Skill India
कौशल भारत - कुशल भारत

Directorate General of Training

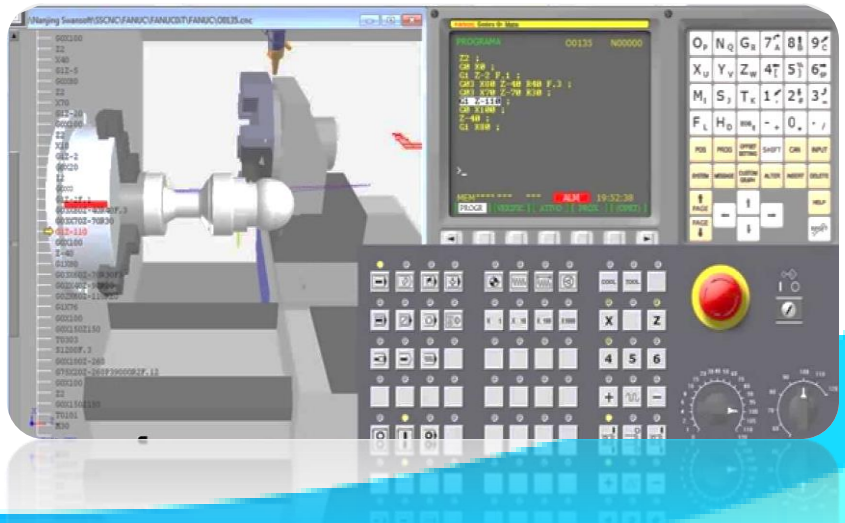
सत्यमेव जयते

GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
DIRECTORATE GENERAL OF TRAINING

COMPETENCY BASED CURRICULUM

CERTIFICATE COURSE ON

FUNDAMENTALS OF COMPUTER AIDED MANUFACTURING (CAM)



NSQF LEVEL- 3.5

FUNDAMENTALS OF COMPUTER AIDED MANUFACTURING (CAM)

Duration: 240 Hours

NSQF LEVEL- 3.5

(Version: 1.0)

Designed in 2024

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

&

CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE

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CONTENTS

1. COURSE INFORMATION

1.1 GENERAL

This course has been developed for CTS/CITS trainees to take up as optional courses during course of study for technical and behavioural upgradation of trainees to meet industry related job roles. During the 240 hours duration of Fundamentals of CAM course, a candidate is trained on professional skills & knowledge related to job role. The Broad components covered during the course are given below:

During the course, the trainee will gain a solid understanding of the principles and concepts, operation, and programming of CAM. They will learn different modules within Computer Aided Manufacturing tool including generating part program in CAM software modules like CNC Lathe programming, CNC Milling. Trainee will also be able to learn about emerging trends in Computer Aided Manufacturing.

1.2 COURSE STRUCTURE

Table below depicts the distribution of training hours across various course elements during a period of 6 weeks: -

S No.	Course Element	Notional Training Hours
1.	Professional Skill (Trade Practical)	180
2.	Professional Knowledge (Trade Theory)	60
	Total	**240**

1.3 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of course through assessment at the end of the course through skill testing at Training Center & CBT through examination conducted by DGT.

The minimum pass percentage for skill test is 60% and for theory will be 33% as in main CTS examination.

2. JOB ROLE

Brief description of Job roles:

CAM programming has diverse applications across various industries that rely on CNC machining for their manufacturing processes. The aerospace and aviation industry benefit from CAM programming for producing intricate components like turbine blades and engine parts. In the automotive sector, CAM programming is essential for manufacturing engine blocks, transmission components and molds for vehicle body panels. The medical industry utilizes CAM programming to create medical devices, implants, and surgical instruments with high precision. Mill 3D CAM Program & Die Machining, 3D Mill Mold cavity making industries rely on CAM programming to manufacture molds for plastic injection, die casting, and stamping operations. CAM programming is also employed in the electronics industry for precise routing and drilling of PCBs. Energy and power generation sectors utilize CAM programming to produce components for power plants and turbines. Tool and die manufacturing, furniture, and woodworking industries also benefit from CAM programming for their specific needs. It is therefore no doubt that CAM programming plays a vital role in various industries that require CNC machining to produce complex, precise and customized components.

The job role in CAM Technician involves leveraging cutting edge technology within manufacturing processes and able to generate precise tool path, simulating machining strategies and ensuring efficient utilization of resources. In addition, this role entails collaborating with cross-functional teams, including engineers and technicians, to translate design specifications into practical manufacturing strategies. With a strong grasp of CAM software and a passion for innovation, that will contribute to driving the success of manufacturing operation.

