

Program Name : Diploma in Production Engineering / Production Technology
Program Code : PG / PT
Semester : Fourth
Course Title : Advanced Machining Processes
Course Code : 22448

1. RATIONALE

This course deals with advancements in the area of machining processes. This course will impart knowledge and skills necessary for working in modern manufacturing environment. The student will familiarize with working principles and operations performed on non-conventional machines, CNC Machines, SPM and surface finishing machines and also will be able to adopt different tooling and programming codes while working on various CNC machines.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Produce components using advanced machining processes.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

- Select relevant non-traditional machining process for given job.
- Use relevant CNC machine for manufacturing components.
- Develop CNC part programs.
- Select relevant tools and work holding devices.
- Produce quality job using relevant surface finishing processes.
- Use relevant SPM to produce components.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme				Credit (L+T+P)	Examination Scheme											
L	T	P	Theory						Practical							
			Paper Hrs.		ESE		PA		Total		ESE		PA		Total	
Max	Min	Max		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min		
3	-	4	7	3	70	28	30*	00	100	40	50#	20	50	20	100	40

(*): Under the theory PA, out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

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

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the



course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

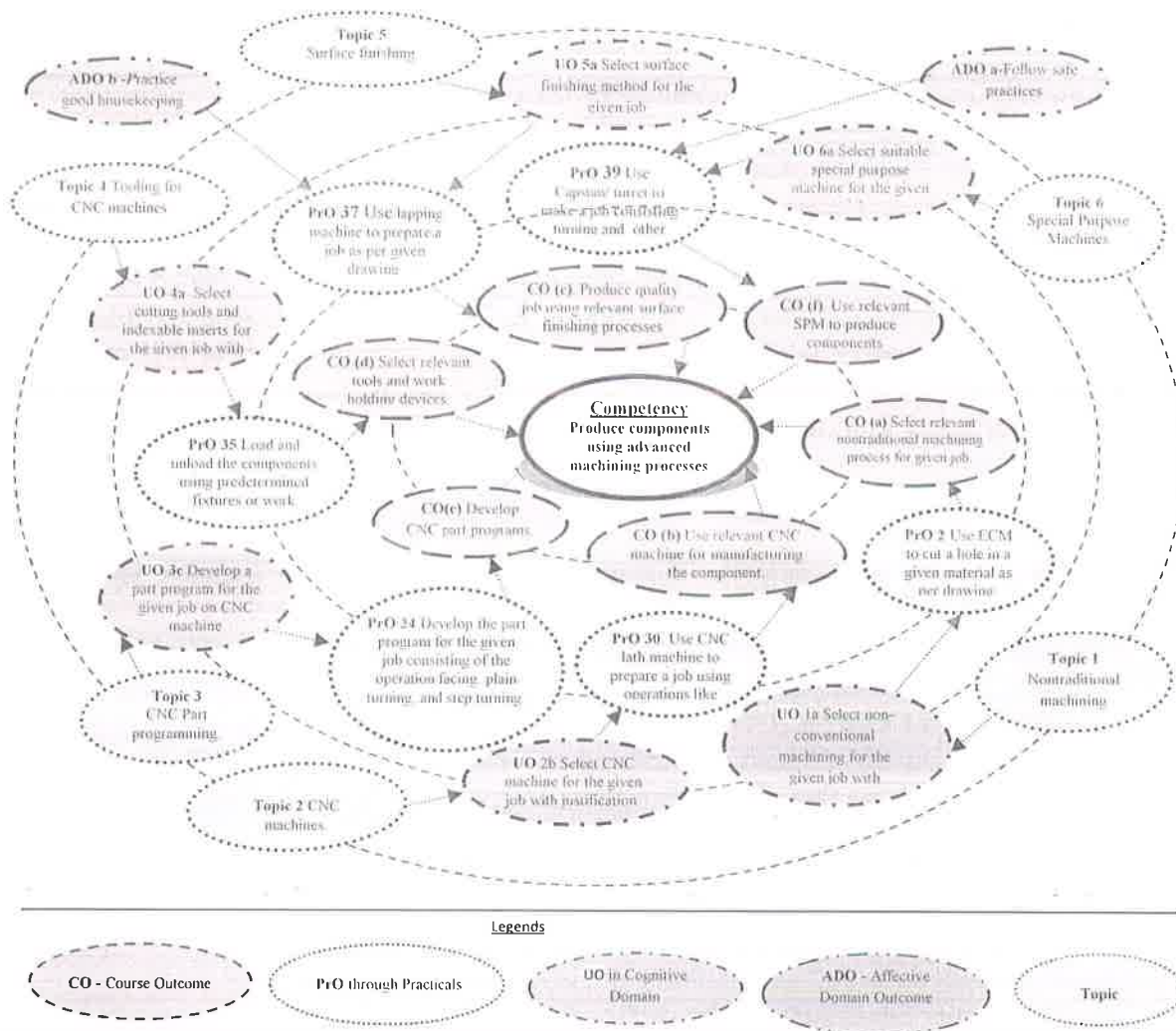


Figure 1 - Course Map

5. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S.No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Set the parameters on the ECM setup to make a job of cutting a slot/hole in a given material as per drawing.	I	02
2	Use ECM to cut a hole in a given material as per drawing.	I	02
3	Use ECM to cut a slot in a given material as per drawing.	I	02
4	Set the parameters on the AJM setup to make a job of cutting a slot/hole in a given material (composites, ceramics, and glass) as per drawing.	I	02
5	Use AJM to cut a hole in a given material (composites, ceramics, and glass) as per drawing	I	02

S.No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6	Use AJM to cut a slot in a given material (composites, ceramics, and glass) as per drawing	1	02
