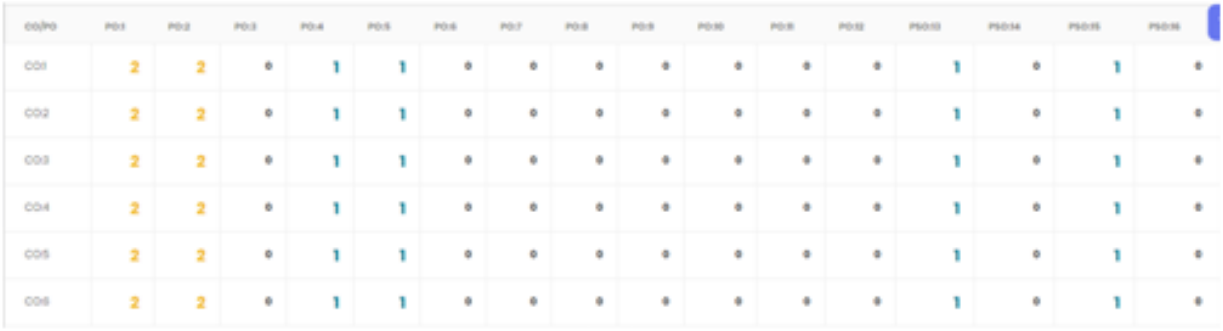
1. Fagan M. J., Finite Element Analysis, Theory and Practice, Pearson Education Limited
2. Kwon Y. W., Bang H., Finite Element Method using MATLAB, CRC Press, 1997
3. S. Moaveni, Finite element analysis, theory and application with Ansys
4. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw-Hill
5. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune

**Moocs Links and additional reading material:** www.nptelvideos.in
https://swayam.gov.in/nd1_noc20_me91/preview
https://www.coursera.org/learn/finite-element-method

**Course Outcomes:**

1. Understand direct stiffness, Rayleigh-Ritz, Galerkin method to solve engineering problems and outline the requirements for convergence
2. Formulate and Solve axially loaded bar Problems.
3. Formulate and analyze truss and beam problems.
4. Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.
5. Formulate and solve Axi-symmetric and heat transfer problems.
6. Use commercial finite element software and understand its structure

**CO PO Map**



| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO13 | PSO14 | PSO15 | PSO16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| CO2 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| CO3 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| CO4 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| CO5 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| CO6 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |

**CO attainment levels**

CO1 - 3, CO2 - 3, CO3- 4, CO4- 4, CO5- 5, CO6 -5

**Future Courses Mapping:** NIL

**Job Mapping:**

Contents of the course will be helpful to understand and observe the role of Design Engineer, Stress Analyst, CAE Analyst etc.

| **Title: Course Structure** | | | | **FF No.: 653** |
|---|---|---|---|---|
| **Branch:** Production Engg | **Year:** B Tech | **Academic Year:** 2021-22 | **Semester:** I & II | **Module:** VII & VIII |
| **Pattern: D-21** | | | | |

# Final Year B. Tech. Production Engineering AY 2021-22 (D21)

| Sr. No. | Subject Code | Subject Name | Teaching Scheme (Hrs/Week) | | | Examination scheme | | | | | | | Total | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Theory | Lab | Tut | CA | | | | MSE | ESA | | | |
| | | | | | | HA | Lab | Seminar | GD | MSE | ESE | CVV | | |
| S1 | MD4202 | Project Management | 2 | - | - | 10 | - | - | - | 30 | 30 | 30 | 10 | 2 |
| | MD4205 | Marketing Management | 2 | - | - | 10 | - | - | - | 30 | 30 | 30 | 100 | 2 |
| | MD4206 | Financial Management & Costing | 2 | - | - | 10 | - | - | - | 30 | 30 | 30 | 100 | 2 |
| S2 | PR4203 | Die & Mold Design | 2 | - | - | 10 | - | - | - | 30 | 30 | 30 | 100 | 2 |
| | PR4201 | Process Engineering & Technology Management | 2 | - | - | 10 | - | - | - | 30 | 30 | 30 | 10 | 2 |
| S3 | PR4213 | World Class Manufacturing & Industry 4.0 | 2 | - | - | 10 | - | - | - | 30 | 30 | 30 | 100 | 2 |
| | PR4210 | Mechatronics & Industrial Robotics | 2 | - | - | 10 | - | - | - | 30 | 30 | 30 | 10 | 2 |
| S4 | PR4274 | Major Project | - | - | - | - | - | - | - | - | - | - | 100 | 10 |
| | PR4285 | Major Project | - | - | - | - | - | - | - | - | - | - | 100 | 10 |
| | | **Total** | | | | | | | | | | | | **16** |
| S1 | PR4271 | Industry Internship | - | - | - | - | - | - | - | - | - | - | 100 | 16 |
| | PR4272 | Research Internship | - | - | - | - | - | - | - | - | - | - | 100 | 16 |
| | PR4273 | International Internship | - | - | - | - | - | - | - | - | - | - | 100 | 16 |
| | PR4276 | Capstone Project | - | - | - | - | - | - | - | - | - | - | 100 | 16 |
| | | **Total** | | | | | | | | | | | | **16** |

**FF No. : 654**

# PR4203::DIE & MOLD DESIGN

**Course Prerequisites:** Manufacturing Technology,Forming Technologies & Tool Technology

## Course Objectives:

1. To learn sheet metal working operations and equipments
2. To design Simple blanking and progressive die design
3.To learn design of deep drawing dies and Bending dies
4.To learn design of pattern, core box and gating system of sand cast and diecast components
5. To understand principle of injection mould design for plastic components

**Credits:2** **Teaching Scheme Theory: 2** Hours/Week
**Tut: ……...** Hours/Week
Lab: **……...** Hours/Week

**Course Relevance:**This course explores the design of dies for sheet metal shearing and forming operations.It also focus on design of casting manufacturing tools such patterns, corebox,gating system,die casting dies, injection moulding dies for plastic components.This will enhance skills and methods of Die, Moulds and Tools design for engineering applications.

