**Program Name** : **Diploma in Mechanical Engineering / Diploma in Production Technology / Diploma in Production Engineering**

**Program Code** : **ME / PG / PT**

**Semester** : **Fifth for ME (Elective) and Sixth for PG/PT**

**Course Title** : **Tool Engineering (Elective for ME)**

**Course Code** : **22565**

## 1. RATIONALE

Tools are basic component required for any machining process. The quality and efficiency of any machining operation basically depends upon quality of tools which in turn depends upon the proper shape, size and material of the tools. Productivity and quality of machining operations may further be enhanced by proper and quick mounting of tools and jobs on machines using suitable Jigs and Fixtures. Therefore, this course attempts to develop abilities in students to select a tool of proper size and shape for required machining operation. The design of basic cutting tools, jigs and fixtures are also dealt with in this course.

## 2. COMPETENCY

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

- **Use different types of tools, dies, jigs and fixtures to machine simple components.**

## 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:

a. Interpret geometries of various cutting tools.
b. Use relevant cutting tool insert and tool holders for different machining operations.
c. Use relevant locating and clamping devices for components.
d. Use relevant Jig and Fixture for components and machining operations.
e. Use relevant Press tools and Press tools operations.
f. Use relevant Die for bending and forging simple components.

## 4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | | | | | | Practical | | | | |
| L | T | P | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| | | | | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| 3 | - | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25@ | 10 | 25 | 10 | 50 | 20 |

*(*): 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.

