Program Name : **Diploma in Mechanical Engineering**

Program Code : **ME**

Semester : **Sixth**

Course Title : **Computer Integrated Manufacturing (Elective-II)**

Course Code : **22658**

1. RATIONALE

Diploma Engineers need to acquire the knowledge of computer integrated Manufacturing (CIM) after getting conversant with conventional manufacturing methods. This subject encompasses entire range of product development and manufacturing activities with the help of different software packages. The course intends to help the students to work on Group Technology, Material Requirement Planning and collection of factory data system.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use of computer integrated manufacturing (CIM) technology in current manufacturing system.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Prepare Computer Aided Design (CAD)/ Computer Aided Manufacturing (CAM)/(CIM) product cycle different products cycle.
b) Apply CAM and CIM practices.
c) Apply business function software in CIM.
d) Apply networking in CIM.
e) Use of Flexible Manufacturing System (FMS) and Automation concepts in industries.
f) Use of Robotics technology in industries.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
				Paper	ESE		PA		Total		ESE		PA		Total	
L	T	P		Hrs.	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends:** L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

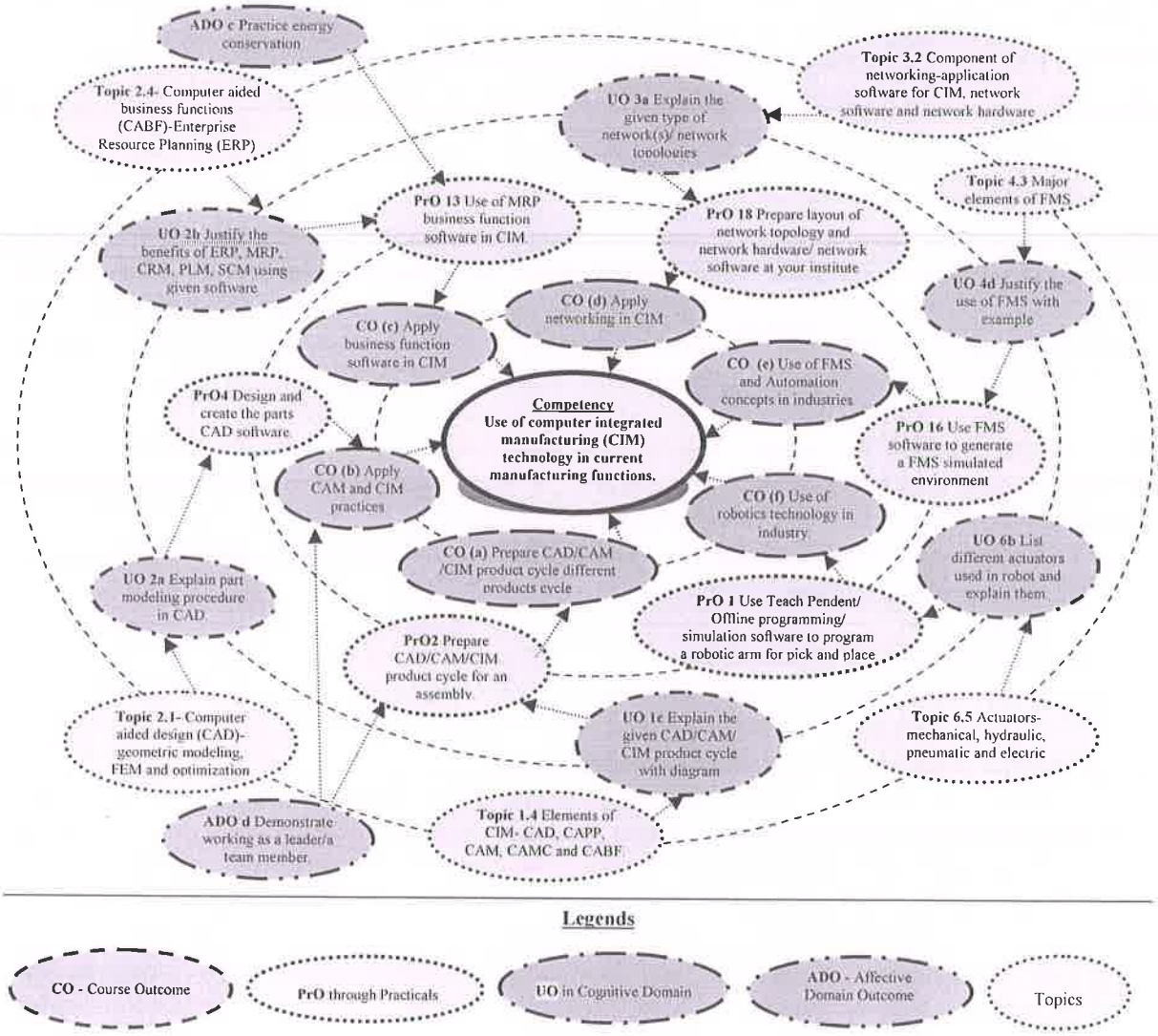

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Prepare traditional product cycle for any one of the assembly.	I	2*
2	Prepare CAD/CAM/CIM product cycle for PrO1 assembly.	I	2*
3	Use of CRM (Customer Relation Management) software for maintaining customer relationship.	II	2
4	Design and create the individual parts of PrO1 assembly by using geometric modeling workbench of CAD software.	II	2*
5	Optimizing, evaluate and design review of parts modeled under PrO3 using any CAD/CAE software.	II	2*
6	Create drawings of parts modeled under PrO3 using drafting workbench of CAD software.	II	2*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	Generate bill of material (BOM) and other data of PrO4 using CAD software.	II	2
8	Prepare Computer aided process plan for the selected part using variant type of CAPP (Computer Aided Process Planning) software.	II	2
9	Generate sample program for any part and verify tool path by simulation using CAM software.	II	2*
10	Generate tool path movement by Interfacing part program or manual part program to CNC machine.	II	2*
11	Inspection of part using CAQC software (Computer Aided Quality Control) by CMM/other system.	II	2
12	Use MRP (Material Resource Planning) software for CIM of and assembly.	II	2*
13	Use PLM (Product Life Management) software for CIM related to any product.	II	2*
