CAD / CAM (3-0-0)

Sub Code : ME0303  
CIE : 50 %

Hrs / Week : 03  
SEE : 50 %

SEE Hrs : 3 Hrs  
Max. Marks : 100

Course Prerequisites: None

Course outcomes:
Upon successful completion of this course, the student will be able to:

1. Describe the significance of computers in various stages in the Manufacturing and Design industries.
2. Comprehend and solve the basic mathematical elements of Computer Graphics
3. Discuss Geometric modeling techniques and its characteristics.
4. Articulate the intricacies of NC & CNC technology and create simple CNC programs for machining operations
5. Explain the concepts and configurations of Robotics and its industrial applications.
6. Demonstrate self-learning capability in the area of CAD/CAM

Course Content

Unit –1
Introduction: Role of computers in design and manufacturing, Product cycle in conventional and computerized manufacturing environment.
Introduction to CAD and CAM processes, Advantages and limitations of CAD/CAM; Integration of CAD / CAM through common database in an industry. Computer integrated manufacturing, Introduction to industrial Automation; Advantages & Applications of Automation Techniques.

Hardware for CAD: Design Workstation, Graphics Terminal - Image generation and maintenance techniques (CRT, LCD, LED), Colour generation in graphic.

SLE: Industrial application of CAD/CAM, CAD/CAM software packages and their feasibility, Data storage in computer memory.

6 Hrs

Unit –2


SLE: Concept of Rendering, shading and hidden surface removal.

7 Hrs
Unit – 3

SLE: Study the various Curves in Modelling and drawing interchange files – DXF, IGES and STEP.

7 Hrs

Unit – 4

SLE: Differentiate between NC, DNC, CNC. Support systems (Chip removal, Work supporting in turning centre)

7 Hrs

Unit – 5


SLE: Cutting – Tool Materials and cutting tools used in CNC centers

7 Hrs

Unit – 6

SLE: Applications of Robots in manufacturing industries.

5Hrs
Text Books:
2. CAD/CAM by Groover, Pearson Education. 2008

Reference Books:

Assessment Methods:
1. Written Tests (Test-I, Test-II & Test-III) are Evaluated for 25 Marks each and the sum of best two will be the CIE.

Mapping of COs to POs:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Programme Outcomes that are satisfied by the COS</th>
<th>Programme Specific Outcomes satisfied by COs</th>
</tr>
</thead>
<tbody>
<tr>
<td>C01</td>
<td>P01</td>
<td>PSO 1</td>
</tr>
<tr>
<td>C02</td>
<td>P01, P02</td>
<td>PSO 1</td>
</tr>
<tr>
<td>C03</td>
<td>P01, P02, P03</td>
<td>PSO 3</td>
</tr>
<tr>
<td>C04</td>
<td>P01, P02, P07</td>
<td>PSO 1, PSO 3</td>
</tr>
<tr>
<td>C05</td>
<td>P01</td>
<td>PSO 1, PSO 3</td>
</tr>
<tr>
<td>C06</td>
<td>P01, P012</td>
<td>-</td>
</tr>
</tbody>
</table>
Coordinate Metrology (1-0-2)

Sub Code : ME0213  
Hrs / Week : 03  
SEE Hrs: 2 Hrs

SEE Hrs: 2 Hrs  
Max. Marks : 50

Course outcomes:
Upon successful completion of this course, the student will be able to:

1. Explain the application of GD&T in industrial practice
2. Elucidate the construction and working principle of coordinate measuring machines
3. Select the appropriate CMM and accessories for a given application
4. Use a standard CMM and software interface to simulate inspection of gears, splines, 2D and 3D surfaces

Course Content:
Unit 1: Geometrical Dimensioning and Tolerancing

Form and Profile tolerances: straightness, flatness, circularity and cylindricity. Profile of a line and profile of a surface. Orientation: parallelism, perpendicularity, runout.
Location tolerances: position, concentricity.