**SECTION-1**

**1) Introduction to Press Working**
Press working terminology, Basic operations, types of presses- mechanical, hydraulic, pneumatic and their mechanisms, elements of die sets, types of die sets, types of dies - simple, compound, progressive, combination and inverted dies, types of punches Methods of reduction of shear force, types of strip layouts, types of strippers, types of pilots, types of stoppers (6h)

**2) Design of Blanking & Progressive dies**
Shearing force, press capacity, clearances, die & punch size types of strippers, types of pilots, types of stoppers, selection of dowel pins & allen screws., center of pressure of progressive die. Problems on progressive and blanking die design (6h)

**3) Design of Deep Drawing & Bending Dies**
Formability of sheet metals,Forming Limit diagram, Anisotropy of sheet metals,Deep drawing mechanism, Design of deep drawing die: blank size, no of draws, drawing punch and die size, drawing force, press capacity and ironing,Types of Bending dies, developed length calculation, bending force, spring back & methods used to overcome it, press brake.Incremental Forming .
(6h)

**SECTION-1I**

**5) Casting design for Expendable moulds:** Casting Design Considerations,Pattern Mould and Core design :Orientation and Parting line design, Mould Parting analysis, Pattern design, Core features,Core print design and analysis, Mould cavity layout. (4h)

**6) Feeder Design Analysis** :Casting Solidification, Freezing range, thermal gradient, Cooling rate, Shrinkage Characteristics, Solidification time and rate, Feeder Location and shape, Feeder and Neck design, Feed Metal volume, Feed Aid design Solidification analysis. Optimization and validation.**Gating system design :**Gating design and analysis :Mould Filling, Gating system and types, Gating Channel layout, Optimal filling time, gating ratio, Gating Element Design, Mould Filling Analysis (6h)

**7) Casting Design for Permanent Moulds**:Die Casting Introduction, Terms Used in Die Casting, Types of Die casting processes, The Die Casting Machine, Casting Metallurgy, Types of Die Casting Dies, Casting Features and Die Considerations, Die Materials, Controlling Die Performance, Design of Metal Feed System, Mechanical Die Design, Die and Plunger Lubrication Checklist for Die Casting Die Specifications, Guidelines For Die Casting Design. (5h)

**8) Injection Mould design:**Injection moulding: Types of machines and equipment,Selection of plastic material for various parts, Design of mould elements: Cavity & Core Two plate injection mould system, three plate injection mould system,, parting lines, split molds, molds for threaded components. Feed system: Designs of various types of runners, gates, balancing of runners, positioning of gates, mould filling patterns etc. Ejection system: Pin ejection, stripper plates, valve ejection, blade ejection, air ejection, etc. Cooling & heating arrangements: Design of cooling channels, layouts etc,runner less molds (5h)

**List of Tutorials: (Any Three)**

1)To design Punch and die for simple blank with selection of hardware, stripper & stopper.
2)To design Punch and die for progressive die with selection of pilot, hardware, stripper & stopper.
3)Deep drawing die design: Blank size, no of draws, drawing force and punch and die design.
4)Estimation of yield of casting and gating ratio.

**List of Practicals: (Any Six)**

1. Drafting of Simple blanking die set assembly and strip layout on A1 drawing sheet.
2. Drafting of progressive die set assembly and strip layout on A1 drawing sheet.
3. Drafting of deep drawing die set assembly on A1 drawing sheet.
4. To design bending die for bend components & Drafting of bending die on A1 drawing sheet.
5. Drafting of Pattern and core box for Expendable mould casting process
6. . Drafting of permanent mould elements of die casting component.
7. Injection mould design for the given component.
8. Drafting of injection mould assembly using CAD software. (AutoCAD, Catia, Pro E),

**List of Projects:**

**Actual Component from manufacturing industry to be taken for case study of Die & Mould Design in following areas**

1. Design of simple Blanking die set for sheet metal blanks.
2. Design of Progressive die set for multiple piercing, complicated profile of component.
3. Design of Compound die for washer type components.
4. Design of Combination die for shearing and forming operations together.
5. Design of Deep drawing die for stainless steel cup.
6. Design of bending die for bend work pieces.
7. Injection Mould design for cap of water bag.
8. Sheet metal working simulation.
9. Plastic components manufacturing simulation for injection mould..
10. Mechanical press working mechanism and performance study.

**List of Course Seminar Topics:**

1. Formability measurement techniques of sheet metal
2. Anisotropy measurement technique and its effect in sheet metal forming
3. Types of Presses and its mechanisms for sheet metal working.
4. Die casting dies for high pressure die casting of Al
5. Cavity and Core cooling techniques in Injection moulding
7. Hot runners system for runnerless injection moulds
8. Core box design considerations for Shell core,Oil sand core and cold box cores
9. Press tonnage reduction techniques in sheet metal working
10. Different moulding methods for Grey Cast iron castings.

**List of Course Group Discussion Topics:**

1. Strip layout design for Maximum Utilization of sheet metals.
2. Selection of Die set for shearing operations
3. Deep drawability of AISI 304 stainless steel
4. Tool material requirements for Hot Chamber die casting process
5. Scope of Gravity Die casting technique
6. Vacuum Die casting Technology
7. SMED technique application in loading of dies
8. High Pressure moulding technique for Cast Iron Production
9. Simulation and modelling for die casting components
10. Injection moulding machines types and working principles.

**List of Home Assignments:**

**Design:**

1. Blanking die design of simple blank
2. Deep drawing die design for cup shape forming
3. Bending die design of bend component
4. Pattern design for expendable mould process
5. Corebox design for shell cores

**Case Study:**
1.Pattern design for Brake drum casting of Grey cast Iron.
2.Core box design for brake drum casting oil sand core
3.Injection mould design for plastic bucket
4.Manufacturing of cylinder head casting.
5. Any component manufactured by Die casting process.

**Blog**
1.Injection moulding plant set up and equipment requirements budget for startup.
2.Die materials and die life improvement techniques for forging dies.
3.Hot stamping technology tools and applications.
4.Pressure die casting technology for Zinc casting applications
5. Permanent moulds for cast iron component production.

**Surveys**
1.Aluminum Die Casting plants capacities in India and potential requirements
2. Closed die forging of aluminum components manufacturing plants in India.
3. Plastic injection moulding plants in India and potential requirements
4. Pressworking components and market potential for automotive components
5.Cast iron manufacturing plants in India and Manufacturing capacities in India.

**Suggest an assessment Scheme:**

- Midsem 20 Marks
- End sem 20 Marks
- Home Assignment 10 marks
- Lab work 10 Marks
- Course Project 10 Marks
- Tutorial 10 Marks
- Viva 10 marks
- GD/PPT 10 marks

**Text Books:** ***(As per IEEE format)***

1.Donaldson, Lecain and Goold, Tool Design, Tata McGraw Hill, ISBN 0 07 099274
2. J R Paquin, Die design Fundamentals, Industrial Press Inc., ISBN 0 8311 1172 0.
3. P. N. Rao, Manufacturing Technology- Foundry, Forming & Welding, Tata McGraw Hill
4. R. G. W. Pye, Injection Mould Design (Design manual for plastic industry), EWP

**Reference Books:** ***(As per IEEE format)***

1. P. H. Joshi, Press Tools Design & Construction, Wheeler Pub
2. P. C. Sharma, Production Engineering, S. Chand
3. Dr. Surender Kumar, Production Engg. Design (Tool Design), Satya Prakashan
4. R. G. W. Pye, Injection Mould Design (Design manual for plastic industry), EWP

5. A. S. Athalye, Plastics Materials handbook, Multitech Pub. Co., ISBN 81 7671 007
6. Denton and Glanvil Injection mould design fundamentals, Industrial Press, Inc.