14	Use Supply Chain Management software for CIM related to any product.	II	2
15	Prepare layout of network topology and network hardware/ network software at your institute place.	III	2*
16	Establish networking between two CNC machines, computers and supported peripherals of your institute to exchange manufacturing data and produce a simple component.	III	2*
17	Observe actual/video film of FMS system and identify various elements of FMS and its nature of controlling by computer.	IV	2*
18	Generate part family code for a machine component using Opitz/MICLASS methods.	IV	2*
19	Observe actual / video film of automation system and identify various elements, type of automation and its nature of controlling by computer.	V	2*
20	Use FMS simulation software to generate a Flexible Manufacturing System simulated environment to control and program Automatic storage and Retrieval system (ASRS), linear shuttle conveyor, Interfacing of CNC lathe/milling and with loading unloading.	V	2
21	Build Electro-Hydraulic circuits for given application and interfacing it to PLC using Electro-Hydraulic Training kit.	V	02*
22	Observe actual / video film of robotics system and identify various element, type of robot, it configurations and its nature of controlling by computer.	VI	2*
23	Use Teach Pendent/Offline programming/simulation software to program a robotic arm to perform pick and place and stacking of objects (2 programs)	VI	2*
	Total		**46**

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S.No.	Performance Indicators	Weightage in %
1	Preparation of experimental setup/simulated environment	40
2	Effective use of related software/hardware.	20
3	Correlation with the real/industrial situation	10
4	Observations/survey and collection of information.	10
5	Answer to sample questions.	10
6	Submit report in time.	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.
d) Work as a leader/a team member.
e) Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computers minimum 4GB RAM and above	2,3 to 22
2	MRP/ ERP/ CRM/SCM and PLM software (1 + 10 user)	2,3,12,13,14
3	Database Management system Software (1 + 10)	2,3,12,13,14
4	Educational networking licensed CAD software (1 + 20 user)	2 & 4 To 7
5	Educational networking licensed CAM software (1 + 20 user)	2 & 4 To 7
6	CNC Milling Machine	9,10,15,16
7	CNC lathe machine	9,10, 15,16
8	Educational networking licensed CAQC software (Computer Aided Quality Control) or CMM/other system	11
9	Flexible Manufacturing System (FMS) model	20
10	Educational networking licensed FMS simulation software	20
11	Previous final year students sample projects containing low cost automation system.	All
12	Educational programmable robotics arm to manipulate objects.	22
13	Educational networking licensed Robotic system simulation software	22

