

## GUJARAT TECHNOLOGICAL UNIVERSITY

### COURSE TITLE: COMPUTER AIDED MANUFACTURING (CAM) (COURSE CODE: 3351805)

| Diploma Programme in which this course is offered | Semester in which offered |
|---|---------------------------|
| Marine Engineering                                | 5 <sup>th</sup>           |

#### 1. RATIONALE.

The use of conventional machines is decreasing day by day. Evolution of information technology, variety of manufacturing concepts with zero lead time demand and quality consciousness has supported fast adaption of Computer Aided Manufacturing. CNC machines (computerized numerical control machines) are the main component in Computer Aided Manufacturing Systems. Efficient use of CNC machines requires excellent knowledge of programming and use of CNC tooling. In this course an attempt has been made to focus exclusively on constructional features of CNC machines, their programming and tooling, so that students may learn to use the CNC machines efficiently for manufacturing desired products. CAM is normally not only limited to machine tools but in real life its use has widened in almost all areas of manufacturing, processes and support activities.

#### 2. COMPETENCIES:

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competencies.

- **Select required operating parameters, appropriate tools, tool holders, accessories and consumables for manufacturing a given job on CNC.**
- **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.

- i. Identify different axes, machine zero, home position, controls and features of CNC machines.
- ii. Select, mount and set cutting tools and tool holders on CNC.
- iii. Prepare part programmes using ISO format for given simple components with and without use of MACRO, CANNED CYCLE and SUBROUTINE using ISO format.
- iv. Interface software application for auto part programming.

#### 4. TEACHING AND EXAMINATION SCHEME.

| Teaching Scheme<br>(In Hours) |   |   | Total<br>Credits<br>(L+T+P) | Examination Scheme |    |                    |    | Total<br>Marks |
|-------------------------------|---|---|-----------------------------|--------------------|----|--------------------|----|----------------|
| L                             | T | P |                             | Theory Marks       |    | Practical<br>Marks |    |                |
| 2                             | 0 | 2 | 4                           | ESE                | PA | ESE                | PA | 150            |
|                               |   |   |                             | 70                 | 30 | 20                 | 30 |                |

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, ESE -End Semester Examination; PA - Progressive Assessment.

#### 5. COURSE DETAILS.

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

| Unit   | Major Learning Outcomes<br>(In Cognitive Domain)  | Topics and Sub-topics   |
|--|---|---|
| <b>Unit – III</b><br><br><b>CNC Turning &amp; Machining Centers.</b> | 3a. List features of specified CNC turning and machining centre.<br>3b. Identify various work holding and tool holding devices.   | 31 CNC turning centres: <ol style="list-style-type: none"> <li>i. Types.</li> <li>ii. Features.</li> <li>iii. Axes nomenclature.</li> <li>iv. Specification.</li> <li>v. Work holding devices -types, working and applications.</li> <li>vi. Tool holding and changing devices - types, working and applications.</li> </ol> 32 CNC machining centres: <ol style="list-style-type: none"> <li>i. Types.</li> <li>ii. Features.</li> <li>iii. Axes nomenclature.</li> <li>iv. Specification.</li> <li>v. Work holding devices-types, working and applications.</li> <li>vi. Tool holding and changing device types, working and applications.</li> </ol>   |
| <b>Unit – IV</b><br><br><b>CNC part programming.</b>                 | 4a. Interpret ISO format of CNC part programming with used codes.<br>4b. Prepare part programme by using applicable codes like G& M etc.<br>4c. Apply advanced CNC part programming features like canned cycle, do loop, subroutine etc.,<br>4d. Describe procedure for Setting various compensations on CNC.<br>4e. Prepare part programme considering | 41 Definition and importance of various positions like machine zero, home position, work piece zero and programme zero.<br>42 CNC part programming: programming format and structure of part programme.<br>43 ISO G and M codes for turning and milling-meaning and applications of important codes.<br>44 Simple part programming for turning using ISO format having straight turning, taper turning (linear interpolation) and convex/concave turning (circular interpolation).<br>45 Simple part programming for milling using ISO format.<br>46 Importance, types, applications and format for: <ol style="list-style-type: none"> <li>i. Canned cycles.</li> <li>ii. Macro.</li> <li>iii. Do loops.</li> <li>iv. Subroutine.</li> </ol> 47 CNC turning and milling part programming using canned cycles, Do loops and Subroutine. |

| Unit                                     | Major Learning Outcomes<br>(In Cognitive Domain)   | Topics and Sub-topics   |
|--|--|---|
|  | various compensations.   | 48 Need and importance of various compensations:<br>i. Tool length compensation.<br>ii. Pitch error compensation.<br>iii. Tool radius compensation.<br>iv. Tool offset.<br>49 Simple part programming using various compensations.  |
| Unit – V<br><b>Recent trends in CAM.</b> | 5a. Select suitable standard for CAD/CAM interfacing.<br>5b. List source of variability for adaptive control.<br>5c. Interpret different FMS layouts.<br>5d. Correlate areas of CIM.<br>5e. Identify types and elements of robots.<br>5f. Describe concept of Rapid prototyping. | 51 Interfacing standards for CAD/CAM - Types and applications<br>52 Adaptive control- definition, meaning, block diagram, sources of variability and applications.<br>53 Flexible Manufacturing System (FMS) - concept, evaluation, main elements and their functions, layout and its importance, applications.<br>54 Computer Integrated Manufacturing (CIM) - Concept, definition, areas covered, benefits.<br>55 Robotics- definition, terminology, classification and types, elements and applications.<br>56 Rapid prototyping - Concept and application |

