

**MRSPTU SKILL CERTIFICATE COURSE IN ADDITIVE MANUFACTURING
SYLLABUS 2022 BATCH ONWARDS**

Additive Manufacturing (1year skill development course)

Semester I

Subject Code	Subject name	Contact Hours		Credits	Internal Marks	External marks	Total Marks
		Theory	Practical				
CMEE3-101	Communication Skills	8	-	1	25	25	50
CMEE3-101P	Communication Skills Lab	-	24	1	25	50	75
CAMFS1-101	Basics of Engineering Drawing	30	-	3	50	100	150
CAMFS1-102	Basic Engineering Drawing Lab	-	96	3	50	100	150
CAMFS1-103	Additive Manufacturing-I	30	-	3	50	100	150
CMEE3-106P	Student Centred Activities	-	48	2	25	---	25
CMEE3-105	Basic Workshop Practice	32	-	2	25	50	75
CMEE3-105P	Basic Workshop Practice Lab	-	144	5	100	100	200
CMEE3-107P	4 weeks Industrial training (during Vacations)	-	-	4	---	100	100
Total		100	312	24	350	625	900

Semester II

Subject Code	Units	Contact Hours		Credits	Internal Marks	External marks	Total Marks
		Theory	Practical				
CMEE3-208	Basic Science	48	-	3	25	75	100
CAMFS1-201	Auto CAD Lab	-	144	5	100	100	200
CAMFS1-202	Additive Manufacturing-II	30	-	3	100	100	200
CAMFS1-203	Additive manufacturing Lab	-	144	5	100	100	200
CAMFS1-204	Inspection & Quality Control	32	-	3	50	100	150
CAMFS1-205	Inspection & Quality Control Lab	-	80	3	50	75	125
CMEE3-106P	# Student Centred Activities (SCA)	-	48	2	25	---	25
CMEE3-107P	4 weeks Industrial training (during Vacations)	-	-	4	---	100	100
Total		110	416	28	500	650	1100

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SCA will comprise of co-curricular activities like extension lectures on entrepreneurship, Industrial tour, environment, sports, hobby club, such as, photography, etc., seminars, declamation contest, educational field visits, NCC, NSS, cultural activities, etc.

+Industrial Training Before completion of the semester, the students will go for training in a relevant industry/field organization for a minimum period of 4 weeks and prepare a diary. The student will prepare a report at the end of training. This report will be evaluated by the concerned instructor in the presence of one industry representative from the relevant trade/field.

Total weeks per semester: 16, Total working days per week: 5, Total hours per day: 7, Total hours in a semester: $16 \times 5 \times 7 = 560$ One credit is defined as one hour of lecture per week or two hours of practical per week in the program.

GUIDELINES FOR ASSESSMENT OF STUDENT CENTRED ACTIVITIES (SCA)

The maximum marks for SCA should be 25. The marks may be distributed as follows:

- i) 5 marks for general behavior and discipline (by Principal or HOD in consultation with the instructor(s)/trainers)
- ii) 5 marks for attendance as per following (by the instructors/ trainers of the department)
 - a) Up to 75% Nil
 - b) 75% to 80% 02marks
 - c) 80% to 85% 03marks
 - d) Above 85% 05marks
- iii) 15marks maximum for sports/NCC/NSS/Cultural/Co-curricular activities as per following: (by In-charge of Sports/ Cultural/NCC/NSS/Co-curricular activities)

15marks - for National level participation or inter-university competition

10 marks - participation any two of the activities

05 marks – participation at the internal sports of the institute/college/university

Note: There should be no marks for attendance in the internal sessional of different subjects.

