GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering
Level: Diploma
Branch: Automation and Robotics
Subject Code : DI04041071
Subject Name : CNC Machines and 3D Printing

w. e. f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	Professional Elective - II

Prerequisite:	Basic understanding of engineering drawing and machine components, including orthographic projection and section views. Familiarity with manufacturing processes such as turning, milling, drilling, and basic machining operations. Introductory knowledge of Computer-Aided Design (CAD) and exposure to 2D/3D modeling software. Fundamentals of mechanical measurements and tools (e.g., micrometers, vernier calipers) for dimensional analysis.
Rationale:	In modern manufacturing, Computer Numerical Control (CNC) and 3D Printing (Additive Manufacturing) technologies play a vital role in achieving precision, productivity, and rapid prototyping. This course introduces students to the fundamental principles, programming, operation, and application of CNC machines and 3D printers. By learning to prepare and simulate CNC part programs and operate FDM-based 3D printers, students gain essential hands-on skills required in today's automated manufacturing environments. The course bridges conventional and digital manufacturing, encouraging students to understand the transition from subtractive (CNC) to additive (3D printing) processes. This subject supports the development of skilled technicians capable of meeting the demands of Industry 4.0, smart manufacturing, and Make in India initiatives, fostering innovation, adaptability, and design-to-production thinking in diploma engineering students.

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Describe the basic components, working principles, and classification of CNC machines.
02	Interpret CNC programming codes (G & M codes) and write part programs for basic turning and milling operations.
03	Simulate and verify CNC programs using appropriate software and execute jobs on CNC machines.
04	Explain the fundamentals, process parameters, and applications of 3D printing technologies.

05	Prepare 3D printable models using slicing software and operate an FDM 3D printer to produce physical prototypes.

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)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to CNC Technology** 1.1 Need and importance of automation in manufacturing 1.2 Evolution and types of CNC machines 1.3 Comparison of NC, CNC, and DNC 1.4 Benefits and limitations of CNC	**04**	**10**
2.	**CNC Machine Construction & Working** 2.1 Main components: machine structure, drive motors, ball screws 2.2 Axes identification (X, Y, Z) and control panel layout 2.3 Open-loop and closed-loop control systems	**06**	**13**
3.	**CNC Part Programming – Turning & Milling** 3.1 Introduction to G and M codes 3.2 Absolute vs. incremental programming 3.3 Basic programming format for turning and milling 3.4 Tool nose radius compensation and canned cycles	**10**	**22**
4.	**Simulation & Operation of CNC Machines** 4.1 Simulation software overview and usage 4.2 Editing and verifying CNC programs 4.3 Setting tool offsets and work zero 4.4 Safety and operating procedures for CNC machines	**06**	**13**

5	**Basics of 3D Printing** 5.1 Introduction to additive manufacturing 5.2 FDM process: principle, materials, and parameters 5.3 Comparison with subtractive manufacturing 5.4 Advantages and limitations	**06**	**13**
6	**3D Modeling and Slicing Software** 6.1 Overview of slicing software (e.g., Cura, PrusaSlicer) 6.2 Importing 3D CAD files and setting parameters 6.3 Generating G-code for 3D printing 6.4 STL file format	**06**	**13**
7	**3D Printer Setup & Operation** 7.1 Introduction to Digital Twin, Industry 4.0, and Smart Manufacturing 7.2 Role of CAD/CAM in additive manufacturing 7.3 Automation and robotics integration with CAM systems 7.4 Basics of virtual prototyping and simulation	**07**	**16**
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	20	40	00	00	00

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

References/Suggested Learning Resources:

Sr. No	Title of Book	Author	Publication with place, year and ISBN
1	CNC Machines	B.S. Pabla & M. Adithan	New Age International Publishers
2	Introduction to CNC Machines	N.K. Mehta	Khanna Publishers
3	CNC Programming Principles and Applications	Mike Mattson	Delmar Cengage Learning

4	Rapid Prototyping: Principles and Applications	Chua Chee Kai & Leong Kah Fai	World Scientific Publishing
5	3D Printing and Additive Manufacturing: Principles and Applications	Rupinder Singh	Cambridge University Press / IK Intl.
6	Mastering CAD/CAM	Ibrahim Zeid	McGraw-Hill Education

Suggested Course Practical List:

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify and explain the components of CNC turning and milling machines.	Unit 1, 2	2 hrs
2	Interpret and write basic G and M code part programs for CNC turning operations (facing, straight turning).	Unit 3	4 hrs
3	Write and simulate a CNC milling part program (slot milling, contouring, drilling cycles).	Unit 3, 4	4 hrs
4	Verify CNC programs using simulation software and identify errors in toolpath or syntax.	Unit 4	2 hrs
5	Demonstrate safe machine setup and dry-run of a CNC program on CNC trainer (lathe or mill).	Unit 4	2 hrs
6	Explain FDM 3D printer components, working, and materials through hands-on exposure.	Unit 5, 7	2 hrs
7	Use slicing software (e.g., Cura) to prepare G-code for a simple 3D part model and adjust print settings.	Unit 6	4 hrs
8	Execute a 3D print of a prepared model, monitor printing, and analyze output quality.	Unit 7	4 hrs
9	Perform post-processing on a printed component (support removal, cleaning, basic finishing).	Unit 7	2 hrs
10	Mini Project: Create a component using CNC and/or 3D printing—from CAD modeling, toolpath generation to execution.	All Units	4 hrs
		Total	30 Hrs

List of Laboratory/Learning Resources Required:
These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	**CNC Machine Trainer Kits (at least one each):** • **CNC Lathe Trainer** • **CNC Milling Trainer**	1 to 9
2.	**3D Printers (FDM Type):** • **Minimum one FDM-based desktop 3D printer (e.g., Creality Ender, Prusa i3, etc.)** • **Essential accessories: nozzles, print bed sheets, scrapers, tweezers**	5 to 9
3.	**Computer Systems (Minimum 10 units):** • **Minimum specifications: i5 processor or higher, 8 GB RAM, graphics support** • **USB/SD card support for transferring G-code**	
4.	**Peripheral Devices:** • **UPS/inverter for printer protection** • **Projector or smart screen for demonstration**	
5.	**CNC Simulation Software:** • **NC Viewer, Sinutrain, Mach3/Mach4, or any industrial CNC simulator**	
6.	**3D Printing Software:** • **Ultimaker Cura (or PrusaSlicer, Repetier-Host)** • **Firmware for printer control (e.g., Marlin or proprietary software)**	
7.	**Consumables:** • **Filaments for 3D Printing: PLA, ABS, or PETG spools (1.75 mm diameter)** • **Cutting tools and raw material blocks for CNC practice (soft metals or plastics)**	

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