



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Mechatronics Engineering

Subject Code : DI05020021

Subject Name : CNC Machines

w. e. f. Academic Year:	2026-27
Semester:	5th
Category of the Course:	PEC-03

Prerequisite:-	Basic concepts of metrology and measurements are needed to ensure accuracy and quality in machined parts. Also students should know the basics of electrical and electronics engineering, especially related to motors, sensors, and control systems used in CNC machines. Familiarity with computer fundamentals is necessary since CNC systems are computer-controlled. A basic understanding of programming logic is helpful for learning G-codes and M-codes used in CNC programming.
Rationale:	In the dynamic landscape of modern manufacturing, the utilization of advanced technologies is pivotal for success. With the evolution of information technology and the emergence of various manufacturing concepts emphasizing zero lead time and heightened quality standards, the rapid integration of computerized numerical control (CNC) machines has become imperative. Much like the increasing significance of mental acuity over physical prowess in human endeavours, CNC programming has gained paramount importance in conjunction with the selection and application of CNC tooling. This course is meticulously designed to equip students with the essential skills for CNC machine programming, tooling, and related aspects. It is noteworthy that CNC machines extend beyond conventional machine tools, permeating various facets of manufacturing processes and support activities. Given the expanding influence of CNC technology across diverse manufacturing domains, mechatronics engineers are presented with a unique opportunity to master these advanced techniques. The course aims to empower students to navigate the complexities of CNC technology, thereby preparing them to meet the challenges and opportunities presented by the contemporary manufacturing landscape.

2. Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	To learn about various axes, machine zero, home position, systems, and controls of CNC machines.	R/U
02	Choose, install, and configure cutting tools and tool holders on CNC machines	U



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03	Develop part programs using the ISO format for simple components, incorporating MACRO, CANNED CYCLE, and SUBROUTINE as needed.	R/A/ U
04	Utilize software applications for automated part programming	R /U / A
05	Implement maintenance procedures for CNC machines	R/U

3. Teaching and Examination Scheme: (*): PA (Progressive Assessment)

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA(M)	PA(I)	ESE (V)	
03	00	02	04	70	30	20	30	150

4. Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Fundamentals of process planning 1.1 Process planning 1.2 Structure of process plan 1.3 Factors influencing process plan 1.4 Sequence of operation of process plan	05	11%
2.	Introduction of CNC systems 2.1 CAM, NC, CNC and DNC 2.2 Selection criteria for CNC machines. 2.3 Adaptive Control	06	13%
3.	Constructional Features of CNC machines. 3.1 Classifications of CNC Machine 3.2 Modes of operation of CNC 3.3 Working of: Machine Structure, Slide ways, Spindle drive, Axis drive, Recirculating ball screw Feedback devices (transducers, encoders), Automatic tool changer (ATC), Automatic pallet changer (APC). 3.4 CNC axis and motion nomenclature 3.5 CNC tooling's – tool presetting, qualified tool, tool holders and inserts	11	25%



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4.	CNC Part Programming 4.1 Axes Identification in CNC turning and Machining centers 4.2 Machine zero, home position, work piece zero, programme zero. 4.3 CNC part programming: Programming format and Structure of part programme. 4.4 ISO G and M codes for turning and milling- meaning and applications of important codes. 4.5 Compensations: Tool length compensation, Pitch error compensation, Tool radius compensation. 4.6 Simple part programming for turning using ISO format having straight turning, taper turning (linear interpolation) and convex/concave turning (circular interpolation). 4.7 Simple part programming for milling using ISO format. 4.8 Importance, types, applications and format for: Canned cycles, Macro, Do loops, Subroutine, Mirror image. 4.9 CNC turning and milling part programming using canned cycles, Do loops and Subroutine. 4.10 CAD CAM integration: Concept Steps involved in CAD/CAM integration, CAM software.	18	40%
5.	Maintenance of CNC Machine 5.1 Types of machine tools maintenance 5.2 Systems and Sub systems of CNC machines 5.3 CNC Maintenance practice: Tools required, Daily checklist, Problems related to mechanical systems, Backlash, Causes and precautions of electronics system	05	11%
	Total	45	100%

5. Suggested Specification Table with Marks (Theory):

Sr.No	Unit Title	Teaching Hours	Distribution of Theory Marks (in %)						Total Marks
			R	U	A	N	E	C	
1.	Fundamentals of process planning	5	4	3	-	-	-	-	7



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2.	Introduction to CNC systems	6	4	6	-	-	-	-	10
3.	Constructional Features of CNC machines.	11	4	8	4	-	-	-	16
4.	CNC part programming.	18	12	8	10	-	-	-	30
5.	Maintenance of CNC Machine.	5	7	-	-	-	-	-	7
		45	31	25	14	-	-	-	70
			45%	35%	20%	-	-	-	100%