#### 6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (THEORY).

| Unit No. | Unit Title                                   | Teaching Hours | Distribution of Theory Marks |           |           |             |
|----------|--|----------------|------------------------------|-----------|-----------|-------------|
|          |  |                | R Level                      | U Level   | A Level   | Total Marks |
| I        | Fundamentals of Computer Aided Manufacturing | 4              | 4                            | 6         | 0         | 10          |
| II       | Constructional Features of CNC machines      | 5              | 6                            | 4         | 4         | 14          |
| III      | CNC Turning & Machining Centers.             | 4              | 2                            | 6         | 2         | 10          |
| IV       | CNC part programming.                        | 10             | 4                            | 6         | 14        | 24          |
| V        | Recent trends in CAM.                        | 5              | 4                            | 8         | 0         | 12          |
|          | Total  | <b>28</b>      | <b>20</b>                    | <b>30</b> | <b>20</b> | <b>70</b>   |

Legends: R = Remember U= Understand; A= Apply and above levels (Bloom's revised taxonomy).

#### Notes:

- This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

- b. If mid-sem test is part of continuous evaluation, unit numbers I, II and III are to be considered.
- c. Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

## 7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (outcomes in psychomotor and affective domain) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

*Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of Course Outcomes related to affective domain. Thus over all development of Programme Outcomes (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

*Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.*

| Sr. No. | Unit No. | Practical Exercises<br>(outcomes in Psychomotor Domain)  | Approx. Hours. required |
|---------|----------|--|-------------------------|
| 1       | II       | <p><b>Demonstrate constructional features of CNC:</b></p> <ol style="list-style-type: none"> <li>a. Demonstrate CNC machines and its operations.</li> <li>b. Identify major parts of CNC and draw sketch.</li> <li>c. Write specification of CNC taken for demonstration.</li> <li>d. Sketch important tool holders.</li> <li>e. Tabulate sensors / feedback devices with type, specification and purposes used on CNC taken for demonstration.</li> <li>f. Sketch display console. Also sketch symbols used on display console with meaning of each.</li> <li>g. State interfacing standards used.</li> </ol>   | 06                      |
| 2       | IV       | <p><b>CNC turning part programming:</b></p> <p>Teacher will assign part drawings. Minimum five drawings having following details are to be assigned. This include parts-</p> <ol style="list-style-type: none"> <li>(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.</li> </ol> <p>Students would:</p> <ol style="list-style-type: none"> <li>a. Sketch each part with dimensions.</li> <li>b. Prepare CNC part programme using G and M codes with ISO format.</li> </ol> | 10                      |

| Sr. No.     | Unit No. | Practical Exercises<br>(outcomes in Psychomotor Domain)   | Approx. Hours required |
|-------------|----------|---|------------------------|
|             |          | c. Show various zeros and tool path on part sketch with color codes and dimensions.<br>d. Simulate the prepared part programmes using available simulation softwares.<br>e. Prepare the parts on CNC.   |                        |
| 3           | IV       | <b>CNC machining centre part programming:</b><br>Teacher will assign part drawings. Minimum three drawings having following details are to be assigned. This include parts-<br>(i) Simple contour milling (ii) Contour milling with (convex / concave) circular interpolation and (iii) contour milling with drilling / tapping. Students would:<br>a. Sketch each part with dimensions.<br>b. Prepare CNC part programme using G and M codes with ISO format.<br>c. Show various zeros and tool path on part sketch with color codes and dimensions.<br>d. Simulate the prepared part programmes using available simulation softwares.<br>e. Prepare the parts on CNC. | 08                     |
| 4           | III      | <b>Demonstration of CAD/CAM integration:</b><br>a. Demonstrate CAD / CAM integration.<br>b. List interfacing standards.   | 02                     |
| 5           | ALL      | <b>Industrial visit:</b><br>Visit nearby industry having CNC machines. List and state important features of them with detail specifications and name of manufacturers.  | 02                     |
| Total Hours |          |   | 28                     |

**Notes:**

- a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher. PA component of practical marks is dependent on continuous and timely evaluation and submission of exercises.
- b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
- c. Mini project and presentation topic/area has to be assigned to the group of specified students in the beginning of the term by batch teacher, if applicable.
- d. For practical ESE part, students are to be assessed for competencies achieved.