CNC Programmer; produce the component program using manual data input or by use of a remote computer, saving the prepared program on the machine controller from the computer. This involves understanding the CNC machine tools used in the process, their application and programming, editing and proving process, in adequate depth to provide a sound basis for carrying out the activities.

Computer Programmers, Other; are computer programmers who write, test and maintain computer programs to meet the needs of users of computer systems and all other Computer Programmers not elsewhere classified

Reference NCO-2015:

i 7223.6003 - CNC Programmer
ii 2514.9900 - Computer Programmers, Other

Mapped NOS:

I. CSC/N9589

3. GENERAL INFORMATION

Name of the Trade	**FUNDAMENTALS OF COMPUTER AIDED MANUFACTURING (CAM)**
Reference NCO - 2015	7223.6003, 2514.9900
NOS Covered	CSC/N9589
NSQF Level	Level 3.5
Duration of Craftsmen Training	240 Hours
Entry Qualification	10th Class passed and perusing/ passed out CTS Fitter, Turner, Machinist, Machinist Grinder, TDM /CITS Candidates of Fitter, Turner, Machinist, Machinist Grinder Trades
Unit Strength (No. of Student), Space & Power Norms	As per CAM Programmer trade under CTS
Instructors Qualification	B.Voc/ Degree/ Post Graduate Degree/ in Mechanical/ Mechatronics/ Industrial Engineering from AICTE/ UGC recognized Engineering College/university with one-year experience in the relevant field. OR 03 years Diploma in Mechanical/ Industrial Engineering/ Mechatronics from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. OR NTC/NAC passed in the trade of "Computer Aided Manufacturing (CAM) Programmer" trade with three years' experience in the relevant field.
List of Tools and Equipment	As per Annexure – I

4. LEARNING OUTCOME

Learning outcomes are a reflection of total competencies of a trainee and assessment will be carried out as per the assessment criteria.

4.1 LEARNING OUTCOMES

1. Demonstrate the geometric dimensions, tolerances, and symbols used in industrial manufacturing drawing and CAD models.
2. CNC Machine Operations & Basics of CNC Programming using G code and M code.
3. Explain machining processes, machine selection, machining parameters like speed, feed, depth of cut also able to calculate cycle time and productivity and cost-effective different types of machining.
4. Understand & practice different features of CAM software. Significance & importance of CAD in CAM software.
5. Identify cutting tool, CAM tooling library to create new, edit and modifying library data also create 2D sketches, 3D models and surface using point data and performing the variable depth and check draft angle for 3D Model by using CAM software for turning & Milling.
6. Demonstrate Importing of CAD models in CAM software and edit / modify and perform transformation of CAD model.
7. Execute set up work piece / component in the holding device and select tools and tool holders as per machining operation; also import, locate, and quickly re-use fixtures in CAM software.

5. SYLLABUS

SYLLABUS – FUNDAMENTALS OF COMPUTER AIDED MANUFACTURING (CAM)			
Duration: 240 Hours			
Duration Weeks	**Reference Learning outcome**	**Professional Skills (Trade Practical)**	**Professional Knowledge (Trade Theory)**
Practical 25 Hrs Theory 05 Hrs	Demonstrate the geometric dimensions, tolerances, and symbols used in industrial manufacturing drawing and CAD models.	1. Identify and make a list of drawings, such as assembly drawings, part drawings, and detail drawings. 2. Practice on dimensions, tolerances, symbols, and annotations present in the drawings and understand their meaning and significance. 3. Applying different dimensioning techniques, such as linear dimensions, angular dimensions, and geometric tolerances, based on the requirements of the drawing as per case study. 4. Perform tolerance analysis exercises to understand how tolerances are applied in manufacturing drawings. 5. Study the impact of different tolerance values on the fit, functionality, and manufacturability as per case study. 6. Create and interpreting section views in manufacturing drawings. Understand how to represent internal features, hidden details, and complex geometries through section views and how they aid in understanding the design and manufacturing requirements.	• Introduction to industrial detail drawing. • Drawing standards and conventions. • Geometric dimensioning and tolerances (GD & T) Symbols, abbreviations, line types, and drawing layout formats, such as ANSI, ISO, or ASME standards.