**Moocs Links and additional reading material:** www.nptelvideos.in

**Course Outcomes:**

Student will be able to

1. select and design appropriate die set and equipment for shearing operations of sheet metal.
2. understand principles of deep drawing operations.
3. design bending die design and selection of press capacity
4. design dies and moulds for expendable mould castings
5. understand die casting process and design of dies for permanent moulds.
6. design elements of injection molding dies and understand the working of injection machines.

**CO PO Map**

| PO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PS1 | PS2 | PS3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO2 | 3 | 2 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO3 | 2 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO4 | 3 | 2 | 2 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO5 | 3 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO6 | 2 | 2 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |

**CO attainment levels**

| CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|---|---|---|---|---|---|
| 3 | 4 | 4 | 5 | 3 | 3 |

**Future Courses Mapping:**

*For Higher studies in Tool and Die Design,Plastic Engineering, MTech Manufacturing Engineering, MTech Design*

**Job Mapping:**

*Die designer in Sheet metal industry, Forging Industry, Plastic component manufacturing as well as casting manufacturers.Die shop ,Toolroom, Job as Engineering design department. Procurement of sheet metal components,plastic components, forged components and castings*

**FF No. : 654**

## PR4209::FINITE ELEMENT ANALYSIS

**Course Prerequisites:** Strength of Materials, Matrices, Design of Machine Elements

## Course Objectives:

1. To introduce the concepts of Mathematical Modeling of Engineering Problems.
2. To appreciate the use of FEM to a range of Engineering Problems
3. To learn basic principles of finite element analysis procedure .
4. To learn the theory and characteristics of finite elements that represent engineering structures.
5. To learn and apply finite element solutions to structural, thermal, dynamic problems to develop the knowledge and skills needed to effectively evaluate finite element analyses.

**Credits: 02** **Teaching Scheme Theory: 02** Hours/Week

## Course Relevance:.....

| **SECTION-1** |
|---|
| **Fundamentals Concepts of FEA**<br>Introduction– Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads & constraints) General FEM procedure, Applications of FEM in various fields, P & h formulation, Advantages and disadvantages of FEM. Consistent units system. Review of Solid Mechanics Stress equilibrium equations, Strain-Displacement equations, Stress-Strain, Temperature Relations, Plane stress, plane strain and axi-symmetric problems, Strain energy, Total potential energy. Essential and natural boundary conditions Review of Matrix Algebra (Vectors, Matrices, Symmetric banded matrix, Determinants, Inverses), banded skyline solutions. Introduction to solvers (Sparse solver, iterative solver, PCG, block Lanczos). Introduction to different approaches used in FEA such as direct approach, Variational approach, weighted residual, energy approach, Galerkin and Rayleigh Ritz approach.<br>**1D Elements**<br>Types of 1D elements. Displacement function, Global and local coordinate systems, Order of element, primary and secondary variables, shape functions and its properties. Formulation of elemental stiffness matrix and load vector for spring, bar, beam, truss and Plane frame. Transformation matrix for truss and plane frame, Assembly of global stiffness matrix and load vector, Properties of stiffness matrix, half bandwidth, Boundary conditions elimination method and penalty approach, Symmetric boundary conditions, Stress calculations. |
| |
| **SECTION-1I** |

**2D Elements**

Types of 2D elements, Formulation of elemental stiffness matrix and load vector for Plane stress/strain such as Linear Strain Rectangle (LSR), Constant Strain Triangles (CST), Pascal's triangle, primary and secondary variables, properties of shape functions. Assembly of global stiffness matrix and load vector, Boundary conditions, solving for primary variables (displacement), Overview of axi-symmetric elements

**Isoparametric Formulation**

Natural coordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

**List of Practicals: (Any Six)**

1. Introduction to analytical methods
2. Elements and their properties
3. Steps in stress analyses
4. Introduction to analysis software
5. Stress analysis of beams (Cantilever, Simply supported & Fixed ends)
6. Stress analysis of a plate with a circular hole.
7. Stress analysis of rectangular L bracket
8. Stress analysis of 3D objects
9. 1D FEA Problems
10. 1D FEA Problems
11. 2D FEA Problems
12. 2D FEA Problems
13. 3D FEA Problems
14. 3D FEA Problems

**List of Projects:**

1. Finite Element Analysis Of Composite Leaf Spring For Automotive Vehicle
2. A Project on Modeling And Structural Analysis Of a Cam Shaft
3. A Project on Bending stress and fatigue analysis of connecting rod of Mahindra tractor through finite element method (ANSYS)
4. A Project on Design & Analysis of Coil Spring with different materials for automotive applications
5. Design And Analysis Of Piston By Composite Materials
6. A Project on Finite Element Analysis Of Connecting Rod
7. A Project on FEA Analysis Of Disc Brake
8. Design And Analysis Of New Model Wheel Rim For A Four Wheeler
9. Stresses Analysis Of Helical Gear Using Finite Element Analysis
10. A Project on Design & Analysis of rocker arm
11. Design & Analysis of Fins with Various Configuration

12. Heat transfer enhancement techniques
13. A Project on Design & Analysis of machine tool spindle

**List of Course Seminar Topics:**

1. Sensitivity Analysis
2. Optimized Mesh Density
3. Dynamic Meshing
4. Element Killing
5. New Elements in Element Library
6. Specialty & Difference between different commercial softwares – ABAQUS, ANSYS Mechanical, ANSYS APDL, COMSOL, NASTRAN, LS DYNA, HYPERWORKS, ASTRIX, ADAMS, COSMOS, Sinda
7. Advances in Multiphysics

**List of Course Group Discussion Topics:**

1. Necessity of Approximation methods like FDM, FEM, FVM etc for Engineering problems
2. Importance of shape functions in finite elements
3. Selection criteria for element types for given applications
4. Advantage of Potential Energy Approach over other FEA methods
5. Elimination and penalty approaches for solving stiffness matrices
6. Importance of isoparametrisation for solving FEA problems
7. Classic mechanics vs Numerical methods- Which one best?
8. Properties of Global Stiffness Matrix - Its effect on accuracy of solutions
9. Role of solvers in Finite Element Analysis
10. Benefits of axisymmetry approach in FEA

**List of Home Assignments:**
**Case Study:**
1. Simulation and Modeling of Metal Turning Process
2. Simulation and Modeling of Milling Process

**Blog**
1. Application of FEA in Bio-technology
2. Role of CAE in Additive Manufacturing

**Suggest an assessment Scheme:**

- Midsem 20 Marks
- End sem 20 Marks
- Home Assignment 10 marks
- Lab work 10 Marks
- Course Project 10 Marks
- Tutorial 10 Marks
- Viva 10 marks
- GD/PPT 10 marks

