GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2024 (COGC-2024)
Semester-V

Course Title: Computer Aided Manufacturing (CAM)
(Course Code: 4356504)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical Engineering (CAD/CAM)	5th

1. RATIONALE:

Computer Aided Manufacturing plays a critical role in modern manufacturing by streamlining processes, improving accuracy and quality, enabling complex designs, reducing waste, and enhancing flexibility and safety. As technology continues to evolve, Computer Aided Manufacturing is expected to become even more sophisticated and play an even greater role in the future of manufacturing.

2. COMPETENCY:

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

- Able to Select required operating parameters, appropriate tools, tool holders, accessories and consumables for manufacturing a given job on CNC.
- Able to manufacture simple jobs using CNC part programming.

3. COURSE OUTCOMES (COs):

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

CO1	Identify different axes, machine zero, home position, controls and features of CNC machines.
CO2	Select, mount and set cutting tools and tool holders on CNC.
CO3	Prepare part programmes using ISO format for given simple components with and without use of MACRO, CANNED CYCLE and SUBROUTINE using ISO format.
CO4	Interface application software for auto part programming.
CO5	Identify recent trends in industrial computer aided manufacturing trends.

4. TEACHING AND EXAMINATION SCHEME:

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	4	5	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment 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, **CA** - Continuous Assessment; **ESE** - End Semester Examination.

5. 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	Fundamentals of Computer Aided Manufacturing	6	4	6	0	10
II	Constructional Features of CNC machines	9	6	4	4	14
III	CNC Turning & Machining Centers.	6	2	6	2	10
IV	CNC part programming.	14	4	6	14	24
V	Recent trends in CAM.	7	4	8	0	12
	Total	**42**	**20**	**30**	**20**	**70**

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination (Bloom's revised taxonomy).

6. SUGGESTED PRACTICAL EXERCISES:

Sr. No.	Unit No.	Practical Exercises (Outcomes in Psychomotor Domain)	Related CO's	Approx. Hours required
1	II	**Demonstrate constructional features of CNC:** a. Demonstrate CNC machines and its operations. b. Identify major parts of CNC and draw sketch. c. Write specification of CNC taken for demonstration. d. Sketch important tool holders. e. Tabulate sensors / feedback devices with type, specification and purposes used on CNC taken for demonstration. f. Sketch display console. Also sketch symbols used on display console with meaning of each. g. State interfacing standards used.	CO1 & CO2	10
2	IV	**CNC turning part programming:** Teacher will assign part drawings. Minimum Six drawings having following details are to be assigned. This include parts- (i) Simple turning with steps, (ii) Turning with tapers, (iii) Turning with circular (concave / convex shape) interpolation, (iv) Turning using canned cycle - with threading or drilling or other and (v) Turning with use of subroutine or macro or do-loop. Students would: a. Sketch each part with dimensions. b. Prepare CNC part programme using G and M codes with ISO format. c. Show various zeros and tool path on part sketch with color codes and dimensions. d. Simulate the prepared part programmes using available simulation softwares. e. Prepare the parts on CNC.	CO3	14

3	IV	**CNC machining centre part programming:** Teacher will assign part drawings. Minimum four drawings having following details are to be assigned. This include parts- (i) Simple contour milling (ii) Contour milling with (convex / concave) circular interpolation and (iii) contour milling with drilling / tapping. Students would: a. Sketch each part with dimensions. b. Prepare CNC part programme using G and M codes with ISO format. c. Show various zeros and tool path on part sketch with color codes and dimensions. d. Simulate the prepared part programmes using available simulation softwares. e. Prepare the parts on CNC.	CO3	14
4	III	**Demonstration of CAD/CAM integration:** a. Demonstrate CAD / CAM integration. b. List interfacing standards. c. Use Fusion 360 Software for Simulation and Integration.	CO4	08
5	V	**Recent trends in computer aided manufacturing :** a. Flexible Manufacturing System b. Computer Integrated Manufacturing c. Robotics d. Rapid Prototyping e. Artificial Intelligence	CO5	10
		Total Hours		56