**8. SUGGESTED LIST OF 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.                            |

### 9. 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,                             |

### 10. SUGGESTED LEARNING RESOURCES.

#### A. List of Books:

| 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.                              |

#### B) List of Major Equipment/ Instruments with Broad Specifications:

| Sr. No. | Resource with brief specification.   |
|---------|--|
| i.      | CNC Turning Centre (Tutor or Productive)-<br>Minimum diameter 25 mm, Length 120 mm with ATC. (Approximate) |

|      |   |
|------|---|
| ii.  | CNC Machining Centre (Tutor or Productive)-<br>X axis travel - 225 mm, Y axis travel - 150 mm, Z axis travel - 115 mm, With ATC.<br>(Approximate) |
| iii. | Simulation software likes: CNC Simulator Pro, Swansoft CNC, etc.  |
| iv.  | Latest version of CAD/CAM integration software like MASTER CAM, NX CAM.<br>etc.   |

**C. List of Software/Learning Websites.**

- i. <http://www.nptel.ac.in>
- ii. <http://www.youtube.com/watch?v=M3eX2PKM1RI>
- iii. [http://www.youtube.com/watch?v=EHQ4QIDqENI&list=PLBkqkLQO2nAt5MNLoeUhvKFS9M0p8y\\_1](http://www.youtube.com/watch?v=EHQ4QIDqENI&list=PLBkqkLQO2nAt5MNLoeUhvKFS9M0p8y_1)
- iv. <http://www.youtube.com/watch?v=hJFLcvtiNQI>
- v. <http://www.youtube.com/watch?v=BIM1AyxfYkw>.
- vi. <http://www.mtabindia.com>
- vii. <http://www.swansoftcncsimulator.com>

**11. COURSE CURRICULUM DEVELOPMENT COMMITTEE,**

**Faculty Members from Polytechnics.**

- **Prof K.P. Patel**, H.O.D, Mechanical Department, B.S.Patel Polytechnic, Kherva.
- **Prof J.B.Patel**, Sr. Lecturer, Mechanical Department, R.C.Technical Institute, Ahmedabad
- **Prof R.A.Prajapati**, Sr. Lecturer, Mechanical Department, R.C.Technical Institute, Ahmedabad

### SUGGESTED QUESTION PAPER FORMAT

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

| Q.NO. | SUB Q.NO. | QUESTION  | MARKS DISTRIBUTION |   |   | UNIT |
|-------|-----------|---|--------------------|---|---|------|
|       |           |   | R                  | U | A |      |
| 1     |           | Answer ANY seven from following.  |                    |   |   | 14   |
|       | i.        |   | 2                  |   |   | I    |
|       | ii.       |   | 2                  |   |   | I    |
|       | iii.      |   | 2                  |   |   | I    |
|       | iv.       |   | 2                  |   |   | II   |
|       | v.        |   | 2                  |   |   | III  |
|       | vi.       |   | 2                  |   |   | IV   |
|       | vii.      |   | 2                  |   |   | IV   |
|       | viii.     |   | 2                  |   |   | IV   |
|       | ix.       |   | 2                  |   |   | V    |
|       | x.        |   | 2                  |   |   | V    |
| 2     | a.        |   |                    | 6 |   | I    |
|       |           | OR  |                    |   |   |      |
|       | a.        |   |                    | 6 |   | I    |
|       | b.        |   |                    | 4 |   | II   |
|       |           | OR  |                    |   |   |      |
|       | b.        |   |                    | 4 |   | II   |
|       | c.        |   |                    |   | 4 | II   |
|       |           | OR  |                    |   |   |      |
|       | c.        |   |                    |   | 4 | II   |
| 3     | a.        |   | 6                  |   |   | II   |
|       |           | OR  |                    |   |   |      |
|       | a.        |   | 6                  |   |   | II   |
|       | b.        |   |                    | 4 |   | V    |
|       |           | OR  |                    |   |   |      |
|       | b.        |   |                    | 4 |   | V    |
|       | c.        |   |                    | 4 |   | V    |
|       |           | OR  |                    |   |   |      |
|       | c.        |   |                    | 4 |   | V    |
| 4     | a.        | Given the simple part drawing of milling contour with circular interpolation, prepare the CNC part programme using G and M codes with ISO format. |                    |   | 7 | IV   |
|       |           | OR  |                    |   |   |      |
|       | a.        | Given the simple part drawing of milling contour with circular interpolation, prepare the CNC part programme using G and M codes with ISO format. |                    |   | 7 | IV   |
|       | b.        |   |                    | 4 |   | IV   |

|   |    |  |  |   |   |     |
|---|----|--|--|---|---|-----|
|   | c. |  |  | 3 |   | IV  |
| 5 | a. | Given the simple part drawing, prepare the CNC turning part programme using G and M codes with ISO format. Include circular interpolation. |  |   | 7 | IV  |
|   | b. |  |  | 4 |   | III |
|   | c. |  |  | 3 |   | III |