**Text Books:** ***(As per IEEE format)***

1. Chandrupatla T. R. and Belegundu A. D., Introduction to Finite Elements in Engineering, Prentice Hall India
2. Seshu P., Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010
3. Bathe K. J., Finite Element Procedures, Prentice-Hall of India (P) Ltd., New Delhi

**Reference Books:** ***(As per IEEE format)***

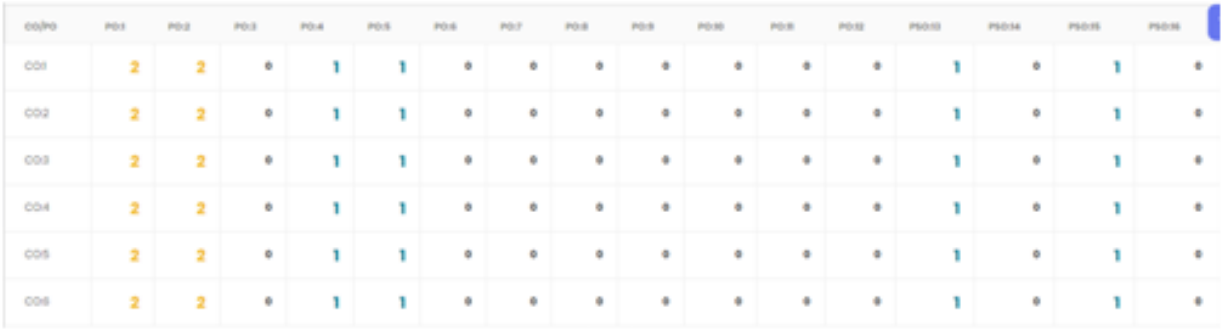
1. Fagan M. J., Finite Element Analysis, Theory and Practice, Pearson Education Limited
2. Kwon Y. W., Bang H., Finite Element Method using MATLAB, CRC Press, 1997
3. S. Moaveni, Finite element analysis, theory and application with Ansys
4. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw-Hill
5. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune

**Moocs Links and additional reading material:** www.nptelvideos.in
https://swayam.gov.in/nd1_noc20_me91/preview
https://www.coursera.org/learn/finite-element-method

**Course Outcomes:**

1. Understand direct stiffness, Rayleigh-Ritz, Galerkin method to solve engineering problems and outline the requirements for convergence
2. Formulate and Solve axially loaded bar Problems.
3. Formulate and analyze truss and beam problems.
4. Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.
5. Formulate and solve Axi-symmetric and heat transfer problems.
6. Use commercial finite element software and understand its structure

**CO PO Map**



| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO13 | PSO14 | PSO15 | PSO16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| CO2 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| CO3 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| CO4 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| CO5 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| CO6 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |

**CO attainment levels**

CO1 - 3, CO2 - 3, CO3- 4, CO4- 4, CO5- 5, CO6 -5

**Future Courses Mapping:** NIL

**Job Mapping:**

Contents of the course will be helpful to understand and observe the role of Design Engineer, Stress Analyst, CAE Analyst etc.

**FF No. : 654**

# PR4201::PROCESS ENGINEERING & TECHNOLOGY MANAGEMENT

## Course Prerequisites:

manufacturing technology,tool design,CIM

## Course Objectives:

1.To introduce process planning concepts to make cost estimation for various products
2.To introduce process planning concepts to locate and clamp and selection of tooling for various products
3.Understand process planning concepts to decide sequence of operation for making various products
4 Learn concepts of design for inspecting the jobs
5.Know the techniques of managing tools and equipments for producing various products

**Credits:....2....** **Teaching Scheme Theory: 2.** Hours/Week
**Tut: …0...** Hours/Week
Lab:**…0…..** Hours/Week

**Course Relevance:** Today's products are complex in nature. Producing them according to design is challenging job. Production of such parts requires decision of appropriate method of manufacturing, correct quantity, capable machines and tools resulting into cost benefits. Hence is the need of process planning. Concepts of these are learnt through this course.

| **SECTION-1** |
|---|
| **Process engineering and its functions:-** Method of reading and interpreting the part print, Identification of functional surfaces, grouping of related surfaces to be machined, Identification of basic process for processing and sequence of operation from part print, **Geometric dimensioning and tolerance analysis,** tolerance stacking, tolerance chart **Work-piece control** -Causes of work-piece variations, variables influencing work-piece control, equilibrium theories, mechanical, geometrical and dimensional control, **Basic process operations**- principal processes and auxiliary processes, Identification of major, critical, qualifying, re-qualifying and supporting operations. Selection of single or combined operations, Identification of finishing operations, Establishing manufacturing sequence. |
| |
| **SECTION-1I** |

Equipment/machine selection -Factors to be considered in equipment/machine selection, determining machine up and down time. Types of tooling, Factors affecting selection of tooling, use of multi-tooling set-up,
Process Selection-Component of process selection, Factor affecting on process selection decisions, Deigning the process (Process flow analysis, Process Re-engineering, Product – Process Mix, Operations Strategy, Capacity utilization,
Capacity Planning-, Importance of capacity decisions, Defining and measuring capacity, Dimensions of capacity, Determining capacity requirements, Developing capacity alternatives, Factors determining effective capacity,
Process Sheet Design: Study of the part-print , logical design of process plan, stock preparation, blank size selection with material estimates, Selection of datum surfaces, identification of machining surfaces, dimension and tolerance analysis, selection of machining methods with time estimates and standard time for each operation, Preparation of process picture sheet and operation route sheet for complete manufacturing part.
CAPP: Generative Process Planning, Knowledge-based Process Planning, Feature Recognition in Computer Aided Process Planning
Management of Technology and innovation-case studies

**List of Tutorials: (Any Three)**

1) Study of various systems on capstan and turret lathes
4. Study of various systems on single spindle automat..
5. Dimensional and tolerance analysis of part print.
6. General description and configuration of the part print.
7. Identification of locating areas on work piece.
8. Identification of, clamping, holding areas on work piece

**List of Practicals: (Any Six)**

1. Process parameters and machining time determination of lathe operations.
2. Process parameters and machining time determination of milling operations.
3. Process sheet design of one component for mass production
4. Process sheet design of one component CNC for batch production
5. Time estimation for assembly using flow charting techniques
6. Determination of processing time, cost for forged components.
7. Determination of processing time, cost for welded components
8. Determination of processing time, cost for cast components
9 . Shop documentation using Seimens NX software

**List of Projects:**

1. Development of process sheet for turned component
2. Development of process sheet for milled component
3. Development of process sheet for cast component
4. Development of process sheet for forged component
5. Development of tool layout and process sheet for turned component on single spindle automat
6. Development of tool layout and process sheet for turned component on capstan and turret lathes.
8. Determination and measurement of geometric features of complex part
9. Survey of various process planning softwares
10. Development of process plan using variant software.
11. Development of process plan using generative software
12. Development of shop documents for CNC machining of part with SIEMENS NX software**.**