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction to CIM	1a Explain the traditional product cycle with diagram and show all elements on it. 1b Explain advantages and benefits of the given CIM system. 1c Explain the given CAD/CAM/CIM product cycle with diagram and show elements on it. 1d Compare the given traditional product cycle with its counter CAD/CAM /CIM product cycle.	1.1 **Traditional product cycle diagram**-role of marketing, R&D, design, PPC, quality control and sales departments. Disadvantages and limitations of traditional product cycle. 1.2 **Current production needs-** production rate, quality, accuracy, repeatability, flexibility, survival. 1.3 **CIM**-concept, advantages and benefits of CIM. 1.4 **Elements of CIM-** computer aided design (CAD), computer process planning (CAPP), computer aided manufacturing control (CAMC), and computer aided business function (CABF). 1.5 **CAD/CAM/CIM product cycle diagram-** customer, marketing, computer aided design (CAD), computer aided process planning (CAPP), computer aided manufacturing control (CAMC), computer aided business function (CABF).
Unit– II Product Cycle Development through CIM	2a Explain part modeling procedure in CAD for the given component. 2b Explain analysis, optimization and evaluation for the given part using any CAE software. 2c Explain automated drafting procedure for the given component using any CAD software. 2d Differentiate given two methods of CAPP justifying with suitable examples 2e Explain the procedure of computerized part program generation for the given part using any CAM software. 2f Explain the procedure of part program interfacing to the given	2.1 **Computer aided design (CAD)**-geometric modeling, finite element analysis and optimization, evaluation and design review (CAE), concept of concurrent engineering, and list of software for CAE, simulation, automated drafting and generation of report. 2.2 **Computer aided process planning (CAPP)**-concept of CAPP, structure of processes planning software, methods of CAPP-variant, generative. Computerized material resource planning (CMRP), computerized work scheduling. 2.3 **Computer aided manufacturing control (CAMC)** – to generate computer program in machining. Interfacing part program to CNC. Computerized control monitoring and control, computer aided quality control (CAQC). Programmable logic control (PLC), software list like SCADA etc. 2.4 **Computer aided business functions (CABF)**-Enterprise Resource Planning (ERP)-role of ERP in business, advantage and applications of ERP softwares. Material Resource Planning (MRP)- role of MRP in business, advantage and benifits.MRP

	CNC machine. 2g Justify the benefits of ERP, MRP, CRM, PLM, SCM using the given corresponding software.	softwares. Customer Relationship Management (CRM) - role of CRM in business, advantage and applications.CRM software. 2.5 Product Lifecycle Management (PLM) - role of PLM in business, advantage and applications. PLM software. 2.6 Supply Chain management (SCM)- role of SCM in business, advantage and applications. SCM software.
Unit– III CIM Hardware, Software, Networking & Data Base Management System(DBMS)	3a. Explain the given type of network(s) and network topologies with diagram. 3b. Explain the given application software, network software, and network hardware with its purpose. 3c. State need of the given DBMS for the specified situation. 3d. Explain with sketches the given type of database.	3.1 **CIM networking**-types of network and its characteristics', applications. Types of network topologies-star, bus and ring topology. 3.2 **Component of networking**-application software for CIM, network software and network hardware. 3.3 **Data Base Management System (DBMS)**-data base types - hierarchical data base, network data base, relational data base, object oriented data base. Functions of data base management system. Advantages of DBMS.
Unit– IV Group Technology and Flexible Manufacturing System	4a. Justify the concept of Group Technology and its benefits for the given situation. 4b. Classify the FMS based on Flexibility for the given types of layouts. 4c. Compare the given two manufacturing systems based on the given criteria with examples. 4d. Justify the use of FMS for the given situation with example.s	4.1 **Group Technology**-concept, basis for developing part families, part classification and coding with example, concept of cellular manufacturing. Advantages and limitations. 4.2 **Flexible Manufacturing System-** Introduction, concept, definition and need, sub systems of FMS, comparing with other manufacturing approaches. 4.3 **Major elements of FMS**-workstations, material handling and storage system, computer control system and human resource. 4.4 **Classification based on flexibility**-dedicated FMS, random order. 4.5 **Classification based on types of layouts**-inline layout type, rotary layout, rectangular layout, loop layout type ladder layout type. 4.6 Applications and benefits of FMS, advantages and disadvantages of FMS.
Unit– V Automation	5a. Explain the main elements of the given automation system. 5b. Explain the given types of automations with respect to their characteristics.	5.1 **Automation**-Define, need of automation, high and low cost automation, examples of automations. 5.2 **Elements of automation** – power source, control unit and feedback control. 5.3 **Types of automations**- Fixed (Hard)