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr.No.	Equipment Name with Broad Specifications	Pr. No.
1	CNC Turning Centre (Tutor or Productive)- Minimum diameter 25 mm, Length 120 mm with ATC. (Approximate)	1,2
2	CNC Machining Centre (Tutor or Productive)- X axis travel - 225 mm, Y axis travel - 150 mm, Z axis travel - 115 mm, With ATC. (Approximate)	1,3
3	CNC physical simulator controller (hardware with provision to program as per ISO, heidenhain, Fanuc, Sinumeric, etc.) Simulation software likes: CNC Simulator Pro, Swansoft CNC, Fusion 360 etc.	1,2,3
4	3D Printer and latest version of CAD/CAM integration software like MASTER CAM, NX CAM. etc.	4

8. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member for Micro project.

b) Follow safety practices and procedure in Lab.

c) Realize the importance of engineering for societal development.

d) Develop gradually the engineering mindset in day-to-day observation

9. UNDERPINNING THEORY:

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit – I. **Fundamentals of CAM.**	1a. Differentiate between NC, CNC and DNC. 1b. Identify parameters governing for selection of CNC machines.	1.1 CAM - concept and definition. 1.2 NC (Numerical Control), CNC (Computerized Numerical Control) and DNC (Direct Numerical Control) - concept, features and differences. 1.3 Advantages and limitations of CNC. 1.4 Selection criteria for CNC machines.
Unit- II **Constructional features of CNC machines.**	2a. Classify CNC machines. 2b. Identify role of main elements of CNC machines. 2c. Identify CNC axes. 2d. Preset tool on CNC machines. 2e. Use qualified tools and tool holders on CNC machines.	2.1 CNC machines: Types, classification, working and constructional features. 2.2 Spindle drives and axes drives on CNC machines. 2.3 Machine structure-Requirements and reasons. 2.4 Elements of CNC machines - Types, sketch, working and importance of: i. Slide ways. ii. Re-circulating ball screw. iii. Feedback devices (transducers, encoders). iv. Automatic tool changer (ATC). v. Automatic pallet changer (APC). 2.5 CNC axes and motion nomenclature. 2.6 CNC tooling : i. Tool presetting concept and importance. ii. Qualified tools-definition need and advantages. iii. Tool holders- types and applications.
Unit – III **CNC Turning & Machining Centers.**	3a. List features of specified CNC turning and machining centre. 3b.Identify various work holding and tool holding devices.	3.1 CNC turning centres: i. Types. ii. Features. iii. Axes nomenclature. iv. Specification. v. Work holding devices - types, working and applications. vi. Tool holding and changing devices - types, working and applications. 3.2 CNC machining centres: i. Types.

		ii. Features. iii. Axes nomenclature. iv. Specification. v. Work holding devices-types, working and applications. vi. Tool holding and changing device types, working and applications.
Unit – IV **CNC part programming.**	4a. Interpret ISO format of CNC part programming with used codes. 4b. Prepare part programme by using applicable codes like G& M etc. 4c. Apply advanced CNC part programming features like canned cycle, do loop, subroutine etc., 4d. Describe Procedure for Setting various compensations on CNC. 4e. Prepare part programme Considering various compensations.	4.1 Definition and importance of various positions like machine zero, home position, work piece zero and programme zero. 4.2 CNC part programming: programming format and structure of part programme. 4.3 ISO G and M codes for turning and milling-meaning and applications of important codes. 4.4 Simple part programming for turning using ISO format having straight turning, taper turning (linear interpolation) and convex/concave turning (circular interpolation). 4.5 Simple part programming for milling using ISO format. 4.6 Importance, types, applications and format for: i. Canned cycles. ii. Macro. iii. Do loops. iv. Subroutine. 4.7 CNC turning and milling 4.8 Need and importance of various compensations: i. Tool length compensation. ii. Pitch error compensation. iii. Tool radius compensation. iv. Tool offset. 4.9 Simple part programming using various compensations.
Unit – V **Recent trends in CAM.**	5a. Select suitable standard for CAD/CAM interfacing. 5b. List source of variability for adaptive control. 5c. Interpret different FMS layouts. 5d. Correlate areas of CIM. 5e. Identify types and	5.1 Interfacing standards for CAD/CAM - Types and applications 5.2 Adaptive control- definition, meaning, block diagram, sources of variability and applications. 5.3 Flexible Manufacturing System (FMS) - concept, evaluation, main elements and their functions, layout and its importance, applications. 5.4 Computer Integrated

	elements of robots. 5f. Describe concept of Rapid prototyping. 6g. List application of AI in Manufacturing.	Manufacturing (CIM) - Concept, definition, areas covered, benefits. 5.5 Robotics- definition, terminology, classification and types, elements and applications. 5.6 Rapid prototyping - Concept and application 5.7 Role of Artificial Intelligence in Manufacturing 5.8 Concept of Industry 4.0