**List of Course Seminar Topics:**

1.preliminary part print analysis
2)computer aided process planning
3)Set up planning for round parts
4)Setup planning for prismatic part
5)Stacking of tolerances in design and manufacturing
6)Selection of equipment
7)Make or buy decision
8)Feature interaction and precedence of operations
9)Calculation of total time for machining
10)Workpiece control
11)jigs and fixtures

**List of Course Group Discussion Topics:**

1 Computer aided process planning
2.Work piece configuration and ease of manufacturing.
3.Roles of engineering in manufacturing.
4.Worldwide competition for global products and their manufacturing
5.High Technology manufacturing
6.New manufacturing systems design ,strategies and management
7.Product life cycle and life cycle cost
8.Control of manufacturing system
9.Quantity Vs process and material alternatives
10.Design and manufacturing of products

**List of Home Assignments:**

**Design:**

1.Design of locating and clamping system for round component
2. Design of locating and clamping system for prismatic component
3. Design of locating and clamping system for complex casting
4. Design of tolerance chart for industrial component
5.Analysis of stacking of tolerance on industrial component

**Case Study:**

1.Case study on make or buy decision in manufacturing industry.
2.Case study of cost optimisation of forged steel crankshaft in global manufacturing environment
3.Case study on determination of standard times for process improvement
4.Process plan for bevel gear
5.web based polishing process planning using data mining techniques

**Blog**

1.Setup planning and tolerance analysis
2.Fixture design in computer aided Manufacturing Planning
3.Tool path planner
4.Manufacturing dependent cad systems
5.Fuzzy modelling and process planning

**Surveys**

1.Web application for knowledge based planning
2.Virtual machining of Milling operations
3.Process planning for one of a kind production.
4.Automated Setup planning
5.Complexity of manufacturing schudling

**Suggest an assessment Scheme:**

***Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.***

MSE-30,ESE-30,Viva-40

**Text Books:** ***(As per IEEE format)***

1. D. F. Eary, G. E. Johnson, Process engineering for manufacturing, Prentice-Hall
2. P. W. Wang, J. Kelly Computer aided process planning-Pearson
3. Nanuasingh, System approach to computer integrated design and manufacturing, Prentice hall
4. Narayana K. L., Kannaiah P., Vankata Reddy K., Production Drawing, New Age International Publisher

**Reference Books:** ***(As per IEEE format)***

1. H. W. Wage Manufacturing Engineering, McGraw hill
2. Manufacturing catalogues for cutting tools and inspection equipments
3. P. Radhakrishnan , S. Subrmaniyum, V. Raju, CAD\CAM\CIM, New Age International Pvt Ltd
4. K. Hitomi, John Willey Manufacturing Systems Engg-Pearson,
5. Groover Mikell. P. Fundamentals of modern manufacturing- materials, processes and systems, 2nd Edition, Willey 2002

**Moocs Links and additional reading material:** www.nptelvideos.in
https://www.coursera.org/lecture/supply-chain-principles/manufacturing-planning-control-xVwoT

**Course Outcomes:**
1. Perform preliminary part print analysis of part
2. Understand concepts of geometric dimensioning and tolerancing in product engineering
3. Classify operations and achieve work piece control for manufacturing of industrial products
4. Manage equipment, tools, gauges, manpower and time economically, required for manufacture of industrial products
5. Select and plan process for manufacturing of industrial products cost effectively
6. Design process sheet for machined component

**CO PO Map**
**All COS map to PO1,PO2,PO3,PSO14 and PSO 15 to level 3**

**CO attainment levels**
**CO1-2,CO2-5,CO3-3,CO4-3,CO5-5,CO6-5**

**Future Courses Mapping:**
*Advanced manufacturing techniques*

**Job Mapping:**
*In any manufacturing organisation*

**FF No. : 654**

# PR4206::WORLD CLASS MANUFACTURING & INDUSTRY 4.0

## Course Prerequisites:

Basics of How Factory works, Facility Planning , Manufacturing Systems and Strategy

## Course Objectives:

1. Understand and Apply basic concepts and Principles of Lean Management
2. Understand Toyota Production System and apply it's principles
3. Acquire knowledge of Total Productive Maintenance Philosophy and
4. Understand and Apply Theory of Constraints to solve industry problems
5. Apply Lean, TPS, TPM and TOC in Service sector like Healthcare, Banking etc.

**Credits: 5**

**Teaching Scheme Theory: 03** Hours/Week
**Tut: 01** Hours/Week
Lab: **02** Hours/Week

## Course Relevance:

Course helps to understand and implement Lean Principles, Toyota Production System, TPM and Theory of Constraints in Industries.

| **SECTION-1** |
|---|
| **Topics and Contents**<br>**Lean Manufacturing** – Definition & Concept. Characteristics of Lean Manufacturing. Concept of MUDA, MURA & MURI, Value Added and NVA activities<br>**Value Stream Mapping** – VSM Symbols, Current State and Future State, Kaizen- Types, Format. Kaizen Development,<br>**Toyota Production System**- Toyota's 14 Principles of Management, Problem Solving Approach, Design of JIT- Pull System, Kanban-Types, Calculations of Kanban, Concept of Standard Work – Standardization, Standard Operating Procedures<br>**Set-up Time Reduction**: SMED Methodology for Set-up reduction, OTED (One Touch Exchange of Dies), Quick Attachment Devices.<br>**Group Technology** Approaches, Characteristics of A Group/Cell Families of Parts, Group Technology – Codification & Classification Systems , Production Flow Analysis and Choice Of Family , Benefits and Applications Of Group Technology.<br>**Cellular Manufacturing**: Work cell concepts and applications, Work cell design, work cell staffing and equipment issues. |
| |
| **SECTION-1I** |

**Topics and Contents**

**Japanese Lean Principles:** Heijunka (Resource Leveling), Jidoka (Autonomation), Genechi Genbitsu (Go and See)

**Maintenance Management** – Breakdown, Preventive, Predictive. Total Productive Maintenance (TPM): Concept & Origin, Outline of TPM – 8 Pillars, TPM Performance Measures – PQCDSM & OEE (Overall Equipment Effectiveness), Introduction to Autonomous Maintenance (Jishu Hozen) activities, Planned Maintenance, Small-Group activities of TPM.

**Visual Management System**- , Introduction to 5S: Steps in 5S Methodology, Concept of 1S(Seiri), 2S(Seiton), 3S (Seiso), 4S (Shiketsu), 5S, (Shitsuke). Implementation of 1S & 2S, Visual Displays, Visual Controls

**Theory of Constraints:** Introduction to TOC, Concept, Constraints – Types, Factory Physics Laws and Bottleneck Scheduling, Concept of Throughput, Inventory & Operating Expenses, Throughput Accounting, TOC Methodology, Numerical & Cases in TOC. Application of TOC in industry, Drum-Buffer-Rope Approach.