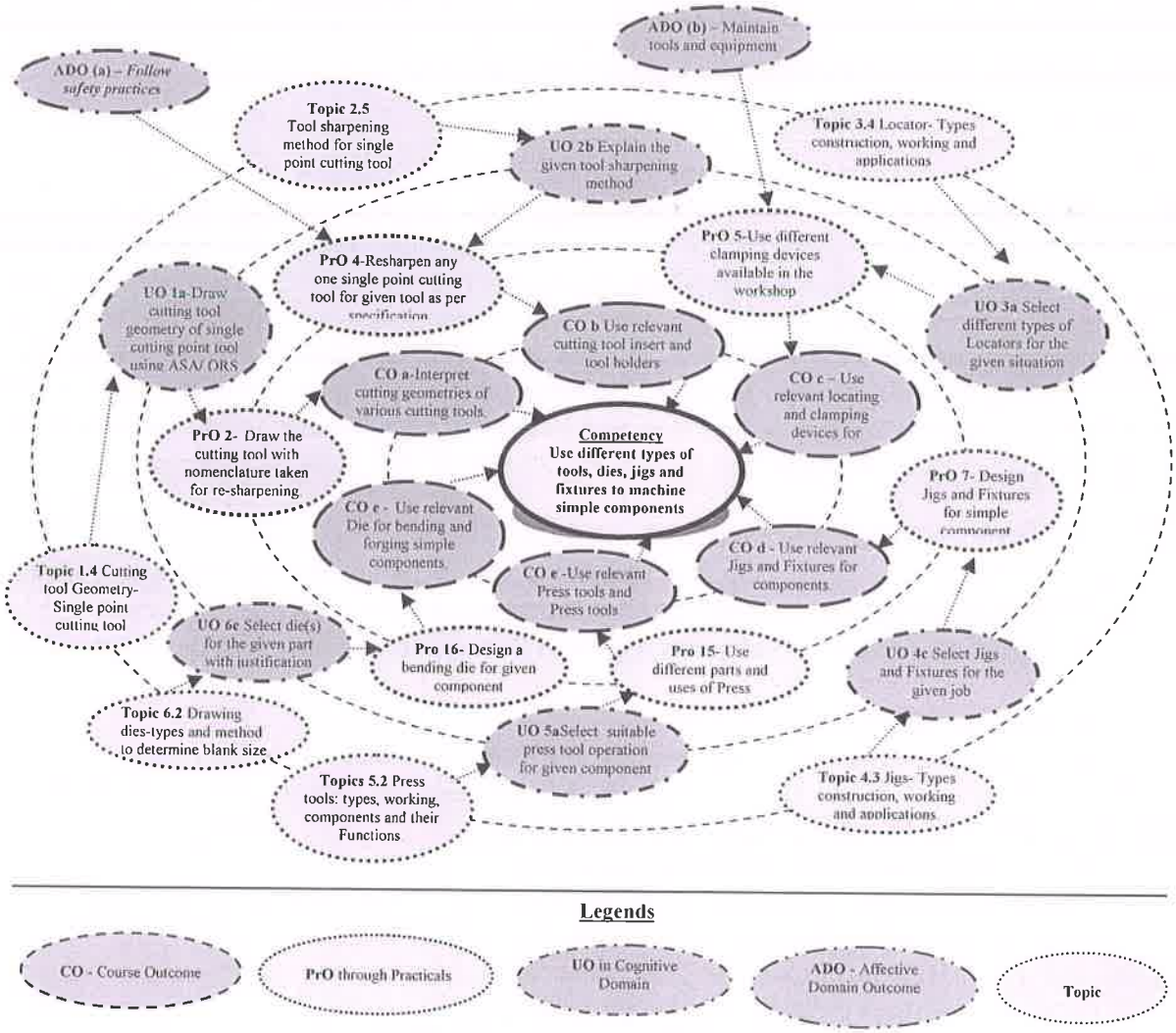


**Figure 1 - Course Map**

## 6. 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 | Identify the use of different types of tools, and their designation systems. | I | 02* |
| 2 | Draw the cutting tool with nomenclature taken for re-sharpening. | I | 02 |
| 3 | Use different tool holders and their use with specific applications. | II | 02* |
| 4 | Re-sharpen any one Single Point Cutting Tool as per given specification. | II | 02 |
| 5 | Use different clamping devices and their use available in the workshop. | III | 02 |
| 6 | Use different locators and their use available in the workshop | III | 02 |
| 7 | Design a Jig and Fixture for machining of a given simple component. (Part-I) | IV | 02* |

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|---|---|---|---|
| 8 | Design a Jig and Fixture for machining of a given simple component. (Part-II) | IV | 02* |
| 9 | Draw assembly and detail drawing of the designed Jig. | IV | 02* |
| 10 | Draw assembly and detail drawing of the designed Fixture. | IV | 02* |
| 11 | Design a progressive cutting die for a simple component. | V | 02 |
| 12 | Draw assembly and detail drawing of the designed progressive cutting die. (Part-I) | V | 02 |
| 13 | Draw assembly and detail drawing of the designed progressive cutting die. (Part-II) | V | 02 |
| 14 | Prepare Strip layout of simple component. | V | 02* |
| 15 | Use different parts and uses of Press. | V | 02* |
| 16 | Design a bending die for given component. | VI | 02* |
| 17 | Draw bending die indicating all parts and dimensions. | VI | 02 |
| 18 | Estimate blank size for Deep Drawing a simple component. | VI | 02 |
| | **Total** | | **36** |

***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 judicial mix of minimum 12 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 experimental set up | 20 |
| b. | Setting and operation | 20 |
| c. | Safety measures | 10 |
| d. | Observations and Recording | 10 |
| e. | Interpretation of Result and Conclusion | 20 |
| f. | Answer to sample questions | 10 |
| g. | Submission of report in time | 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. Practice energy conservation.
d. Demonstrate working as a leader/a team member.
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.

## 7. 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 | Single point cutting tool- 2 Qty | 1,4,5 |
| 2 | Drill – M12/M16/M20 size | 1 |
| 3 | Grinding Machine- Grinder Size 100 mm min. | 1,4,5 |
| 4 | Tool holders- Milling Cutter mandrill, Drill tool holder, Tool post of Lathe machine ( Qty one each) | 2 |
| 5 | Clamping devices for drilling machine, Milling machine, Chucks ( Qty one each) | 5 |
| 6 | Different Press tools | 13 |