		7. Assign the dimensioning components based on given tolerances. Choose various geometric features, such as holes, shafts, or surfaces, and apply appropriate tolerances based on the functional requirements and manufacturing capabilities. 8. Perform tolerance stack-up analysis on assemblies or sub-assemblies. 9. Apply GD&T symbols on given industrial manufacturing drawing. 10. Identify and make a list of types fits in assembly.	
Practical 25 Hrs Theory 05 Hrs	CNC Machine Operations & Basics of CNC Programming using G code and M code.	11. Explaining Architect and components of CNC / VMC Machine using Machine Simulator 12. Explaining various controllers like Fanuc, Siemens, Mitsubishi, Mazak, Hass etc. using Simulators and their significance in building CAM Post Processor 13. Practice on basics of G & M codes and manufacturing process by creating virtual part of turning program 14. Creating virtual part of Milling program	• Introduction to CNC Machine Simulator • Components of CNC machines, including the various control units, tooling, and work holding devices. • Programming simple parts and troubleshooting common issues.
Practical 20 Hrs Theory 10 Hrs	Explain machining processes, machine selection, machining parameters like speed, feed, depth of cut also able to calculate cycle time and productivity and cost-effective	15. Define the machining process as per industrial case study. 16. Modify machining parameters, tool geometries, or machining strategies to enhance productivity, surface finish, or tool life. 17. Calculate cycle time of machining as per case study data.	• Introduction to turning and milling operations. Types of tooling. • Types of tool holder. • Impact of machining parameters like speed, feed, and depth of cut. • Impact on surface finish, and dimensional tolerances.

	different types of machining.	18. Calculate total time as per case study data. 19. Calculate the lead time as per case study data. 20. Calculate the productivity as per case study.	• Tools Cutting parameters, Tool geometry and tool wear. • Importance of work piece material on tool selection. Concept of cycle time, Tact time, Lead time. • Comparing cycle time vs Tact time vs lead time. • Case study and Importance of calculation in industry. Concept of productivity. • Industrial case study for machining shop. • Sequence of operations. • List out the turning machine operation. • List out the milling machine operation.
Practical 35 Hrs Theory 10 Hrs	Understand & practice different features of CAM software. Significance & importance of CAD in CAM software.	21. Use the function of CAM Menu bar (File, Edit, View, etc.) 22. Draw a layout and checklist of user interface. 23. Perform basic setting and toolbar orientation for CAM software. 24. Understanding CAD such as Part, assembly, drafting and motion analysis.	• List out the importance of machine parameters, tool offsets, work piece zero points, and coordinate systems Orientation of user interface (UI) of CAM software. • Understand Uses of Menu bar (File, Edit, View, etc.) Operation manger, toolpath manager, plan manager, Status bar, graphic window. • Make a list of CAM software benefits. • Industrial case study for CNC turning operation. • Industrial case study for milling machine operation. • Understanding basics of CAD
Practical 35 Hrs Theory 10 Hrs	Identify cutting tool, CAM tooling library to create new, edit and modifying library data also create 2D sketches, 3D models	25. Create a new tool and upload to library. 26. Edit cutting tool data and cutting parameter. 27. Modifying the existing library tool data.	• Operation in a tool library. • Concept about tool selection turning right hand tools, left hand tools. • Tool file import in a CAM.

	and surface using point data and performing the variable depth and check draft angle for 3D Model by using CAM software for turning & Milling.	28. Create tooling using Cutting Tool. 29. Open CAM software and start a new project or select an existing one. 30. Create 2D sketches of the part or feature to be machined. This can include basic geometrical shapes using lines, arcs, circles, rectangles, or more complex shapes. 31. Editing and modifying 2D sketch. 32. Revolving 2D Sketch, 33. Extruding the 2D sketch. 34. Create a 3D model in CAM Software. 35. Modifying 3D models by using the CAM software, 36. Check draft angle using CAM software tools. 37. Create the 3D surface using basic point data. 38. Perform machining on a curved surface through advance tooling in CAM software.	• Concept tooling assembly builder in cam software. • Orientation of cam software sketcher toolbar. • Plane selection and its importance. • 2D Sketch concept in cam software. • Orientation of 3D modelling toolbar CAM software. • Concept of draft angle inspection using cam software. • Creating a 3D surface using CAM, quality checks ensure the final 3D surface aligns with specifications. • Concept of engraving on a curved surface.
Practical 20 Hrs Theory 10 Hrs	Demonstrate Importing of CAD models in CAM software and edit / modify and perform transformation of CAD model.	39. Keep or save 3D model in specific folder. 40. List out the Supported file formats such as SAT, IGES, EPS, DWG, CADL, STL, ASCII etc. 41. Verify the file formats supported by CAM software for importing CAD model, 42. Create or open a new or existing project in CAM software. 43. Import CAD model: Choose the appropriate file format for CAD model and select the file to import. 44. Setting up model orientation: rotate,	• Concept of utilizing transformation tools such as translation, rotation, scaling, and mirroring, adjust dimensions, create symmetrical features, or optimize the overall design.