**Lean Applications in Service Sector** - Logistics, Healthcare

**Industry 4.0:** Introduction**,** Globalization and Emerging Issues, The Fourth Revolution, Smart Factories, Drivers and Enablers of Industry 4.0, Cyber Physical Systems, Industrial IoT (IIoT)

**List of Tutorials: (Any Three)**

1. Waste Identification and Classification -3M of Lean
2. Kaizen preparation- operator or circle level
3. Standardization of processes
4. Design Work Cell as per requirements
5. Identification and Reduction TPM Losses
6. Autonomous Maintenance -Jishu Hozen
7. Use of SIPOC Diagiram
8. Identification of Bottleneck and constraint classification
9. Use of constraint management tools like CRT, FRT, Evaporating Cloud etc
10. Relevance of Industry 4.O in WCM

**List of Practicals: (Any Six)**

1. Value Stream Mapping- Current State and Future State **( e-VSM Software )**
2. Design of JIT / Kanban System for manufacturing firm
3. Design of Single Piece Flow
4. Assignment based on SMED approach
5. Group Technology- Cellular Manufacturing
6. Assignment on TPM Performance Measures
7. Assignment on Overall Equipment Effectiveness
8. Understanding and Implementation of 5S
9. Application of Theory of Constraints-
10. TOC based Case study
11. Industry 4.O applications

**List of Projects:**

1. Value Stream Mapping, ( e-VSM Software )
2. Kaizen Improvement Projects
3. Setup Time Reduction using SMED approach
4. Autonomation (Jidoka) and Andon implementation
5. Kanban, JIT feasibility and implementation
6. Group Technology and Cellular Manufacturing
7. TPM- KK Pillar, Overall Equipment Effectiveness,
8. TPM-Pillars- JH and PM
9. TPM Abnormalities
10. 5S Implementation
11. Developing Maintenance Schedule
12. Standardization - Formation of SOP, Work Instructions
13. Theory pf Constraints Applications- (Goldratt's TOC Software)
14. Lean Applications in Services
15. Industry 4.O applications.

**List of Course Seminar Topics:**

1. Core of Lean – 3M: Muda, Mura and Muri in Manufacturing and Service sector
2. Lean Principles and its applicability in Manufacturing and Service sector
3. Value Stream Mapping
4. Just in Time Philosophy – Kanban in action
5. Achieving Flexibility by using SMED
6. Total Productive Maintenance
7. Toyota Production System – 4P's and 14 Principles
8. Theory of Constraints approach and Constraint Management
9. Integration of lean with Industry 4.O
10. Industry 4.O technologies and Operational Excellence

**List of Course Group Discussion Topics:**

1. Is there linkage between Lean Management and Order winners / Order Qualifiers ?
2. How should Companies attack to implement Lean – MUDA, MURA, MURI
3. Why companies fail to copy Toyota Production System (TPS) ?
4. Lean in Services – Feasibility, Challenges and Benefits.
5. TPM is way of doing business or just another certification
6. Lean Implementation in MSME India.
7. TPM is boon or just another certification?
8. Want Business Excellence: Choose Appropriate Strategy. Lean / TPM / TOC/ Any other?
9. Integration of Lean and Industry 4.O
10. Does Industry 4.0 really needed along with WCM in Indian companies.?

**List of Home Assignments:**

**Design:**

1. Design Kanban or JIT system for manufacturing / service organization
2. Design and Implement Single Piece Flow System
3. Design Cellular manufacturing systems by using Lean principles
4. Design TOC based manufacturing / service system
5. Design Industry 4.O and Lean based integrated system

**Case Study:**

1. Case study based on Value Stream Mapping
2. Case study based on Kanban Simulation
3. Case study based on TPM Performance measures and OEE
4. Case study based on Theory of Constraints ( TOC ) methodology
5. Case study based on Integration of Lean and Industry 4.O

**Blog**

1. Application of any lean technique for the hypothetical or simulated scenario
2. Implementation of any lean technique to solve industry problems (Manufacturing )
3. Understand and Implementation of any lean technique to solve industry problems (Service )
4. Apply Theory of Constraints methodology to solve industry problems
5. TPM benefits and abnormalities

**Surveys**

1. Survey of Companies for Lean Implementation
2. Survey of MSME's to know challenges of Lean Implementation
3. Survey of Companies implemented TPM and its effect on Business
4. Survey of Lean Implementation methodologies in Domestic and MNCs
5. Survey of Critical Success and Failure Factors for Lean implementation

**Suggest an assessment Scheme:**
***Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.***
Mid semester - theory - 15
End semester theory - 15
Lab assignments - 10 marks
Home assignment - 10 marks
Course project - 10 marks
Seminar - 10 marks
Group discussion – 10 Marks
Orals - 10 marks

**Text Books:** ***(As per IEEE format)***

1. B.S. Sahay, Saxena, World Class Manufacturing - A strategic perspective, Laxmi Publications Pvt Ltd, 1st Edition, 2018
2. Richard Schonberger, World Class Manufacturing – The Next Decade: Building Power, Strength, and Value, Free Press, 1996
3. Jeffrey Liker, The Toyota Way, McGraw Hill Publications, Indian Edition, 2017

**Reference Books:** ***(As per IEEE format)***

1. Mishra R.C., Pathak K, Maintenance Engineering and Management, PHP Publications, 2nd Edition, 2016
2. James Womack & Daniel Jones, Learning to See, 1998
3. John Bicheno, Cause and Effect Lean – The essentials of Lean Manufacturing, 1994
4. Nakajima Seiichi ,Introduction to TPM: Total Productive Maintenance, 1995
5. Terry Wireman, Total Productive Maintenance, Industrial Press, 2004
6. Kelley, M.J. Harris, Management Of Industrial Maintenance, Newness Butterworths

**Moocs Links and additional reading material:** www.nptelvideos.in
https://nptel.ac.in/courses/110/107/110107130/
https://www.coursera.org/learn/lean-manufacturing-services

**Course Outcomes:**
1. Identify, eliminate and reduce the non-value added activities (wastes) in manufacturing organization
2. Apply the tools and techniques of lean manufacturing to improve productivity in manufacturing organizations
3. Understand the principles and benefits of Toyota Production System philosophy

4. Apply the concept, tools and techniques in TPM philosophy
5. Apply the tools and techniques of constraint management to improve productivity in manufacturing and service organizations
6. Apply the tools and techniques of lean manufacturing to improve productivity in service organizations

**CO PO Map**

**CO attainment levels**
CO1- 3
CO2- 4
CO3- 4
CO4- 3
CO5-4
CO6-5

**Future Courses Mapping:**
Logistics & Supply Chain Management, Project Management, Design For X

**Job Mapping:**
Industrial Engineer
TPM Facilitator
Lean Implementor
Service sector industries
Health care

**FF No. : 654**

# PR4203::COMPOSITE MATERIALS & PROCESSING

**Course Prerequisites: Production Metallurgy,Manufacturing Technology**

**Course Objectives:**

Many conventional materials are currently being replaced with composite materials. Their wide use has also been facilitated by the development of new materials, improvements in manufacturing processes, and the availability of new analytical tools.