8 Hrs

Unit 2: Co-ordinate Measuring Machines
Introduction. Structure of CMM: (a) Cantilever, (b) Bridge, (c) Column, (d) Horizontal arm, and (e) Gantry types. Advantages and Limitations, Probes (Contact/Non-contact) – Touch trigger & Scanning (Active & Passive), Styli, Calibration, Geometry & its interpretation, Construction of features, Interpretation of results, Import & export of CAD models, Programming with CAD, Simulation, measurement and interpretation of results, Evaluation of results like detailed printout, custom printout and form & position plots. Applications of CMMs.

8 Hrs

Unit 3: CMM Software (CALYPSO, a product of Carl Zeiss)
CMM software to create measuring programs by selecting features used in CAD drawings. At least 10 laboratory sessions to simulate inspection of the following:
1. Measurement of 2D and 3D curves: curve slope, cam throw, curve length, curve form, known & unknown curves etc.

2. Evaluation and reporting: presentation of results with colour illustrations as per industry standards

**Unit 4: Industry Interface**

a. One day visit to Carl Zeiss plant in Bengaluru
b. Presentation of case studies by Carl Zeiss experts at NIE (at least two)

**Text Book:**


**Evaluation Pattern:**

Continuous internal evaluation (CIE) : 25 marks  
Semester end examination : 25 marks  
TOTAL : 50 marks

**CIE Assessment:**

a. Written quiz : 10 marks  
b. Assessment in practical classes : 10 marks  
c. Report on industry visit : 05 marks  
d. SEE is conducted for 50 marks.

**Mapping of COs to POs:**

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Programme Outcomes that are satisfied by the COS</th>
<th>Programme Specific Outcomes satisfied by COs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>P01</td>
<td>PSO 3</td>
</tr>
<tr>
<td>CO 2</td>
<td>P01, P02</td>
<td>PSO 1</td>
</tr>
<tr>
<td>CO 3</td>
<td>P03, P07</td>
<td>PSO 3</td>
</tr>
<tr>
<td>CO 4</td>
<td>P02, P0 3, P0 7</td>
<td>PSO 4</td>
</tr>
</tbody>
</table>
Micro-Grid system with RE Integration (1-0-2)

Sub Code : ME0212  
Hrs / Week : 03  
SEE Hrs: 2 Hrs  
CIE: 50 %  
SEE: 50 %  
Max. Marks : 50

Course Prerequisites: None

Course Outcomes

Upon successful completion of this course, the student will be able to:

1. Describe and explain Micro-grid system & its integration with RE sources.
2. Apply engineering techniques to build a Micro-grid integrated with solar PV, wind turbine, biofuel and Micro-hydro system.
3. Conduct of experiments to learn hands on solar PV, Micro-hydro, and Micro-grid systems.

Course Content

UNIT-1

Introduction:
Renewable Energy sources and technology, Integration of Renewable energy - need and advantages, Micro-grids basics & its importance for remote locations. Integration of Renewable energy to Micro-Grid system : Schemes to integrate Renewable energy technologies – stand alone systems, Hybrid systems.
Integration of solar PV, wind turbine, bio diesel engine and micro hydro – principle.
SLE: Decentralized energy distribution & its significance. 06 hrs

UNIT-2

Energy storage:
Pumped storage - pumped storage systems, application of pumped storage system in Microgrids.
SLE: Benefits of pumped storage systems 07 hrs

UNIT-3

Micro-Grid features and controller

Case study of Micro-Grid system: A small 1Kw to 10Kw microgrid systems installed anywhere in the world. 07 hrs
UNIT-4
Experiments
1) Performance test of a 1Kw Micro-grid system.
2) Experiment on solar PV system - Calculation of power flow for a standalone PV system AC load with battery.
3) Experiment on solar PV system - Calculation of power flow for a standalone PV system DC load with battery.
4) Experiment on solar PV system - To draw the I-V curve for different radiation.
5) Experiment on solar PV system - To draw the I-V curve for different temperature.
6) Experiment on Microhydro – performance study.  12 hrs

TEXT BOOKS:

REFERENCE BOOKS:

Assessment Methods:
1. CIE is inclusive of lab components.
2. Presentation by students will be evaluated for 20 marks and Lab component test shall be evaluated for 30 marks. Total50 Marks.
3. SEE shall be evaluated for 50 marks.