7	Set the parameters on the EDM setup to make a job of stepped cavities/die cavities in a given material as per drawing.	1	02
8	Use EDM to cut a cavity in a given job/die.	1	02
9	Use EDM to cut a profile in a given job/tool.	1	02
10	Set the parameters on the LBM setup to prepare a cutting / drilling job in a given material (metals, composites, plastics, and ceramics) as per drawing.	1	02
11	Use LBM to cut a simple profile in a given job of given material (metals, composites, plastics, and ceramics) as per drawing.	1	02
12	Use LBM to cut a complex profile in a given job of given material (metals, composites, plastics, and ceramics) as per drawing.	1	02
13	Prepare a cutting / drilling job in a given material using LBM (metals, composites, plastics, and ceramics) as per drawing.	1	02
14	Set tool offsets on CNC machine for the given job.	II, III, IV	02*
15	Set work offsets on CNC machine for the given job.	II, III, IV	02
16	Determine machine home position; program zero position and tool touch-off points for setting a CNC Lathe.	II, III, IV	02*
17	Determine machine home position; program zero position and tool touch-off points for setting a CNC Milling Machine.	II, III, IV	02*
18	Prepare the part program for the given job consists of the slot milling/ drilling operation.	II, III	02*
19	Upload the part program for the given job consists of the slot milling/ drilling operation.	II, III	02
20	Verify the program for the given job by block by block execution and dry run on CNC milling (for PrO no 18).	II, III	02*
21	Prepare the part program for the given job consists of the pocket milling operation.	II, III	02*
22	Upload the part program for the given job consists of the pocket milling operation	II, III	02*
23	Verify the program for the given job by block by block execution and dry run on CNC milling (for PrO no 21).	II, III	02
24	Prepare the part program for the given job consists of the operation facing, plain turning, and step turning.	II, III	02*
25	Upload the part program for the given job consists of the operation facing, plain turning, and step turning.	II, III	02*
26	Verify the program for the given job by block by block execution and dry run on CNC Lathe (for PrO no 24).	II, III	02
27	Prepare the part program for the given job consist of the operation taper turning, threading.	II, III	02*
28	Upload the part program for the given job consist of the operation taper turning, threading.	II, III	02*