**Credits: 2** **Teaching Scheme Theory:2** Hours/Week

**Tut: Nil** Hours/Week

Lab: **Nil** Hours/Week

**Course Relevance:** This course will be useful to understand fundamentals of composite materials requirements. It explores classification of composite materials, its processing techniques and materials to enhance properties and lifespan performance.

| **SECTION-1** |
|---|
| **1. Introduction to Composites:** Classification, Advantages of Composites, Disadvantages of Composites, Properties of Composites, Fiber-Reinforced Composites : Elastic Behavior under Longitudinal & Transverse Loading, Longitudinal & Transverse Tensile Strength, Discontinuous Fiber-Reinforced Composites, Particulate Composites, Applications. (4h)<br>**2.Dispersed Phase**: Fiber Reinforcements: Natural & Synthetic Fibers, Surface modification of Fibers, Fiber selection Criteria, Particulate Reinforcements, Nano Reinforcements : Nao Fibers, Nanotubes,Nano Clays Nanoparticles, (4h)<br>**3. Polymer Matrix Composites :Polymer Matrix Materials**: Thermoset Polymers: Polyester, Epoxy, Vinyl, Phenolic and Polyamide Resins, Thermoplastics : Aliphatic polyamides, Polyethylene Terephthalate, Polypropylene, Polyether Ether Ketone, Polyphenylene Sulfide, **Elastomers**: Natural Rubber, Styrene–Butadiene Rubber, Polybutadiene Rubber, Synthetic Polyisoprene Rubber (IR), Polymer Matrix Materials: Selection Criteria. (4h)<br>**4.Processing of Polymer Matrix Composites:** Hand Lay-Up Process, Spray-Up Process, Resin Transfer Molding, Vacuum Impregnation Methods, Compression Molding, Thermoplastic Composite Processing, Structure and Properties of PMCs, Environmental Effects on PMCs, Applications of PMCs ,Recycling of PMCs, Polymer Nanocomposites (8h) |
| |
| **SECTION-1I** |

**5.Metal Matrix Composites:** Metallic Matrix Materials :Aluminum Alloys, Titanium Alloys, Magnesium Alloys, Copper, Intermetallic Compounds Selection of Reinforcements. (3h)

**6.Processing of Metal Matrix Composites**: Liquid-State Processes :Stir Casting, Squeeze Casting, Slurry Casting, Centrifugal Casting, Melt Infiltration, Spray-Forming Technique, In Situ Processes, Melt Oxidation Process. Solid-State Processes: Powder Metallurgy Techniques, Diffusion Bonding, Explosive Shock Consolidation, Roll Bonding and Co extrusion, Gaseous-State Processes, Deposition Techniques, Secondary Processing. Machining and Joining of MMCs . Properties of Metal Matrix Composites, Applications of Metal Matrix Composites, Mechanical Properties of CMCs . Metal Matrix Nanocomposites. (8h)

**7.Ceramic Matrix Materials** Crystalline Oxides: Alumina, Mullite, Zirconia, Silica, Silicon Carbide, Silicon Nitride, Boron Carbide, Boron Nitride, Aluminum Nitride, Glasses and Glass–Ceramics,Failure Be Cold Compaction behavior of CMCs, Toughening Mechanisms in CMCs. (3h)

**8.Processing of Ceramic Matrix Composites:** Ceramic Particle–Based Processes, Cold Compaction, Slurry Impregnation, Sol–Gel Processing, Sintering, Hot Pressing, Hot Isostatic Pressing, Reaction Bonding Process, Self-Propagating High-Temperature Synthesis, Self-Propagating High-Temperature Synthesis, Advantages of In Situ Composites, Melt Processing, Ceramic Nanocomposites (6h)

**List of Tutorials: (Any Three)**

1)Design of Composite material composition and required properties.
2)Calculation of Mechanical properties of PMC.
3)Estimation of Mechanical Properties of MMC.
4) Analysis of Mechanical properties of CMC.

**List of Practicals: (Any Six)**

1) Processing of Polymer Matrix Composites (PMC)
2) Processing of Metal Matrix Composites (MMC)
3) Processing of Ceramic Matrix Composites (CMC)
4) Tensile behaviour of polymer matrix composites
5) Impact behaviour of polymer matrix composites
6) Microstructural Characterization of MMC
7)Mechanical Characterization of MMC
8)Mechanical Characterization of CMC
9) Estimation of Volume fraction of reinforcements in Composites
10) Design of Charge with respect to required properties of composites.

**List of Projects:**

1.Synthesis of Fiber/ Particle reinforced Phenol Formaldehyde Composite.
2.Synthesis of Fiber/Particle reinforced Polycarbonate Composites.
3.Synthesis of particle/ fiber reinforced Polyster Nanocomposites.
4.Synthesis of Al Matrix composites.
5. Synthesis of Cu Matrix composites.
6.Development of tape casting for ceramic matrix composites.
7. Mechanical and Microstructural Characterization of AL MMC
8. Development of Aumina matrix Composites.
9.Development of Clay -Epoxy nanocomposites.
10.Development of steel composites by powder metallurgy process.

**List of Course Seminar Topics:**

1. Aluminum Matrix Composites by casting method
2. Aluminum Matrix Composites by powder metallurgy method.
3.Titanium Matrix Composites by casting method
4.Titanium Matrix Composites by Powder Metallurgy method
5.Nano Composite manufacturing Technology
6.Ceramic Matrix Composites by Spark Plasma Sintering Technique
7.Microstructural Characterization techniques for MMC
8. Characterization techniques of Polymer Matrix Composites.
9.Characterization techniques for CMC
10.Steel Matrix Composites

**List of Course Group Discussion Topics:**

1.Toughening mechanism in CMC
2.Sintering Mechanism of Powder compacts.
3.Self Propagating High temperature synthesis
4.Reinforcemnt Materials
5.Magnesium Matrix Composites
6.Vacuum Impregnation Methods
7. Carbon Carbon Composites
8.Polymer Nanocomposites
9. Alumina Matrix Composites
10.Pultrusion.(PMC)

**List of Home Assignments:**

**Design:**

1.Estimation of Critical Fiber Length in Fiber Reinforced Composites.
2.Elastic Modulus Determination of Composite Materials.
3. Design of Tubular Composite shaft
4.Design of Composites for tailor made properties
5.Estimation of Longitudinal and Transverse Tensile Strength.