10. SUGGESTED STUDENT ACTIVITIES

SR.NO.	ACTIVITY
i.	Visit nearby industry having CNC machines. List and state important features of them.
ii.	Prepare specifications of various types of CNC machines with images and names of manufacturers.
iii.	Download images and videos of CNC machines and its parts. Prepare one VCD/DVD in a batch and submit to batch teacher.
iv.	Download free simulation softwares available on website and practice for part programming.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Sr. No.	Unit	Unit Name	Strategies
i.	I	Introduction.	Videos, Presentations, Demonstration.
ii.	II	Constructional Features of CNC machines	Videos, Presentations, Industrial Visits, Demonstration,
iii.	III	CNC Turning & Machining Centers.	Videos, Presentations, Industrial Visits, Demonstration,
iv.	IV	CNC part programming.	Simulation softwares, actual practice on CNC machines, Demonstration,
v.	V	Recent trends in CAM.	Videos, Presentations, Industrial Visits,

12. SUGGESTED PROJECT LIST

Only one micro-project is planned to be undertaken by a student that needs to be assigned at the beginning of the semester. The number of students in the group should be 3-5. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass at least COs with in integration of PrOs, UOs, and ADOs. The duration of the micro project should be about 4-5 (four to five) student engagement hours during the course. The students ought to submit a micro-project by the end of the semester to develop the industry-oriented Cos.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1. Collect leaflets of various CNC machine manufacturers and prepare detailed report on it.
2. Prepare CNC turning part program of any complex mechanical component.
3. Prepare CNC milling part program of any complex mechanical component.
4. Prepare CNC part program of any complex mechanical component using CAM software like Maste rcam etc.

5. Visit any CAM related industry and prepare report on it.
6. Prepare any mechanical component on 3D Printer.
7. Prepare working model of Flexible Manufacturing System.
8. Prepare working model of any robot used in industry.
9. Prepare detailed report on Artificial intelligence.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
i.	CNC Machines.	Pabla B.S., Adithan M.	New Age International, New Delhi, 2014 (reprint).
ii.	Computer Numerical Control-Turning and Machining centers.	Quesada Robert	Prentice Hall 2014.
iii.	CAD/CAM.	Sareen Kuldeep	S.Chand 2012.
iv.	Introduction to NC/CNC Machines.	Vishal S.	S.K.Kataria & Sons. 2012.
v.	Computer Aided Manufacturing.	Rao P N, Tiwari N K, Kundra T	Tata McGraw Hill 2014.
vi.	CAD/CAM: computer aided design and manufacturing.	Groover Mikell P, Zimmered W Emory	Prentice Hall 2011.

14. SOFTWARE/LEARNING WEBSITES

a. http://www.nptel.ac.in
b. http://www.youtube.com/watch?v=M3eX2PKM1RI
c. http://www.youtube.com/watch?v=EHQ4QIDqENI&list=PLBkqkLQO 2nAt5MNLo eUhvkFS9M0p8y_1
d. http://www.youtube.com/watch?v=hJFLcvtiNQI
e. http://www.youtube.com/watch?v=BIM1AyxfYkw.
f. http://www.swansoftcncsimulator.com
g. http://www.mtabindia.com

15. PO-COMPETENCY-CO MAPPING:

Semester V	Computer Aided Manufacturing (Course Code:4356504)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Course Outcomes CO1 Identify different axes, machine zero, home position, controls and features of CNC machines.	3	-	-	2	-	-	-
CO2 Select, mount and set cutting tools and tool holders on CNC	3	2	2	-	-	-	3
CO3	3	3	3	3	-	-	3

Prepare part programmes using ISO format for given simple components with and without use of MACRO, CANNED CYCLE and SUBROUTINE using ISO format							
CO4 Interface software application for auto part programming.	3	2	-	-	-	-	-
CO5 Identify recent industrial computer aided manufacturing trends.	3	-	-	2	-	-	-

Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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BOS RESOURCE PERSONS

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