Mapping of COs to POs:

<table>
<thead>
<tr>
<th>COs</th>
<th>Programme Outcomes that are satisfied by the COS</th>
<th>Programme Specific Outcomes satisfied by COs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>P01, P02, P06, P07</td>
<td>PSO 1, PSO 3</td>
</tr>
<tr>
<td>CO2</td>
<td>P01, P02,P03, P04, P05, P07, P011</td>
<td>PSO 1, PSO 3</td>
</tr>
<tr>
<td>CO3</td>
<td>P01, P02, P03, P04, P05, P06, P07</td>
<td>PSO 1, PSO 4</td>
</tr>
</tbody>
</table>
Product Design and Development (2-2-0)

Sub Code: ME0330  
Hrs / Week: 03  
SEE: 3 Hrs  
CIE: 50%  
SEE: 50%  
Max. Marks: 100

Course Prerequisites: None

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Describe the fundamentals of new product development process and planning.
2. Establish product specifications identifying customer needs.
3. Generate and select various concepts for a product.
4. Understand the concept of Product Architecture and Industrial Design.
5. Appraise the concept of Design for Manufacturing and Prototyping.

Course Content

Unit-1

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.

Development Processes and Organizations: A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organizations.

Product Planning: The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

SLE: Characteristics of different organizational structures

4L + 4T hrs
Unit-2

**Identifying Customer Needs:** Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

**Product Specifications:** What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

**SLE:** A Case study on product planning (Tata Ace).

3L + 3T hrs

Unit-3

**Concept Generation:** The activities of concept generation clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process.

**Concept Selection:** Overview of methodology, concept screening, and concept scoring.

**Concept Testing:** Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

**SLE:** Caveats in Concept selection.

4L + 4T hrs

Unit-4

**Product Architecture:** What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning.

**Industrial Design:** Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assess the quality of industrial design.

**SLE:** Related System Level Design Issues.

3L + 3T hrs

Unit-5

**Design for Manufacturing:** Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production.

**Prototyping:** Prototyping basics, principles of prototyping, technologies, planning for prototypes.
SLE: Impact of DFM on other factors.  

3L + 3T hrs

Unit-6

**Product Development Economics:** Elements of economic analysis, base case financial mode. Sensitive analysis, project trade-offs, influence of qualitative factors on project success.

**Managing Projects:** Understanding and representing task, baseline project planning, accelerating projects, project execution, post mortem project evaluation.

SLE: Qualitative Analysis.

3L + 3T hrs

**Text Books:**


**Reference Books:**


**Assessment Methods:**

1. Written Tests (Test 1,2 & 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.
Computer Vision & Image Processing (4-2-0)

Sub Code: IAR0526
Hrs/Week: 06
SEE Hrs: 3Hrs
Course Prerequisites: None

CIE: 50% Marks
SEE: 50% Marks
Max.Marks: 100

Course Outcome:
After the successful completion of this course, the student will be able to:
1. Describe & explain the applications of computer vision in automation, method of feature detection & select the appropriate image processing technique and appropriate segmentation technique for typical automation assembly line application.
2. Demonstrate the use of stereo camera for surface reconstruction & illustrate 3D reconstruction techniques.

Course Content

Unit I:
Introduction: What is computer vision? A brief history, Image formation, Geometric primitives and transformations, Photometric image formation, the digital camera.
SLE: Image compression 8 Hrs

Unit II:
Image processing: Point operators, Linear filtering, More neighborhood operators, Fourier transforms, Geometric transformations, Global optimization.
SLE: Image restoration 9 Hrs

Unit III:
Feature detection and matching: Points and patches, Feature detectors, Feature matching, Feature tracking, Edge detection, Edge linking, Lines, Successive approximation, Vanishing points.
SLE: Rectangle detection 8 Hrs

Unit IV:
Segmentation: Active contours, Split and merge, Mean shift and mode finding, K-means and mixtures of Gaussians, Normalized cuts, Graph cuts and energy-based methods.
SLE: Medical image segmentation 10Hrs