## 8. 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 Basics of Tool Engineering** | 1a. Classify the given cutting Processes.<br>1b. Estimate cutting forces in the given simple numerical problem situation.<br>1c. Draw cutting tool geometry of single cutting point tool using given ASA or ORS system.<br>1d. State the shear angle required for the given job with justification | 1.1 Principles in tool engineering.<br>1.2 Mechanics of Metal cutting: requirements of tools.<br>1.3 Cutting forces – Merchant circle, types of chips, chip thickness ratio, shear angle. Shear angle- concept, need and method to give shear angle on punch and die.<br>1.4 Types of metal cutting process - orthogonal, cutting<br>1.5 Cutting tool Geometry- Single point cutting tool |
| **Unit– II Cutting Tool Material and Holding Devices** | 2a. List the different properties and composition of the given tool material(s).<br>2b. Interpret ISO designation of the given tool insert.<br>2c. Select tool holders and inserts for the given component and machining operation with justification.<br>2d. Explain the given tool sharpening method(s). | 2.1 Cutting tool materials - types, composition, properties and applications.<br>2.2 Carbide inserts -types, ISO -designation and Applications. Other inserts like CBN and PCBN.<br>2.3 Tool holders for turning, milling machines and CNC machines.<br>2.4 ISO designations of Tool holders.<br>2.5 Tool sharpening method for single point cutting tool. |
| **Unit-III Locating and Clamping devices** | 3a. Explain principle of location with reference to the given work piece.<br>3b. Calculate the Degrees of freedom in the given | 3.1 Concept, definition locating and clamping.<br>3.2 Use of locating and clamping principles on shop floor.<br>3.3 Degree of freedom concept and importance. |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| | situation.<br>3c. Select different types of Locators for the given situation with justification.<br>3d. Select different types of Clamping devices for the given situation with justification. | 3.4 Locator- Types construction, working and applications.<br>3.5 Clamping devices - Types construction, working and applications<br>3.6 Fool proofing and ejecting techniques. |
| **Unit –IV Jigs and Fixtures** | 4a. Differentiate between given type of jig and fixture.<br>4b. Select the relevant Jigs for the given component with justification.<br>4c. Select the relevant fixtures for the given component with justification<br>4d. Explain the design procedure for the given Jig and fixture. | 4.1 Concept, definition of jigs and fixtures. difference between jigs and fixtures.<br>4.2 Jigs- Types construction, working and applications.<br>4.3 Fixtures - Types construction, working and Applications.<br>4.4 Design considerations and procedure for Jigs and Fixtures. |
| **Unit-V Press Tool design** | 5a. Select suitable press tool operation for the given simple press tool component with justification.<br>5b. Calculate press tonnage and centre of pressure for the given press tool component.<br>5c. Prepare scrap strip layout for the given press tool component.<br>5d. Design progressive cutting die for the given simple press tool component. | 5.1 Press working processes-types, sketches and Applications.<br>5.2 Press tools: types, working, components and their Functions.<br>5.3 Concept, meaning, definitions and calculations of press tonnage and shut height of press tool. Shear action in die cutting operation.<br>5.4 Centre of pressure: Concept, meaning, definition, Methods of finding and importance.<br>5.5 Die clearance: Concept, meaning, definition, Reasons, effects and methods of application.<br>5.6 Cutting force: Methods to calculate and methods of reducing.<br>5.7 Scrap strip layout: - Concept, importance, method to prepare, and determining percentage stock utilization.<br>5.8 Types, working, and applications of stock stop, pilots, strippers and knockouts.<br>5.9 Cutting dies-types and applications.<br>5.10 Design of progressive cutting die:<br>a) Sketch the component.<br>b) Prepare scrap strip layout.<br>c) Calculate tonnage.<br>d) Determine centre of pressure.<br>e) Determine dimensions of punches, die block and die shoe.<br>f) Prepare sketch of stripper plate.<br>g) General assembly sketch of punches arrangement, die block, die shoe and |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| | | stripper plate. |
| **Unit-VI Bending, Drawing and Forging Dies** | 6a. Calculate bend radius, bend allowance and spring back for the given simple part.<br>6b. Draw labeled sketch of the given die(s).<br>6c. Select die(s) for the given part with justification. | 6.1 Bending dies -<br>a) Types and Parts and functions of bending die.<br>b) Definition, calculations and factors affecting bend radii, bend allowance and spring back.<br>c) Method to compute bending pressure.: Types, sketch, working and applications of bending dies.<br>6.2 Drawing dies-types and method to determine blank size for drawing operation, Types, sketch, working and applications of drawing dies (embossing, curling, bulging, coining, swaging and hole flanging).<br>6.3 Forging dies- terminology, types, sketch, working and application |

***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'*

## 9. 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 | Basics of Tool Engineering | 06 | 02 | 02 | 04 | 08 |
| II | Cutting Tool Material and holding devices | 06 | 02 | 02 | 04 | 08 |
| III | Locating and Clamping devices | 06 | 02 | 04 | 04 | 10 |
| IV | Jigs and Fixtures | 08 | 02 | 04 | 06 | 12 |
| V | Press Tool design | 12 | 04 | 06 | 10 | 20 |
| VI | Bending, Drawing and Forging Dies | 10 | 02 | 04 | 06 | 12 |
| **Total** | | **48** | **14** | **22** | **34** | **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.*