	5c. Justify the need of automation for the given situation. 5d. Explain the kind of strategies to be considered while designing automation in industry for the given situation.	automation, programmable automations and Flexible automations (Soft).Comparison of types of automations. 5.4 **Strategies in automation-** simplification, specializations of operations, multiple operations, integration of work stations, increased flexibility, automated material handling storage system, on line inspection, on line monitoring, processes control and optimization, control of plant operations and computer integrated manufacturing.
Unit–VI Robotics	6a. Explain with sketches the function of the specified actuators used in a robot. 6b. Explain given types of grippers used in robot with diagram. 6c. Explain with sketches the function of the given sensors used in a robot. 6d. Justify the use of Robot in the given industrial situation.	6.1 **Introduction to robotics-** definition of robot and robotics, advantages disadvantages. 6.2 **Basic components of robot**-manipulator, end effectors, actuators, sensors, controller, processor and software. 6.3 **Robot joints**-linear, orthogonal, rotational, twisting and revolving. 6.4 **Degree of freedom of robot**-vertical, radial, rotational traverse, wrist pitch, wrist yaw wrist roll. 6.5 **Actuators**-mechanical, hydraulic, pneumatic and electric. 6.6 **End effectors**-grippers and types. 6.7 **Robot sensors**-classification of sensors. 6.8 **Basic configuration of robot-** Cartesian, cylindrical, polar(spherical) 6.9 **Applications of robot**-loading unloading, material handling, processing operations, assembly and inspection.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to CIM	06	02	04	04	10
II	Product Development through CIM	12	04	04	06	14
III	CIM Hardware, Software, Networking and Data Base Management System (DBMS)	08	02	04	06	12
IV	Group Technology and Flexible manufacturing System	08	02	04	06	12
V	Automation	06	02	04	04	10
VI	Robotics	08	02	04	06	12
Total		**48**	**14**	**24**	**32**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare journals based on practical performed in laboratory.
b) Follow the safety precautions.
c) Use various software and equipment related to CAD/CAM/CIM/CAE/CAPP
d) Read and use specifications various software and equipment related to CAD/CAM/CIM/CAE/CAPP
e) Library / Internet survey of CAD/CAM/CIM/CAE/CAPP/FMS.
f) Prepare power point presentation or animation for GT/FMS/CIM/PLM
g) Perform Market survey of business function such as flipkart /amazon service etc.
h) Visit Industries and Companies consisting CIM, FMS, automation and robot system.
i) Survey any one of the company and study of its product cycle and compare it with CIM product cycle.
j) Visit any industry to understand total CIM product cycle functions.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Guide student(s) in undertaking micro-projects.
f) Arrange visit to nearby industries for understanding CIM functions.
g) Show video on films to explain functioning of CIM/FMS/automation/robot technology.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more

COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a) Collect information of any one of the company and compare every step with CIM product cycle.
b) Prepare a report related to suggestions to control business function according to CIM product cycle.
c) Collect information of advanced techniques related with quality control from nearby industry
d) Collect the different ERP, MRP PLM, SCM, DBMS and CRM software names, company name, product name and its features.
e) Perform web search and prepare a report on latest advancements and industrial practices in India and abroad in the field of CAD/CAM/CAPP/CAE/CIM/FMS/ ERP, MRP/PLM/SCM/DBMS and CRM.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Automation Production System and Computer Integrated Manufacturing	Groover. Mikell P.	Pearson Education, Canada, (2018), ISBN-978-93-325-4981-4
2	CAD/CAM/CIM	Radhakrishnan. P.	New Age International Publisher, New Delhi, (2008) ISBN-97-81-224-3980-9
3	Computer Aided Manufacturing	Rao. P. N.	McGrawhill Education, New Delhi, (2010) ISBN- 9780074631034
4	Principles of computer Integrated Manufacturing	Kant. S.	PHI Learning, New Delhi, (1995), ISBN-10: 812031476X
5	Cim: Principles of Computer- Integrated Manufacturing	Waldner. J. B.	John Wiley & Sons Inc. UK, (1992), ISBN- 9780471934509

14. SOFTWARE/LEARNING WEBSITES

a) http://nptel.ac.in/courses/112102103/17
b) http://nptel.ac.in/courses/112107077/module5/lecture2/lecture2.pdf
c) http://www.intelitek.com/pdf/DS01_BU_CIM-A_100761.pdf
d) https://nptel.ac.in/courses/112103174/module1/lec2/3.html
e) https://www.researchgate.net/publication/231832221_FMS_in_CIM_Flexible_Manufacturing_Systems_in_Computer_Integrated_Manufacturing
f) https://www.researchgate.net/post/What_are_the_differences_among_flexible_manufacturing_system_FMS_computer_integrated_manufacturing_CIM_and_totally_integrated_automation_TIA
g) http://www.me.nchu.edu.tw/lab/CIM/www/courses/Computer%20Integrated%20Manufacturing/Chapter2%20-CIM-introduction.pdf
h) https://brainmass.com/business/kaizen/cad-cae-cam-cim-fms-manufacturing-47731
i) http://www.alphace.ac.in/downloads/notes/me/10me61.pdf
j) http://www.me.nchu.edu.tw/lab/CIM/www/courses/Computer%20Integrated%20Manufacturing/Chapter2%20-CIM-introduction.pdf