**Case Study:**

1.Ti MMC
2. Cu MMC
3.Al MMC
4.Zirconia Matrix Composites
5.Epoxy Resin Matrix Composites

**Blog**

1.Alumiunm Nanocomposites
2. Powder Metallurgy Technique for MMC
3. Rapid Solidification Techniques for MMC
4. Metal Matrix Composites for Aerospace applications
5. Cu Matrix composites

**Surveys**

1.Potential requirement of Polymer composites in India
2.Polymer composites components in Aeroplane
3.Aluminum metal matrix composites potential in India
4.Titanium matrix composites in Aerospace applications
5.Ceramic composites components and its potential.

**Suggest an assessment Scheme:**

- Midsem 20 Marks
- End sem 20 Marks
- Home Assignment 10 marks
- Lab work 10 Marks
- Course Project 10 Marks
- Tutorial 10 Marks
- Viva 10 marks
- GD/PPT 10 marks

**Text Books:** ***(As per IEEE format)***

1.M. Balasubramanian, Composite materials and processing,CRC Press is an imprint of the Taylor & Francis Group.
2. Deborah D.L. Chung,Composite Materials Science and Applications,2nd Edition,Springer London Dordrecht Heidelberg NewYork.
3.Matthews F L and Rawlings R D, “Composite Materials: Engineering and Science”, Chapman and Hall, 1994.

4.Ronald F Gibson, "Principles of Composite Material Mechanics", McGraw Hill Book Co, 1994.

**Reference Books:** ***(As per IEEE format)***

1.Nikhilesh Chawla, Krishan K. Chawla, Metal Matrix Composites, Springer London Dordrecht Heidelberg NewYork.
2.Terry Richardson, "Composites - A Design Guide", Industrial Press Inc, 1987.
3.Robert M Jones, "Mechanics of Composite Materials", McGraw Hill Book Co, 1970.
4.Sanjay K Mazumdar, "Composites Manufacturing", CRC Press, 2003
5.Autar K Kaw, "Mechanics of Composite Materials", CRC Press, 1997

**Moocs Links and additional reading material:** www.nptelvideos.in

**Course Outcomes: Students will be able**

1)To Understand the the methodology of Composite materials.
2) To apply and develop polymer Matrix Composites.
3)To select appropriate Metallic materials as a matrix material.
4)To develop Metal matrix composites to enhance required properties.
5)To understand development of Ceramic Composite Materials
6)To develop new materials with appropriate processing techniques and combinations of Materials.

**CO PO Map**

| PO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PS1 | PS2 | PS3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO2 | 3 | 2 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO3 | 2 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO4 | 3 | 2 | 2 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO5 | 3 | 3 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |
| CO6 | 2 | 2 | 3 | | | | | | | | | 1 | 2 | 1 | 1 |

**CO attainment levels**

| CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|---|---|---|---|---|---|
| 3 | 4 | 4 | 5 | 3 | 3 |

**Future Courses Mapping:**

Smart Materials, Advanced Engineering Materials,Mechanics of Composite Materials

**Job Mapping:***Research and Developments Labs, New Product Developments,*

**FF No. : 654**

# PR4207::MECHATRONICS & INDUSTRIAL ROBOTICS

**Course Prerequisites:**
i) Knowledge of Electrical and Electronic Technology,
ii) Knowledge of Theory of machines and Machine Design

**Course Objectives:**

1. Provide skills / tools for developing Automation solutions
2. Understand the components and devices used in mechatronic devices
3. Impart skills of programming and developing microcontroller and PLC based Automation solutions
4. Understand robot system and components and Select type of robot for industrial applications
5. Learn about Robot programming and configuration for typical operations.
6. Learn about IoT, Industry 4.0 and new technologies in Robotics and Automation.

**Credits: 02** **Teaching Scheme Theory: 02** Hours/Week
**Tut: ……...** Hours/Week
Lab: **……...** Hours/Week

**Course Relevance:** Very important and useful for future engineers, to make them job ready and employable.

| **SECTION-1** |
|---|
| **1. Introduction to Mechatronics and Automatic Systems and Components :** Terminology, Classification, Automatic control systems, sensors, input devices, actuators, signal conditioning, etc. Study of typical mechatronics systems. (4h)<br>**2. Introduction to Microncontroller programming and Applications :** Terminology, Architecture of microcontrollers and the interfaces. introduction to arduino board, programming and simple applications. simulation on tinkercad. (5h)<br>**3. Programmable Logic controllers - Introduction, programming and applications :** Introduction to relay logic, Advantages of Programmable Logic controller, architecture of PLC, ladder diagram and programming, simple automation applications on PLC simulation. (5h) |
| **SECTION-1I** |

**4. Introduction to Industrial robot Systems, Components and Applications :** Classification of robotic systems, anatomy, Specifications and configuration. Basic concepts and terminology. Basic components in a typical robot system, Industrial and other applications of robots. Robotic sensors actuators end effectors etc. Arm and body motions, wrist motions (5h)

**5. Robot Kinematics Dynamics and Programming :**

Orientations and frames, Mappings: Changing descriptions from frame to frame, Operators: Translations, Rotations and Transformations - Transformation Arithmetic - D-H Representation - Forward and inverse Kinematics Of Six Degree of Freedom Robot Arm – Robot Arm dynamics, Statics of planer arm robot, Mass and inertia of links, (5h)

**6. Advances in robotics and automation Technologies, IoT, and Industry 4.0 :**

Mobile robots, humanoid and soft robotics, collaborative robots, internet of things and automation in fourth industrial revolution. role of 5G, AI, machine learning and other advanced Technologies for future automation systems. (4h)

**List of Practicals: (Any Six)**

1. Study of any two to advanced mechatronics systems
2. Design and simulation of 3 arduino microcontroller board based automatic systems
3. Design simulation and programming of PLC based 3 automatic system using ladder diagram
4. Study and selection of robotic configuration for three typical applications
5. Design programming and simulation of 6 degree of freedom robotic arm.
6. Learn programming of simple robotic system for a given application on simulator.

**Text Books:** ***(As per IEEE format)***

1. *Mittal, Nagrath - Industrial Robotics, Tata McGraw Hill*
2 W. Bolton - Mechatronics
3 W. Bolton - PLCs.

**Moocs Links and additional reading material:** www.nptelvideos.in

**Course Outcomes: Students should be able to :**

1. Understand and design simple mechatronic systems and their components.
2. Design and program simple microcontroller based automation systems.
3. Understand, design and program PLC based systems using ladder diagrams
4. Understand, design and select robotic systems for a particular application
5. Understand design and program typical robot systems, along with knowledge of their kinematics and dynamics
6. learn and understand the impact of latest advances in the field of robotics and automation.