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

6. SUGGESTED PRACTICAL EXERCISES: -

The following practical outcomes (PrOs) are the sub-components of the COs. Some of the PrOs marked '*' are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. required
1.	Preparatory activity: Collect mechanical components manufactured on CNC machines and show difference compared to conventional machining	04*
2.	Identify operations on that components c. Prepare conventional process plan for at least two components.	02*
3.	Demonstrate constructional features and modes of operations of CNC.	02*
4.	Demonstrate and interpret CNC controllers features.	02*
5.	Demonstrate inserts, holders and tool management systems.	02*
6.	Develop and simulate CNC turning part program (at least five) and identify errors and manufacture on CNC turning machine.	10*
7.	Develop and simulate CNC milling part program (at least three) and identify errors and manufacture on CNC milling machine	06*



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8.	Prepare part program with CAD/ CAM software (like master cam, NX) and interface with CNC machine.	04*
	Total (Hours)	30

NOTES: -

I. More Practical Exercises can be designed and offered by the concerned course teacher to develop the industry-relevant skills/outcomes to match the COs. The above table is only a representative list.

II. It is compulsory to prepare log book/continuous records of exercises. It is also required to get each exercise recorded in log book/continuous records, checked and duly dated signed by teacher. CA component of practical marks is dependent on continuous and timely evaluation of exercises.

III. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.

a. Brief details of industry visited.

b. Type, location, products, rough layout, human resource, etc., of industry.

c. Details, description and broad specifications of machineries/processes observed.

d. Safety norms and precautions observed.

e. Student's own observation on industrial environment, productivity concepts, quality consciousness and quality standards, cost effectiveness, culture and attitude.

f. Any other details/ observations asked by accompanying faculty.

IV. For practical ESE part, students are to be assessed for competencies achieved. They should be assigned the necessary data and should be given any one experience to perform. The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above-listed Practical Exercises of this course required, which are embedded in the COs and, ultimately, the competency.

SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Sr. No.	Unit	Unit Name	Strategies
1	I	Fundamentals of Process Planning	Study of actual route sheets available, Industrial visits
2	II	Introduction to CNC systems	Videos, Presentations, Industrial Visits, expert Lectures
3	III	Constructional Features of CNC machines	Videos, Presentations, Industrial Visits, expert lectures



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4	IV	CNC Programming	Simulation software's
5	V	Maintenance in CNC machines	Demonstration

7. References/Suggested Learning Resources:

(a) Books:

Sr. No	Title of Book	Author	Publication
1.	CNC Machines	Pabla B.S., Adithan M	New Age International, New Delhi, 2014(reprint)
2.	CAD/CAM: computer-aided design and manufacturing	Groover Mikell P, Zimmered W Emory	Prentice Hall 2011
3.	Computer Aided Manufacturing	Rao P N, Tiwari N K, Kundra T	Tata McGraw Hill 2014
4.	CNC Fundamentals And Programming	P. M. Agrawal, Dr. V. J. Patel	Charotar Publication

(b) Open source software and website:

1. <https://academy.titansofcnc.com/>
2. <https://www.cnccookbook.com/online-cnc-training-courses-guides-help/>
3. <https://www.siemens.com/global/en/industries/machinebuilding/machine-tools/cnc4you/education-training.html>
4. <https://www.mastercam.com/news/blog/learn-how-to-use-cnc-software/>
5. <https://www.siemens.com/global/en/industries/machinebuilding/machine-tools/cnc4you/education-training/cnc-courses.html>
6. <https://www.autodesk.in/solutions/cnc-programming>
7. <https://archive.nptel.ac.in/courses/112/105/112105211/>
8. <https://nptel.ac.in/courses/112102103>
9. <https://www.youtube.com/watch?v=IPnr1cdaT1s&list=PLT1NMjA2P81Frwoo5PLbL9IbhjMEaO8kK&pp=iAQB>
10. <http://vlabs.iitkgp.ernet.in/vlabs/rtvlab1/cncbase%20software.html>
11. <https://fab-coep.vlabs.ac.in/exp/3d-machining/>



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8. MAJOR EQUIPMENT / INSTRUMENTS AND SOFTWARE REQUIRED

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	CNC turning Machine (Tutor or productive) Min Diameter: 30 mm, Min Length: 120mm, ATC facility	1,2,6
2.	CNC milling Machine (Tutor or productive) X axis travel:150mm Y axis travel: 150mm Z axis travel:100mm ATC facility	5,7
3.	CNC programming simulation software Latest version of any one from following software CNC simulator Pro Swan soft CNC	5,7,8
4.	Software for CAD/CAM integration. Latest version of any one from following software Mastercam, NX Solid Edge.	ALL PrO.

9. Suggested Project List & Student Activities:

Sr. No.	Activity.
1.	CNC part programming of any simple object with the use of CNC codes.
2.	Implement features such as MACRO, CANNED CYCLE, and SUBROUTINE using ISO format.
3.	Visit any Manufacturing industry and find out production parts and prepare detailed part and Assembly drawings.
4.	Visit the Automation industry and prepare specifications for CNC turning, CNC Milling, etc.
5.	Prepare Axis Designation model of CNC Turning, CNC Milling, etc.
