GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Mechanical Engineering (CAD/CAM)

Subject Code: DI04065031

Course/Subject Name: Fundamentals of CNC Programming

w. e. f. Academic Year:	2025-2026
Semester:	4th
Category of the Course:	PCC

Prerequisite:	Students should possess basic knowledge of manufacturing processes, engineering drawing, and CAD before studying Computer Aided Manufacturing. They should be familiar with conventional machining operations such as turning, milling, and drilling, as well as the working principles of machine tools. A fundamental understanding of computer operations, coordinate geometry, and mathematical concepts like interpolation is essential. In addition, students should have prior exposure to material science and metrology to comprehend machining parameters, material behavior, and quality control. This foundational knowledge will enable them to effectively understand CNC programming, CAD/CAM integration covered in this course.
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.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
CO1	Understand the fundamentals of NC, CNC, and DNC systems.
CO2	Observe drives, tooling, and control systems of CNC machines.
CO3	Develop and Simulate CNC part programs for turning and machining center operations
CO4	Perform CNC machine set up and operations.

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE(E)	PA(M)	PA(I)	ESE(V)	
0	1	4	3	0	0	20	30	50

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**To study basics of Computer Aided Manufacturing.** • Definition of CAM, Evolution of CAM. • scope and role in modern manufacturing. • Concept of NC, CNC, DNC and their integration with CAM. Selection Criteria for CNC Machine. • Benefits, limitations and industrial applications of CAM.	04	6 %
2	**To study CNC Machine Tools and Drives.** • CNC Turning and Machining Centers: Features, Axes nomenclature, specification, drives, work holding devices and Tool holding devices. Automatic tool changer (ATC) • CNC controller architecture: MCU, feedback loops, interpolation systems, Sensors used in CNC machines (position, load, temperature). Types of Controller and comparison.	08	14%
3	**Demonstrate constructional features of CNC:** • Demonstrate CNC machines and their operations. • Identify major parts of CNC and draw sketches. • Write specifications of CNC taken for demonstration. • Sketch important tool holders. • Tabulate sensors / feedback devices with type, specification and purposes used on CNC taken for demonstration. • Sketch display console. Also sketch symbols used on display console with meaning of each. • State interfacing standards used. • Functions of keys on CNC Console	06	10 %
4	**CNC Part Programming Fundamentals-** • CNC Co ordinate System • Types of CNC programming Format • Basic G Code and Their Function • Basic M Code and Their Function • Cutting Parameter • Turning Part Programming Basics • Milling Part Programming Basics • Demonstration of Turning and Milling Program on CNC Simulator	04	06 %

5	**CNC Turning Part Programming – I(Basic Turning Programming)** Teacher will assign **minimum Four part drawings** covering the following: • Facing • Straight • Turning • Step turning • Taper turning • Circular interpolation (concave/convex profiles) **Students will:** 1. Sketch each component with dimensions. 2. Prepare CNC part programs using ISO-standard G and M codes. 3. Indicate work zero, tool offsets, and tool path on the sketch. 4. **Simulate each program using available CNC simulation software.** 5. **Load any one CNC Program and manufacture part on a CNC turning Centre.**	**6**	**10 %**
5	**CNC Turning Part Programming – II (Advanced Turning Programming)** Teacher will assign **minimum Four part drawings** covering: • Canned cycles for drilling, boring, grooving, or threading • Thread cutting using G32/G76 (or equivalent controller cycles) • Use of subroutine, macro statement, or loop for repeated features **Students will:** 1. Sketch each component with dimensions. 2. Prepare CNC part programs using ISO G and M codes including cycles/subroutines. 3. Mark work zero, tool offsets, and tool path on the sketch. 4. Simulate the programs using CNC simulation software. **5.** Load any one CNC Program and manufacture part on a CNC turning Centre.	**8**	**14 %**
6	**CNC Machining Centre Part Programming – I (Basic Milling)** Teacher will assign **minimum Four part drawings** covering: 1. Face milling and straight-line milling 2. Circular interpolation (convex/concave contours) 3. Use of tool length offsets and work coordinate offsets (G54/G55 etc.) **Students will:** 4. Draw each part with proper dimensions.	**6**	**10 %**

	5. Prepare CNC milling programs in ISO format with tool change commands. 6. Indicate work zero, tool path, and machining sequence. 7. Simulate each program using available CNC simulation software. **8.** Load any one CNC Program and manufacture part on a CNC Machining center.		
7	**CNC Machining Centre Part Programming – II (Advanced Milling)** Teacher will assign **minimum Four part drawings** covering: 1. Pocket milling (rectangular/circular) using canned cycles or multi-pass strategies 2. Contour milling with circular interpolation and fillet radii 3. Pattern drilling, peck drilling, and tapping cycles 4. Multi-tool machining and tool change sequencing **Students will:** 5. Sketch each component with dimensions. 6. Prepare ISO-format CNC programs including all required cycles. 7. Identify and mark work offsets, tool length offsets, and tool path. 8. Simulate each program using available CNC simulation software. **9.** Load any one CNC Program and manufacture part on a CNC Machining Center.	**8**	**14 %**
8	**Demonstration of CAD/CAM integration:** • Demonstrate CAD / CAM integration. • List interfacing standards. • Teacher will assign part drawings. Minimum four drawings (Two for Turning and Two for machining centre). • Student would : i. Generate CNC code for assigned drawing using any CAM software e.g. Autodesk Fusion 360 / SolidCAM (for SolidWorks) / MasterCAM / NX CAM / EdgeCAM / CATIA Manufacturing Module). ii. Insert the code in CNC machine and prepare the part.	**10**	**16 %**
	Total	**60**	**100 %**

References/Suggested Learning Resources:

(a) Books:

Sr. 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.

(b) Open source software and website:

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

List of Laboratory/Learning Resources 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)	2,3,4
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)	2,3,5
3	CNC physical simulator controller (hardware with provision to program as per ISO, heidenhain, Fanuc, Sinumeric, etc.)	4,5
4	Latest version of CAD/CAM integration software like Autodesk Fusion 360 / SolidCAM (for SolidWorks) / MasterCAM / NX CAM / EdgeCAM / CATIA Manufacturing Module. etc.	6,7

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 component using CAM software like Mastercam etc.
5. Visit any CAM related industry and prepare report on it.
6. Prepare typical specification of Controllers used in industries

Suggested Activities for Students:

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.

Any Other:

Other than the 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 perform following activities in groups and prepare reports of about 5 pages for each activity. They should also collect/record physical evidence for their (student's) portfolio which may be useful for their placement interviews.

- Massive open online courses (MOOCs) may be used to teach various topics/subtopics.
- Guide students on addressing issues on environment and sustainability using the knowledge of this course.
- Guide students for keeping the drawings in digital form and reduce use of paper.

* * * * * * *