COURSE MODULE

MACHINING SCIENCE & METROLOGY(IPCC)			IV
Course Code	**BME402**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8 -10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)		**Theory**	

Course objectives:

- To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
- To introduce students to different machine tools to produce components having different shapes and sizes.
- To develop the knowledge on mechanics of machining process and effect of various parameters on machining.
- To understand the basic principles of measurements
- To enrich the knowledge pertaining to gauge, comparator and angular measurement.

Teaching-Learning Process (General Instructions)

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

1. Adopt different teaching methods to develop the outcomes through presentations/ video demonstrations/ simulations.
2. Chalk and talk method for problem-solving.
3. Arrange industrial visits to show the live working models other than laboratory topics.
4. Adopt collaborative learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.
6. Conduct laboratory demonstrations and practical experiments to enhance experiential skills.

MODULE-1

Introduction to Metal cutting: Orthogonal and oblique cutting. Classification of cutting tools: single, and multipoint; tool signature for single point cutting tool. Mechanics of orthogonal cutting; chip formation, shear angle and its significance, Merchant circle diagram. Numerical problems. Cutting tool materials and applications.

Introduction to basic metal cutting machine tools: Lathe- Parts of lathe machine, accessories of lathe Machine and various operations carried out on lathe. Kinematics of lathe. Turret and Capstan lathe.

MODULE-2

Milling Machines: up milling & down milling, classification of milling machines, constructional features (Column and Knee and vertical milling machine), milling cutter nomenclature, various milling operations, calculation of machining time. **Indexing:** Need of indexing Simple, compound and differential indexing calculations. Simple numerical on indexing. **Shaping, Slotting and Planning Machines Tools**: Driving mechanisms of Shaper, Slotter and Planer. Operations done on Shaper, Planer & Slotter Difference between shaping and planning operations. **Drilling Machines**: Constructional features (Radial & Bench drilling Machines), operations, types of drill & drill bit nomenclature. Calculation of machining time. **Grinding:** Grinding operation, classification of grinding processes: cylindrical, surface & centreless grinding.
MODULE-3
Thermal aspects, Tool wear, and Machinability: **Temperature in Metal Cutting:** Heat generation in metal cutting; temperature distribution in metal cutting, effect of cutting speed on temperatures, measurement of cutting temperatures Tool life and tool Wear: progressive tool wear. **Forms of Wear in Metal Cutting:** crater wear, flank wear, tool-life criteria, cutting tool materials: basic requirements of tool materials, major classes of tool materials: high-speed steel, cemented carbide, ceramics, CBN and diamond, tool coatings; the work material and its machinability **Cutting fluids:** Action of coolants and application of cutting fluids
MODULE-4
Introduction: Introduction to metrology & measurements, definition, objectives and classification of metrology, standards of length- wavelength standard, subdivision of standards, numerical problems on length calibration. **Line & End Standards:** Line and end standard, slip gauges, wringing phenomena, numerical problems on slip gauges. **Systems of Limits, Fits & Tolerance:** Definition of tolerance, tolerance specification in assembly, principle of interchangeability and selective assembly, limits of size, Indian standards, concepts of limits of size and tolerances, cost v/s tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation.
MODULE-5
Gauges: Classification of gauges, Taylor's principle, design of GO, NO GO gauges, wear allowance on gauges, types of gauges- plain plug gauges, ring gauges, snap gauge, limit gauge, simple problems. **Comparators:** Introduction to comparators, classification, characteristics, systems of displacement amplification in mechanical comparators, Reed type, Sigma comparator, Zeiss ultra-optimeter, Solex air gauge, ultrasonic gauges, LVDT. **Angular Measurements**: Bevel protractor, sine bar, angular gauges, numerical on building of angles.

PRACTICAL COMPONENT OF IPCC (May cover all / major modules)

Sl. No.	Experiments
1.	Preparation of one model on lathe involving - Plain turning, Facing, Knurling, Drilling, Boring, Internal Thread cuts and Eccentric turning.
2.	Preparation of One model on lathe involving - Plain turning, Facing, Taper turning, Step

	turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.
3.	One Job, Cutting of V Groove/ dovetail / Rectangular groove using a shaper.
4.	Cutting of Gear Teeth using Milling Machine.
5.	Simple operations and One Job on the drilling and grinding machine.
6.	Cutting force measurement with dynamometers (Demonstration) for turning, drilling, grinding operations.
7.	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.
8.	Experiment on anyone advanced machining process
9.	Study & Demonstration of power tools like power drill, power hacksaw, portable hand grinding, cordless screw drivers, production air tools, wood cutter, etc., used in Mechanical Engineering.
10.	Demonstration/Experimentation of simple programming of CNC machine operations.
11.	Demonstration / Experiment on tool wears and tool life on anyone conventional machining process.
12.	To study the tool geometry of a single point turning tool (SPTT) in the American Standards Association (ASA) system.

Course outcomes (Course Skill Set):

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

Analyze various cutting parameters in metal cutting.

Understand the construction of machines & machine tools and compute the machining time of various operations.

Understand the concept of Temperature in Metal Cutting, forms of wear in metal cutting and Cutting fluids.

Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters. Explain tolerance, limits of size, fits, geometric and position tolerances, gauges, and their design.

Understand the working principle of different types of comparators, gauges, angular Measurements.

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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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 the IPCC (Maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are 25 marks and that for the practical component is 25 marks.
- 25 marks for the theory component are split into 15 marks for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and 10 marks for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for 25 marks).
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

• 15 marks for the conduction of the experiment and preparation of laboratory record, and 10 marks for the test to be conducted after the completion of all the laboratory sessions.

• On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.

• 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 02/03 hours) after completion of all the experiments shall be conducted for 50 marks and scaled down to 10 marks.

• Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for 25 marks.

• The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

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.

• 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.

• Marks scored by the student shall be proportionally scaled down to 50 Marks

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 may include questions from the practical component.

Suggested Learning Resources:

Books

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.

7. Mechanical Measurements Beckwith Marangoni and Lienhard Pearson Education 6th Ed.,

8. Instrumentation, Measurement and Analysis B C Nakra, K K Chaudhry McGraw–Hill 4th Edition

9. Engineering Metrology R.K. Jain Khanna Publishers 2009

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 anyone machining centre or machining industry and/or
Case study on process parameter influence on anyone advanced machining process and hybrid machining process.

The Correlation of Course Outcomes (CO's) and Program Outcomes (PO's)

Subject Code: BME402	TITLE: Machining Science & Metrology (IPCC)	Faculty Name:

List of Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	
CO-1	3	-	-	-	-	-	-	-	2	-	-	2	
CO-2	3	-	-	-	-	-	-	-	2	-	-	2	
CO-3	3	-	-	-	-	-	-	-	2	-	-	2	
CO-4	3	-	-	-	-	-	-	-	2	-	-	2	
CO-5	3	-	-	-	-	-	-	-	2	-	-	2	

Program Specific Outcomes (PSOs)

	PSO1	PSO2	
CO-1	2	-	
CO-2	2	-	
CO-3	2	-	
CO-4	2	-	
CO-5	2	-	

Note: 3 = Strong Contribution 2 = Average Contribution 1 = Weak Contribution - = No Contribution