Unit V:
Stereo correspondence: Epipolar geometry, Sparse correspondence, Dense correspondence, Local methods, Global optimization, Multi-view stereo
SLE: Volumetric and 3D surface reconstruction 8 Hrs
Unit VI:
3D reconstruction: Shape, Active range finding, Surface representations, Volumetric representations, Model-based reconstruction, Recovering texture maps.
SLE: 3D photography 9 Hrs

Text Books:

Reference Books:

Assessment Methods:
Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of COs to POs:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Programme Outcomes that are satisfied by the COS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>PO1, PO2, PO4, PO5 &amp; PO6</td>
</tr>
<tr>
<td>CO 2</td>
<td>PO1, PO2, PO4, PO5 &amp; PO6</td>
</tr>
</tbody>
</table>
Automotive Electronics (4-0-0)

Sub Code: IAR0414
Hrs/Week: 04
SEE Hrs: 3Hrs

CIE: 50% Marks
SEE: 50% Marks
Max.Marks:100

Course Prerequisites: None

Course outcome:
After the successful completion of this course, the student will be able to:
1. Describe and explain various sensors, communications & Instrumentation used in automobile.
2. Summaries HVAC & Air/Fuel system of an automobile.
3. Analyze the importance of engine performance data for automobile.

Course Content

Unit-I:
Automotive Fundamentals Overview: Four Stroke Cycle, Engine Control, Ignition System, Spark plug, Spark pulse generation, Ignition Timing, Drive Train, Transmission, Brakes, Steering System, Battery, Starting System. 9 Hrs

Unit-II:
Air/Fuel Systems – Fuel Handling, Air Intake System, Air/ Fuel Management 9 Hrs

Unit-III:

Unit-IV:
Unit-V:


8 Hrs

Unit-VI:


9 Hrs

Reference Books:

Assessment Methods:
Written Tests (Test 1,2& 3) are Evaluated for 25 Marks each out of which sum of best two for 50 marks are taken.

Mapping of COs to POs:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Programme Outcomes that are satisfied by the COS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>PO1, PO2, PO3, PO4</td>
</tr>
<tr>
<td>CO 2</td>
<td>PO2, PO3, PO4, PO5 &amp; PO6</td>
</tr>
<tr>
<td>CO 3</td>
<td>PO3, PO4, PO5, PO6</td>
</tr>
</tbody>
</table>
Course Outcome:
On successful completion of the course the students will be able to

1. Acquire clear understanding of Big Data and Related Technologies

2. Analyze Technologies for Handling Big Data and Hadoop Ecosystem

3. Acquire clear understanding of MapReduce Fundamentals and HBase

4. Acquire clear understanding of NoSQL Data Management

5. Acquire a clear understanding of Analytics and Big Data

6. Analyze the various Analytical Approaches Tools to Analyze Data and Exploring R

Course Content

Unit I:

Getting an Overview of Big Data


SLE: Business Intelligence, Preventing Fraud Using Big Data Analytics 6 Hrs

Unit II:

Introducing Technologies for Handling Big Data and Hadoop Ecosystem


SLE: HBase, Hive, Pig, Sqoop, Flume 6 Hrs
Unit III:

Understanding MapReduce Fundamentals and HBase

The MapReduce Framework, Exploring the Features of MapReduce, Working of MapReduce, Exploring Map and Reduce Functions, Techniques to Optimize MapReduce Jobs, Hardware/Network Topology, Synchronization, File System, Uses of MapReduce, Role of HBase in Big Data Processing, Characteristics of HBase.

SLE : Installation of HBase 6 Hrs

Unit IV:

NoSQL Data Management

Introduction to NoSQL, Characteristics of NoSQL, Evolution of Databases, Aggregate Data Models, Key Value Data Model, Document Databases, Relationships, Graph Databases, Schema-Less Databases, Materialized Views, Distribution Models, Sharding, MapReduce Partitioning and Combining, Composing MapReduce Calculations

SLE: CAP Theorem 6 Hrs

Unit V:

Understanding Analytics and Big Data

Comparing Reporting and Analysis, Reporting, Analysis, The Analytic Process, Types of Analytics, Basic Analytics, Advanced Analytics, Operationalized Analytics, Monetized Analytics, Characteristics of Big Data Analysis, Points to Consider during Analysis, Frame the Problem Correctly, Statistical Significance or Business Importance?, Making Inferences versus Computing Statistics, Developing an Analytic Team, Convergence of IT and Analytics, Understanding Text Analytics

SLE: Skills required for an Analyst 6 Hrs

Unit VI

Analytical Approaches and Tools to Analyze Data


SLE: Installing R, R Studio 9 Hrs
Lab Experiments

1. Hands on session on SQL – Data Definition Language (DDL), Data Manipulation Language (DML) and Data Control Language (DCL)
2. Hands on session on Creation of table
3. Hands on session on Modification of Table
4. Hands on session Insertion, Deletion, Selection operations
5. Hands on session on the Installation and Setup of R Language
6. Hands on session on working with Vectors in R Language
7. Hands on session on R-Essential in R Language
8. Hands on session on Dataframes in R Language
9. Hands on session on Matrices in R Language
10. Hands on session on Core Programming in R Language
11. Hands on session on Strings manipulation (stringr package)
12. Hands on session on Writing functions and best practices
13. Hands on Session on Debugging and error handling

13 Hrs

Textbook:
1. Big Data: Black Book, DT Editorial Services, Wiley India Pvt Ltd, 2015 Edition (Chapters 1,2,3,4,5, 15,18,19,20)

Reference Books:
2. Big Data Analytics with R and Hadoop, Vignesh Prajapati, -Packt Publishing 2013
6. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data

EMC Education Services, Wiley India Pvt Ltd

Assessment Method:
1. Written Tests (Test, Mid Semester Exam & Make Up Test) are Evaluated for 20 marks each, out of which sum of best two are taken.
2. Laboratory exercise / Seminar/Assignment submission – 10 marks CIE = 1 + 2 above
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Programme Outcomes that are satisfied by the COS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>PO1, PO3, PO4, PO8</td>
</tr>
<tr>
<td>CO 2</td>
<td>PO1, PO3, PO4, PO8</td>
</tr>
<tr>
<td>CO 3</td>
<td>PO1, PO3, PO4, PO8</td>
</tr>
<tr>
<td>CO 4</td>
<td>PO1, PO3, PO4, PO8</td>
</tr>
<tr>
<td>CO 5</td>
<td>PO3, PO4, PO5, PO7, PO8</td>
</tr>
<tr>
<td>CO 6</td>
<td>PO3, PO4, PO7</td>
</tr>
</tbody>
</table>
Automation Laboratory (0-0-2)

Sub Code: IAR0104  
Hrs / Week : 02  
SEE Hrs : 3 Hrs  
CIE: 50 %  
SEE: 50 %  
Max.Marks: 50

Course Prerequisites: Pneumatics and Hydraulics, PLC programming.

Course Outcomes:
Upon the completion of the course, successful students will be able to:
CO1: Develop and implement PLC logic, vision system for any industrial applications.
CO2: Analyse and implement hydraulic and pneumatic circuit.
CO3: To know about Industrial drives, Industrial identification systems.
CO4: Implement Microcontroller (Arduino) related projects.

List of lab Experiments:
1. PLC programming for any one module of Mechatronics training system.
2. Inspection of parts using COGNEX vision system.
3. Design and development of one hydraulic circuit.
4. Design and development of one pneumatic circuit.
5. Experimental study of Industrial drives.
6. Experimental study of RFID, Barcode and Actuator sensor (AS) interface kit.
7. Learning and implementation of Arduino platform.

Reference Books:
1. Programmable Logic Controllers by W.Bolton.