		translate, or scale the model as needed in cam software. 45. Model verification: Review the imported CAD model to ensure it matches the desired part. 46. Transform the geometry for individual objects, groups, or entire assemblies. 47. Translate and move the selected geometry along specified directions or distances. 48. Using rotation tool to rotate the selected geometry around specified axes or pivot points. This enables to change the orientation or alignment of the CAD model to suit the desired design or assembly requirements. 49. Use the scaling tool to resize the selected geometry uniformly or along specific axes. 50. Review the modified CAD model using the software's visualization tools.	
Practical 20 Hrs Theory 10 Hrs	Execute set up work piece / component in the holding device and select tools and tool holders as per machining operation; also import, locate, and quickly re-use fixtures in CAM software.	51. Identify and make a list of the appropriate holding device for the specific component want to set up. 52. Determine the optimal orientation and positioning of the work piece within the holding device. Consider factors such as access to machining features, tool clearance, and the desired final part orientation. 53. Align the work piece position within the holding device as per tooling	• Concept of holding devices, tool clearance and access to machining features. • Importance of workpiece and tool material properties, tool life calculations. • Tool selection criteria. Impact of cutting parameters, cost analysis. • Concept of Import, locate, and quickly re-use fixtures in CAM software. • Make a list of selection of tool according to material properties, such as

		direction and machine's coordinate system. 54. Identify and make a list of the machining operations needed, such as turning, milling, drilling. 55. Introduction of chip breaking facilities to increase tool life in CAM. 56. Import, locate, and quickly re-use fixtures in CAM software.	hardness, toughness, and heat resistance. • Calculate the tool life based on industrial case study.

6. ASSESSMENT CRITERIA

LEARNING OUTCOME	ASSESSMENTCRITERIA
1. Demonstrate the geometric dimensions, tolerances, and symbols used in industrial manufacturing drawing and CAD models.	Interpret the various symbols, dimensions, and annotations present in the drawing, list out the intended meaning and purpose.
	Demonstrate the geometric shapes, features, and relationships depicted in the drawing, such as lines, arcs, circles, angles, and their corresponding measurements.
	Analyze the impact of tolerances on the functionality and fit of the components or parts.
2. CNC Machine Operations & Basics of CNC Programming using G code and M code.	Interpret purpose and function of various G codes and M codes.
	Demonstrating the ability to identify and troubleshoot issues related to G codes and M codes, such as incorrect syntax, incompatible codes, or programming errors.
	Make a virtual part of Milling program.
3. Explain machining processes, machine selection, machining parameters like speed, feed, depth of cut also able to calculate cycle time and productivity and cost-effective different types of machining.	Select cutting tools and machine selection based on the machining operation, material.
	Define machining Parameter such as cutting speed, feed rate, depth of cut, and based on the machining operation, material.
	Calculating cycle time and productivity.
	Perform cost effective machining based on case study.
4. Understand & practice different features of CAM software. Significance & importance of CAD in CAM software.	Make a list of benefits of CAM software.
	Make a layout and checklist of CAM user interface.
	Demonstrate different features & Significance of CAM software
	Importance of CAD in CAM software
5. Identify cutting tool assembly builder, CAM tooling library to create new, edit and modifying library data also create 2D sketches, 3D models and surface using point data and perform engraving on a curved surface and check draft angle for 3D Model by using CAM software for turning.	Edit cutting tool data and cutting parameter.
	Modify the existing library tool data.
	Create 2D sketches using appropriate tools and techniques within the CAM software such as lines, arcs, splines etc.
	Create 3D Model using the CAM software's.
	Engraving on curved surface.
	Create and define various features such as holes, pockets, fillets, chamfers, and threads within the 3D models.
	Demonstrate the ability to accurately import and align the point data within the CAM software.

6. Demonstrate Importing of CAD models in CAM software and edit / modify and perform transformation of CAD model.	Import CAD models from various file formats commonly used in the industry.
	Make a transformation of cad model such as translation.
7. Execute set up work piece / component in the holding device and select tools and tool holders as per machining operation; also import, locate, and quickly re-use fixtures in CAM software.	Align the component accurately within the holding device, ensuring proper orientation and positioning.
	Select an appropriate holding fixture based on the component's shape, size, material, and machining requirements.
	Demonstrate and ensure adequate clearance between the component and the cutting tools or machine components to avoid collisions.