Salient features of the course

1	Sector	Industry 4.0/ Mechanical Engineering
2	Name of the Certificate Program	Additive manufacturing
3	Entry Qualification	Matriculation or equivalent NSQF level as prescribed by MRSPTU, Bathinda
4	Duration of Program	1 year
5	Intake	30
6	Pattern of Program	Semester Pattern
7	NSQF level	Level III
8	Ratio of Theory & Practice	20:80

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UNIT – 1.1 Subject Code: CMEE3-101 COMMUNICATION SKILLS	
LEARNING OUTCOMES: After undergoing this unit, the students will be able to: <ul style="list-style-type: none"> • Speak confidently. • Overcome communication barriers. • Write legibly and effectively. • Listen in proper prospective. • Read various genres adopting different reading techniques. • Respond to telephone calls effectively. 	
Practical (24 Hours)	Theory (08 Hours)
	Basics of Communication <ul style="list-style-type: none"> • Process of communication • Types of communication - formal and informal, oral and written, verbal and non-verbal • Objectives of communication • Essentials of communication • Barriers to communication <p align="right">(1 hour)</p>
<ul style="list-style-type: none"> • Looking up words in a dictionary (meaning and pronunciation) (2 hours) 	Functional Grammar and Vocabulary <ul style="list-style-type: none"> • Parts of speech • Tenses • Correction of incorrect sentences <p align="right">(2 hours)</p>
<ul style="list-style-type: none"> • Self and peer introduction • Greetings for different occasions (1 hour) 	Listening <ul style="list-style-type: none"> • Meaning and process of listening • Importance of listening • Methods to improve listening skills Speaking <ul style="list-style-type: none"> • Importance • Methods to improve speaking • Manners and etiquettes <p align="right">(2 hours)</p>
<ul style="list-style-type: none"> • Newspaper reading (1 hour) 	Reading <ul style="list-style-type: none"> • Meaning • Techniques of reading: skimming, scanning, intensive and extensivereading (1 hour)
<ul style="list-style-type: none"> • Vocabulary enrichment and grammar exercises • Exercises on sentence framing accurately (6 hours) 	Functional Vocabulary <ul style="list-style-type: none"> - One-word substitution - Commonly used words which are often misspelt - Punctuation - Idioms and phrases <p align="right">(2 hours)</p>

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<ul style="list-style-type: none">• Reading aloud articles and essays on current and social issues• Comprehension of short paragraph (5 hours)	
<ul style="list-style-type: none">• Write a short technical report• Letter writing (3 hours)	
<ul style="list-style-type: none">• Participate in oral discussion• Respond to telephonic calls effectively• Mock interview (6 hours)	

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Laboratory and practical work
- Viva-voce

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Unit: 1.2 Subject Code: CAMFS1-101 BASICS OF ENGINEERING DRAWING	
LEARNING OUTCOMES: After undergoing this unit, students will be able to: <ul style="list-style-type: none"> • Utilize various types of lines used in engineering drawing. • Draw free hand sketches of various kinds of objects. • Read and apply different dimensioning methods on drawing of objects. • Read technical drawings for cost estimation and manufacturing/fabrication purpose 	
Introduction: Applications of various types of lines in engineering drawing, Technical lettering, Dimensioning, method of dimensioning, types of dimensioning, and rules of dimensioning.	3 hrs
Geometrical construction: Construction of regular pentagon, and hexagon, inscribe polygon (triangle, square, pentagon, hexagon) in a circle, circumscribe polygon (triangle, square, pentagon and hexagon) to a circle.	6 hrs
Orthographic projections: Features of first angle projection, Features of third angle projections, symbols, General preparation for multi-view drawings, conversion of pictorial view /isometric view into orthographic view	5 hrs
Isometric Projections: Terminology, isometric scale, isometric projection and isometric view, Methods of drawing an isometric view of right solids, truncated solids composite solids, four centre method for drawing approximate ellipse and elliptical arcs, Conversion of orthographic views into isometric views.	5 hrs
Projections of solids: Classification of regular solids, Polyhedron, Prism, Pyramid, solid of revolution, Frustum of pyramid and cone and orientation of solid.	6 hrs
Development of surfaces: development of prism, cylinders, cones and pyramids.	5 hrs