Evaluation Pattern:
1. CIE is the average of the marks awarded for all practical classes and the marks awarded for lab records.
2. In the SEE, the students are required to conduct specific experiments which are evaluated for 25 marks.
3. The Marks from SEE & CIE are summed up to obtain final evaluation
## Mapping of Cos to POs

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Programme Outcomes that are satisfied by the COs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>PO1, PO4, PO5, PO7</td>
</tr>
<tr>
<td>CO2</td>
<td>PO1, PO2, PO3, PO6</td>
</tr>
<tr>
<td>CO3</td>
<td>PO1, PO3, PO8</td>
</tr>
<tr>
<td>CO4</td>
<td>PO1, PO3, PO4, PO8</td>
</tr>
</tbody>
</table>
Industrial Nanotechnology (4:0:0)

Sub Code: MNT0405  CIE: 50% Marks
Hrs/ Week: 05  SEE: 50% Marks
SEE Hrs.: 03  Exam Marks: 100 Marks

Course Prerequisites: NIL

Course Outcomes (CO's): After the successful completion of this course, the student will be able to:
1. Understand the basic and essential in electronics industry
2. Explain the role and applications of nanotechnology in biomedical and pharmaceutical industry
3. Discuss the use of nanomaterials for processing in chemical industry
4. Define how nanotechnology can be used in agriculture
5. Apply nanotechnology ideas in textile industry
6. Identify environmental and safety issues in nanomaterials.

UNIT-I


UNIT - II


Self Learning Exercise: Nanopolymers in medical textiles

UNIT- III

Nanotechnology in Defence: Military applications of Nanotechnology - Artificial intelligence materials - Propulsion – Vehicles - Propellants and Explosives – Camouflage distributed sensors
- Amour protection - Conventional weapons - Soldier systems - Implanted systems, Body
manipulation - Autonomous systems - Mini-/Micro robots - Bio-technical hybrids - Small
satellites and Space launchers - Nuclear weapons - Chemical weapons - Biological weapons -
Chemical/Biological protection.

**Self Learning Exercise:** Nuclear Weapons

** UNIT- IV**

**Nanotechnology in Agriculture and Food Technology:** Nanotechnology in Agriculture -
Precision farming, Smart delivery system – Nanofertilizers: Nanourea and mixed fertilizers,
Nanofertigation - Nanopesticides, Nano-seed Science.

**Self Learning Exercise:** Nanourea

** UNIT - V**

**Nanotechnology in Environmental and Health Effects:** Environmental pollutants in air, water,
soil, hazardous and toxic wastes - Application of Nanotechnology in remediation of pollution in
Industrial and waste water treatment – Drinking water and Air/Gas purifications - The challenge
to occupational health and hygiene, toxicity of nanoparticles, effects of inhaled nanosized
particles, skin exposure to nanoparticles, impact of CNTs on respiratory systems, hazards and
risks of exposure to nanoparticles, monitoring nanoparticles in work place.

**Self Learning Exercise:** Toxicity of nanoparticles

** UNIT – VI**

**Industrial R&D &Product Development:** Research & development. Product development and
project management in Agri, Pharma, Health and other biotech industries. Overview of issues
and techniques involved in conducting & outcome of research. The multidisciplinary nature of
outcomes research, research design and methods, data collection measurement instruments and
clinical endpoints, quality of life issues, behavior change, and cost-effectiveness. Analysis
Transition from R&D to business units, market learning and transition from R&D. Management
of radical innovation technologies vs. stage gate approach in product development. Case studies.

**Self Learning Exercise:** Management of radical innovation technologies

**TEXTBOOKS**

1. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication,
2. J. Altmann, Routledge, Military Nanotechnology: Potential Applications and Preventive Arms
Control, Taylor and Francis Group, 2006.
3. Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production,

REFERENCE BOOKS

Assessment Methods:
1. Written Tests (Test, Mid Semester Exam & Make Up Test) are Evaluated for 20 Marks each
2. Assignment for 10 marks. Students are required to
   a. Deliver a presentation on a topic of significance in the relevant field.

Mapping of COs to POs:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Programme Outcomes that are satisfied by the COS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>PO2, PO3</td>
</tr>
<tr>
<td>CO 2</td>
<td>PO1, PO2</td>
</tr>
<tr>
<td>CO 3</td>
<td>PO2, PO4, PO7</td>
</tr>
<tr>
<td>CO 4</td>
<td>PO2, PO3 &amp; PO4</td>
</tr>
<tr>
<td>CO 5</td>
<td>PO1, PO3 &amp; PO4, PO7</td>
</tr>
</tbody>
</table>