SEMESTER – IV

MACHINING SCIENCE AND JIGS & FIXTURES (IPCC)			
Course Code	21ME42	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

* ***Additional one hour may be considered as per requirement***

Course objectives:

- To know the various subtractive machining processes in industries.
- To calculate the values of various forces involved in the machining operations.
- To understand and determine tool wear and tool life of different machining processes.
- To know various non-conventional machining and hybrid machining processes.
- To know the design of jigs and fixtures for various industrial/ machining members.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

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- Adopt different teaching methods to develop the outcomes through presentations/ video demonstrations/simulations.
- Chalk and talk method for problem-solving.
- Arrange industrial visits to show the live working models other than laboratorytopics.
- Adopt collaborative learning in theclass.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzinginformation.
- Conduct laboratory demonstrations and practical experiments toenhance experiential skills.

MODULE-1 **8 HOURS**

Introduction to Machining Processes and Machine Tools: Subtractive manufacturing processes and classifications.
Construction, specification operations of machine tools:– Lathe, Shaping, Milling, Drilling, Grinding Machine.
Introduction to CNC machines: CNC Lathe, Milling, Drilling, Machine Center.

Teaching-Learning Process	1. Presentation, 2. Video/ Simulations demonstration, 3. Chalk and Talk are used for Problem Solving(In-general), 4. Laboratory Demonstrations and PracticalExperiments on turning, milling operations

MODULE-2 **8 HOURS**

Mechanics of Metal Cutting:
Single point turning tool geometry (SPTT) influences the chip formation mechanisms of the Orthogonal and Oblique cutting process.
Cutting Force Analysis (Orthogonal Cutting): Analysis of machining forces and power requirement, 'Merchant's model of Orthogonal Cutting and Theory of Lee & Shaffer' Chip Velocity, Velocity relationships (simple numerical); the influence of cutting temperature on machinability.
CuttingFluids: Characteristics of Cutting fluids, Selections, and applying methods of cutting fluids.

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Teaching-Learning Process	1. Power-pointPresentation, 2. Video demonstration orSimulations, 3. Chalk and Talk are used for Problem Solving(In-general).

MODULE-3 **8 HOURS**

Machinability and Tool Life

Process of cutting tool failure wears and time relationship, tool wear index, feed marks, the effect of tool wear on the machined surface, surface finish, machinability, machinability index/rating, tool life & variables affecting tool life, tool materials.

Finishing Process: Importance of surface finishing processes, Grinding, Abrasive Flow Machining, Honing. Sanding, Abrasive blasting, Polishing, Lapping.

Surface Finishing and Protection: Powder Coating, Liquid Coating, Electroplating, Galvanizing, Anodizing.

Teaching-Learning Process	1. Power-pointPresentation, 2. Video/ Simulations demonstration, 3. Chalk and Talk are used for Problem Solving(In-general).

MODULE-4 **8 HOURS**

Advanced Machining Process;

Importance and classification of advanced machining process;

Process principal, process parameters, and application of: - Abrasive Jet Machining (AJW), Water Jet Machining (WJM), Abrasive Water Jet Machining (AWJM); Ultrasonic Machining (USM);Electrical Discharge Machining (EDM); Wire Electrical Discharge Machining (WEDM); Electro Chemical Machining (ECM). Laser Beam Machining (LBM), Electron Beam Machining (EBM), and Plasma Arc Machining (PAM).

Hybrid Machining Process: Importance of hybrid machining process;

Process principal, process parameters, and application of: - Electrochemical Discharge Machining (ECDM), Ultrasonic Assisted Electric Discharge Machining (UAEDM), Electrochemical Discharge Grinding (EDG), Powder Assisted Electric Discharge Machining (PAEDM).

Teaching-Learning Process	1. Power-pointPresentation, 2. Video/ Simulations demonstration, 3. Chalk and Talk are used for Problem Solving(In-general).

MODULE 5 **8 HOURS**

Jigs and Fixtures:

Importance of jigs and fixtures; the difference between jigs and fixtures; types of jigs and fixtures; essential features of jigs and fixtures, Materials used.

Factors to be considered for the design of Jigs and Fixtures;

Jigs: Template, Plate, Channel, Diameter, Leaf, Rung, Box,

Fixtures: Turning, Milling, Broaching, Grinding, Boring, Indexing, Tapping, Duplex, Welding, and Assembly fixtures.

Teaching-Learning Process	1. Power-pointPresentation, 2. Video/ Simulations demonstration, 3. Chalk and Talk are used for Problem Solving(In-general).

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	One Job on Lathe machine with simple operations (turning, facing, Thread cutting and tapering) on low carbon steel and/or heat-treated low carbon steel, and Demonstration of tungsten carbide cutting tool inserts.

2	Operations and One Job each on shaping/milling machine
3	Simple operations and One Job on the drilling and grinding machine.
4	Demonstration/Experimentation of simple programming of CNC machine operations.
5	To study the tool geometry of a single point turning tool (SPTT) in the American Standards Association (ASA) system.
6	Cutting force measurement with dynamometers (Demonstration) for turning, drilling, grinding operations.
7	Application of cutting fluids in turning operations and case study on optimizing process parameters onturning operation.
8	Analysis of chip formation and chip reduction coefficient in turning of mild steel by HSS tool with different depth of cut, speed, and feed rate.
9	Experiment on tool wears and tool life on anyone conventional machining process.
10	Experiment on anyone advanced machining process
11	Design of Jigs and Fixture for any one application using any software tool.
12	Experiment using Drill/template Jig and Demonstration on turning and grinding fixtures.
13	Experiment using milling Indexing fixtures.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Demonstrate the Conventional CNC machines and advanced manufacturing process operations
- Determine tool life, cutting force, and economy of the machining process.
- Analyze the influence of various parameters on machine tools' performance.
- Select the appropriate machine tools and process, the Jigs, and fixtures for various applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.

- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Textbook:

1. Shaw, M C, (2014), Metal Cutting Principles, Oxford University Press.
2. McGeough, J A, (1988), Advanced Methods of Machining, Springer.
3. Boothroyd, G., and Knight, W. A., Fundamentals of Machining and Machine Tools, CRC Press.
4. Chattopadhyay, A B, (2013), Machining and Machine Tools, Wiley India.
5. Mikell P. Groover, (2019), Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley Publications.
6. Rao P. N., Manufacturing Technology II, Tata McGraw Hill.

Web links and Video Lectures (e-Resources):

1. V. K. Jain, Advanced Machining Processes, NPTEL Course Department of Mechanical Engineering, IIT Kanpur, Link: http://nptel.ac.in/courses/112104028/.
2. U. S. Dixit, Mechanics of Machining, NPTEL Course Department of Mechanical Engineering Guwahati, Link: http://nptel.ac.in/courses/112103248/.
3. A. B. Chattopadhyay, Manufacturing Processes II, NPTEL Course of Department of Mechanical Engineering, IIT Kharagpur, https://nptel.ac.in/courses/112/105/112105126/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Visit any one machining center or machining industry and/or

Case study on process parameter influence on anyone advanced machining process and hybrid machining process.