ANNEXURE-I

LIST OF TOOLS & EQUIPMENT			
FUNDAMENTALS OF COMPUTER AIDED MANUFACTURING (CAM)			
S No.	**Name of the Tools and Equipment**	**Specification**	**Quantity**
Same as CAM programmer Trade under CTS			
Additional Tools & Equipment required			
1.	Interactive Panel with OPS	Panel 75/86” with OPS I5/I7 CPU/16 GB RAM/500GB SDD/2GB Graphics Card	1

ANNEXURE-II

The DGT sincerely acknowledges contributions of the Industries, State Directorates, Trade Experts, Domain Experts and all others who contributed in designing/ revising the curriculum. Special acknowledgement is extended by DGT to the following expert members who had contributed immensely in this curriculum.

Trade committee meeting to finalize the syllabus of "CAM Assistance held on 16.04.2024 at CSTARI.			
Sl. No.	**Name and Designation (Shri/Smt./Kumari)**	**Organization with Address**	**Remarks**
1.	G C Saha, Jt. Director	CSTARI, Kolkata	Chairman
2.	Brindaban Das, Dy. Director	CSTARI, Kolkata	Member
3.	Joydeb Roy Chowdhury, Instructor	Govt. ITI, Tollygaunge	Member
4.	Binoy Krishna Biswas, Asst. Professor	B.P.P. Institute of Management & Technology, Kolkata – 700 052	Member
5.	Dilip Kumar Chattopadhyay, Ex-ADT	46 A/8, Shibpur Road, Howrah – 2	Member
6.	Rounak Bandopadhyay,	Zreyas Technology. New Town, Kolkata	Member
7.	Subrata Pully, Supervisor	Govt. ITI, Gariahat	Member
8.	Jayanta Koley	ITI Durgapur	Member
9.	Jaharlal Maity, Instructor (RAC)	Govt. ITI, Gariahat	Member
10.	Atanu Ghosh, Training Officer	NSTI, BBSR, Odisha	Member
11.	Anurag Chakraborti, Asst. Professor	Techno Engineering Collage, Banipur, Habra	Member
12.	Subhankar Bhattacharjee, Asst. Professor	Techno Engineering Collage, Banipur, Habra	Member
13.	Amaresh Naskar, Instructor	Govt. ITI, Tollygaunge	Member
14.	Md. Waseem Siddiqui	VECC/DAE I/AF Bidhannagar, Kolkata – 64	Member
15.	Atanu Bhuniya Instructor (RAC)	Govt. ITI, Howrah Homes, Santaragachi, Howrah	Member
16.	Prodip Mukhopadhyay, Former MD – Webel and Sr. Advisor - MAKAUT	Webel MAKAUT	Member
17.	B. Sharanappa, Asst. Director	CSTARI, Kolkata	Member
18.	Sk. Altaf Hossain, Asst. Director	CSTARI, Kolkata	Member
19.	Murari Barui, Asst. Director	CSTARI, Kolkata	Member
20.	Akhilesh Pandey, Asst. Director	CSTARI, Kolkata	Member

21.	Nirmalya Biswas, PA-to-Director	CSTARI, Kolkata	Member
22.	B. Biswas, Training Officer	CSTARI, Kolkata	Member
23.	P.K. Bairagi, Training Officer	CSTARI, Kolkata	Member
24.	B K Nigam, Training Officer	CSTARI, Kolkata	Member
25.	K.V.S. Narayana, Training Officer	CSTARI, Kolkata	Member
26.	Pradip Biswas, Jr. D/man	CSTARI, Kolkata	Member
27.	Hemant Kujur, Jr. D/man	CSTARI, Kolkata	Member
28.	Abhisek Mitra, HoD In-charge	Asansol institute of engineering and management polytechnic Kalipahari Asansol	Member
29.	Sunil Sitaram Chore, CMD, Simusoft Technologies, Pune	Simusoft Technologies B11-1204, Near IBM Infocity, Kumar Infenia, Phursungi, Pune 412308	Member
30.	Makarand Joshi, Product Manager	Grok Learning Pvt. Ltd. Plot No. 29, Amba Bhavan, 3rd Floor, 'A' Wing, Sion Circle (West), Mumbai	Member
31.	Kunal Sharad Bhagat, Development Engineer	Grok Learning Pvt Ltd 3rd Floor, A-wing, Amba Bhavan, Plot No 29, Next to Bharat Petrol Pump, Sion Circle (west), Mumbai 400022	Member
32.	Manohar Sadashiv Desai, Technical Head	SKILL BAHN LLP. UNIT NO. 912 / Plot-B, Lodha Supremus, Lodha Business District, Kolshet Rd, Thane, Maharashtra 400607	Member
33.	Mandar Bhate, Associate Manager	Tata Technologies Ltd Hinjewadi, Ph-1, Pune, Maharashtra	Member
34.	Ashish Kulkarni, Industrial Skill Consultant	Bhan skill Mumbai Thane Mumbai	Member