S.No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
29	Verify the program for the given job by block by block execution and dry run on CNC Lathe (for PrO no 27)	II, III	02
30	Use CNC Lathe machine to prepare a job using operations like facing, plain turning, and step turning as per the given drawing.	II, III	02*
31	Use CNC Lathe machine to prepare a job having taper turning and threading operations as per the given drawing.	II, III	02*
32	Use CNC milling machine to prepare a job having slot milling/drilling operation as per the given drawing.	II, III	02*
33	Use CNC milling machine to prepare a job having pocket milling operation as per the given drawing.	II, III	02*
34	Preset a milling cutter on a CNC milling machine for a given job.	II, III, IV	02
35	Load and unload the components using predetermined fixtures or work holding devices on CNC Lathe and measure the critical parameters of machined component after trial run. Correct the offsets.	II, III, IV	02 *
36	Load and unload the components using predetermined fixtures or work holding devices on CNC Milling Machine and measure the critical parameters of machined component after trial run. Correct the offsets	II, III, IV	02*
37	Use lapping machine to prepare a job as per given drawing.	V	02
38	Use honing machine to prepare a job as per given drawing.	V	02
39	Use Turret/Capstan Lathe to make a job consist of facing, plain/step turning and drilling operations as per the given drawing.	VI	02
Total			78

Note

- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
a.	Preparation of Job Drawing, selection of material, tool and estimation of cutting parameters.	20
b.	Setup of machine, tool and Job	15
c.	Actual machining operation	20
d.	Inspection of Job using measuring instrument.	15
e.	Answer to questions on operations	10
f.	Submission of job and workshop diary in time.	10
g.	Safety precautions and good housekeeping	10
Total		100



The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field-based experiences:

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organising Level' in 2nd year.
- 'Characterising Level' in 3rd year.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Electro-Chemical Machine (ECM)	1,2,3
2	Abrasive Jet Machine (AJM)	4,5,6
3	Electric Discharge Machine (EDM)	7,8,9
4	Laser Beam Machine (LBM)	10 to13
5	CNC Lathe: Suggested specifications-X axis travel-150mm, Z-axis travel-200mm, chuck size-100mm, Max. turning diameter-30-40 mm, max. length-150-200mm, 8 stations turret, centralized lubrication or any suitable trainer	14 to 16, 24 to 31, 35
6	CNC Milling Machine: Suggested specifications -X axis travel -250 mm, Y axis travel -175 mm, Z-axis travel -200 mm, table size -500 x 200 mm, max. tool size-dia -12mm, length 70-80 mm ATC with 12 stations, centralized lubrication or any suitable trainer.	14,15, 17 to 23, 32 to 34, 36
7	Lapping Machine	37
8	Honing Machine	38
9	Capstan and turret lathe (Single spindle with bar feeding mechanism)	39

7. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Non Traditional Machining	1a. Select non-conventional machining for the given job with justification. 1b. Explain with sketch the working principle of given non-conventional machining processes. 1c. Identify non-conventional machining processes to be performed on the given job with justification.	1.1 Need, importance and classification of non-conventional machining. 1.2 Working principles, advantages, disadvantages and applications of Electro-Chemical Machining (ECM), Abrasive jet Machining (AJM), Electro discharge machining (EDM), Wire cut discharge machining (WEDM), Laser beam machining (LBM).
Unit-II CNC machines	2a. Explain with sketch the construction and working of the given CNC machine. 2b. Select CNC machine for the given job with justification. 2c. Identify the features of the control system for the given CNC machine. 2d. Identify coordinate system of the given CNC machine.	2.1 Introduction, Classification of CNC machines, axis standards and its identification. 2.2 Constructional features and working of CNC machines (Turning and machining centers), ball screw, servo-drive and swarf removal system. 2.3 Advantages and disadvantages of CNC, open loop and closed loop control systems. 2.4 Absolute and incremental coordinate system. 2.5 Point to point, continuous and contouring system.
Unit –III CNC Part Programmi ng	3a. Identify 'G' codes and 'M' codes for the given job with justification. 3b. Identify speed, feed, dimension and tool functions codes for the given job with justification. 3c. Develop a part program for the given job on the given CNC machine. 3d. Select the relevant codes for tool compensation with justification.	3.1 Introduction to part programming, G and M codes, programming formats, sequence numbers (N), codes to specify dimensions (X, Y Z etc.), codes to specify speeds (S-words) and feeds (f-words), codes to specify tool function (T-words), Miscellaneous functions, End of Block (EOB). 3.2 Part programming for CNC turning and machining center, tool length and radius compensation, Canned cycles, subroutine.
Unit –IV Tooling for CNC Machines	4a. Select cutting tools and indexable inserts for the given job with justification. 4b. Explain with sketch tool presetting procedure for the given job on the given CNC machine. 4c. Select tools and work holding devices for the given job with	4.1 Type of cutting tools and indexable inserts. 4.2 Tool presetting procedure, working of Automatic Tool Changing (ATC) device and types of tool magazine. 4.3 Standard work holding devices. 4.4 Safety precautions.