## 10. 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.

a. Visit any industry and collect information related to tool engineering practices.

b. Prepare journal based on practical performed in Tool Engineering laboratory. Journal consists of drawing, observations, required materials, tools, equipments, date of performance with teacher signature.
c. Prepare/Download specifications of followings:
   i. Tools and equipment in Tool engineering laboratory.
   ii. Machineries in Tool Engineering laboratory
d. Undertake a market survey of local dealers for tools, equipments; machineries and raw material and prepare a report.
e. Visit to any press tool industry and prepare a report consisting of
   i. Types of press
   ii. Types of dies
   iii. Types of operations
   iv. Types of fool proofing arrangement
   v. Safety precautions observed.

## 11. 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:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'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.
c. 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 COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.
i. Guide student(s) in undertaking micro-projects.
j. Arrange visit to nearby industries for understanding various tool engineering operations
k. Show video/animation films to explain tool design processes.
l. Use different instructional strategies in classroom teaching.
m. In respect of item no.10 above the teachers need to ensure to create opportunities and support sustem for such co-curricular activities.

## 12. 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-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up thc 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.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Preparation of Wax/Rubber model of various dies/single point cutting tools.
b. Collect various Carbide inserts as per ISO specification.
c. Measure press capacity of any press available in industry or nearby industry.
d. Design simple Clamming devices/Jigs/Fixtures/locating for simple jobs.
e. Collect specifications of different Jigs and fixtures.
f. Sketch different jigs /fixtures/clamping devices available in institute workshop.
g. Identify and restrict degree of freedom of a given component for designing a clamping/locating device for a given machining operation.

## 13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication |
|---|---|---|---|
| 1 | Fundamentals of Electrical Networks | Gupta, B.R, and Singhal Vandana | S.Chand and Co., New Delhi, 2005 ISBN: 978-81-219-2318-7 |
| 2 | Tool Design | Donaldson Cyrll | Mcgraw Hill Education, 2000 ISBN: 9780070153929, 0070153922 |
| 3 | Tool Engineering, Jigs and Fixture | Atkins Albert | McGraw-Hill, 1922 ISBN/ASIN: 1151454966 |
| 4 | Fundamentals of Tool Engineering Design | Basu S. K. | Oxford Ibh, 1979 ISBN 812040016X, 9788120400160 |
| 5 | Tool Engineering and Design | Nagpal G. H. | Khanna Publication, 2003 ISBN : 817409203X |
| 6 | Machine tool and Tool Design | Sharma P. C. | S.Chand Publishing, 2012 SBN: 9788121923620, |

## 14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=Mn9jpqI8rao
b. https://www.youtube.com/watch?v=bUrp8JMRwx4andvl=en
c. https://www.youtube.com/watch?v=qaG_vxsfLUg
d. https://www.youtube.com/watch?v=EgTzD_8dUFc
e. https://www.youtube.com/watch?v=CrWxJ58la1E
f. https://www.youtube.com/watch?v=Pb20Rkx25yA
g. https://www.youtube.com/watch?v=Hp7UC5ite5M
h. https://www.youtube.com/watch?v=lcrK2Po8fJI
i. https://www.youtube.com/watch?v=_E1GCE2dDcY
j. https://www.youtube.com/watch?v=7yzvno4AvKw
k. https://www.youtube.com/watch?v=yoUxqeAN0So
l. https://www.youtube.com/watch?v=_r7djWX8X34
m. https://www.youtube.com/watch?v=Us7kjBmRL-Q
n. https://www.youtube.com/watch?v=S9qzJat3Mzk
o. https://www.youtube.com/watch?v=I71YrXafg0o
p. https://www.youtube.com/watch?v=wulJZzORm3wandpbjreload=10
q. https://www.youtube.com/watch?v=i5ZGSMXw5nU
r. https://www.youtube.com/watch?v=WJ_VlWd0EsA
s. https://www.youtube.com/watch?v=93-VH01ACB4
t. https://www.youtube.com/watch?v=MtNTFvP0uAI
u. https://www.youtube.com/watch?v=eqKa2gv9Kx0
v. https://www.youtube.com/watch?v=m8EoGASM0SI
w. https://www.youtube.com/watch?v=til4UOBTRg0