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	justification. 4d. Use safety procedure for specified machine.	
Unit –V Surface Finishing	5a. Select surface finishing method for the given job with justification. 5b. Select lapping parameters for the given job with justification. 5c. Explain with sketch the working principles of surface finishing for the given job. 5d. Explain surface finishing procedure for the given job.	5.1 Need of surface finishing, methods of surface finishing. 5.2 Working principles, merits, demerits and applications of lapping, honing, super finishing, polishing, buffing and burnishing.
Unit –VI Special Purpose Machines	6a. Select suitable special purpose machine for the given job with justification. 6b. Explain indexing mechanism used in the given machine. 6c. Explain bar feeding mechanism used in the given machine.	6.1 Need and importance of SPM, General elements of SPM. 6.2 Construction and working of capstan and turret lathe, turret head indexing mechanism, bar feeding mechanism on capstan lathe. 6.3 Comparison between Capstan and turret Lathes.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.



8. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Non Traditional Machining	10	04	06	04	14
II	CNC Machines	08	04	04	04	12
III	CNC Part Programming	10	02	04	06	12
IV	Tooling for CNC Machines	08	04	04	04	12
V	Surface Finishing	06	02	04	04	10
VI	Special Purpose Machines	06	02	04	04	10
Total		48	18	26	26	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

9. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and 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 conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare journals based on practical performed in workshop.
- Use CNC Lathe and CNC Milling Machines to produce a component.
- Library/Internet survey related to advanced machining processes and prepare a report.
- Visit to concerned industries.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- 'L' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the LOs/COs through classroom presentations (see implementation guideline for details).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- Use Flash/Animations to explain working of machines and its process.
- Guide student(s) in undertaking micro-projects
- Arrange a visit to nearby industries.

11. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so



that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

Suggestive lists of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

- Prepare a demonstration model for any machining process and write a report on the same.
- Visit nearby industry and prepare a report on types of nontraditional machines, nontraditional machining process used, its specifications and different types of job done on the machines.
- Surface Finishing: Prepare a presentation on any of the given surface finishing methods along with the video clips and write a report on the same.
- Demonstration Model for any special purpose machine: Prepare a presentation for any special purpose machine and write a report on the same.
- CNC Tooling: Prepare presentation on CNC tooling along with the video clips and write a report on the same.
- Prepare display boards for indexable inserts, CNC tools, CNC indicators, CNC controls etc.

12. SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1.	Elements of workshop Technology-Volume II	Hajra Choudhury S. K., Roy Nirjhar, Hajra Choudhury A. K	Media Publishers and Promoters, India, New Delhi, ISBN- 9788185099156
2.	Production Technology, Volume- II	Khanna O. P.	Dhanpat Rai Publications, New Delhi, 2012, ISBN- 9383182032
3.	Non-Conventional Machining	Mishra P.K.	Narosa Publishing House, New Delhi, ISBN- 8173191387
4.	CNC Machines	Pabla B.S. and Adithan, M.	New Age International Ltd, New Delhi, ISBN-81-224-0669-6
5.	Manufacturing Technology Vol-II	Rao P. N.	McGraw Hills, publication ltd, New Delhi, ISBN- 9781259081231
6.	CNC Machines	HMT, Bangalore	New Age International Ltd, New Delhi
7.	CNC Programming Made Easy	Jha Binit Kumar	S Chand Publishing, New Delhi , 2016, ISBN -10: 8125911804

13. SUGGESTED SOFTWARE/LEARNING WEBSITES

- www.the-mtc.org/...ologies/non-conventional-machining
- onlinecourses.nptel.ac.in/noc17_me17/announcements
- www.youtube.com/watch?v=RNPOjGFg9-8
- www.youtube.com/watch?v=9rIwyGOPb0o
- www.cnc-tool.com/
- [en.wikipedia.org/wiki/Super finishing](http://en.wikipedia.org/wiki/Super_finishing)
- Simulations of machining processes from you tube and educational websites