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Viva-voce

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Unit: 1.3	
Subject Code: CAMFS1-102	
BASICS OF ENGINEERING DRAWING LAB	
LEARNING OUTCOMES:	
After undergoing this unit, students will be able to:	
<ul style="list-style-type: none"> • Drawing practice for various types of lines used in engineering drawing. • Draw free hand sketches of various kinds of objects. • Apply different dimensioning methods on drawing of objects. 	
Practical demonstration with the help of blue prints/computer prints.	6 hrs
Drawing board, T-square, mini drafter, set squares, protractor, drawing instrument box, pencils of different grades, erasing shield • Learn methods of folding of blue print/drawing prints as per BIS SP: 16-2003 • Size of drawing sheets and designation of sheets. • Preparation of A3/A2 sheet for preparing drawings.	9 hrs
Practice construction of different types of lines (horizontal and vertical)	6 hrs
Construction of triangle, rectangle, rhombus, parallelogram circle quadrilateral and ellipse.	3hrs
Practice writing alphabets and numerals in capital/lower case as per BIS: 9609 in vertical and inclined style:	6 hrs
Practice construction of elements dimensioning with the help of a view of an object. • Practice dimensioning of a diameter, radius, angles, holes, chamfers, undercut, functional dimensions, nonfunctional dimensions.	6 hrs
Practice of free hand sketch of an object in orthographic and isometric views.	6 hrs
Free hand sketches of orthographic views of an object in first angle and third angle projections.	6 hrs
Construction of different points existing in first/second/third and fourth quadrants. • Identification of the position of points w.r.t. their projection drawings.	6 hrs
Practice the construction of plan and elevation of lines w.r.t. their different positions such as a line parallel to both V.P. and H.P, line perpendicular to V.P. and parallel to H.P., line perpendicular to H.P. and parallel to V.P., line parallel to H.P. and inclined to V.P., line parallel to V.P. and inclined to H.P.	9 hrs
Practice construction of cone, cylinder, pentagonal prism and hexagonal pyramid.	6hr
Practice on the sheets showing all conventions as graphical symbols for materials and equipment/instruments/engineering components cast iron, aluminum audits alloys, steel, brass, bronze, copper etc. concrete, glass, plastic/rubber/insulating material/pack material (Marble, Slate, Porcelain and stone wares) Liquids, Woods	9 hrs
Practice on the sheets showing the different welding joints	6 hrs
Practice the construction of views of the riveted joints.	6 hrs
Practice of sign convention of D.C. A.C. Positive, Negative, Single Phase, Three Phase, AC/DC, 3- Phase, Neutral line.	6 hrs

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Viva-voce
- Sketching
- Drawing

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Unit: 1.4	
Subject Code: CAMFS1-103	
ADDITIVE MANUFACTURING- I	
LEARNING OUTCOMES: After undergoing this unit, students will be able to: <ul style="list-style-type: none">• Understand various types of manufacturing processes and industry 4.0.• Understand the working of various types of additive manufacturing processes.• Understand various slicing parameters required for 3D printing.	
Introduction to additive manufacturing, flexible manufacturing system,	4 hrs
Manufacturing processes, Industry 4.0	6 hrs
Classification of various additive manufacturing techniques such as fused deposition modeling (FDM), laminated object manufacturing (LOM), selective laser sintering (SLS), stereolithography (SLA), direct metal printing etc.	10 hrs
Fused deposition modelling, working principle, process parameters, types of materials used in FDM, types of 3D printers.	10 hrs

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Viva-voce

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UNIT – 1.5	
Subject Code: CMEE3-105	
BASIC WORKSHOP PRACTICE	
LEARNING OUTCOMES:	
After undergoing this unit, the students will be able to:	
<ul style="list-style-type: none"> • Observe general workshop safety precautions • Identify, select and use appropriate hand tools and carry out simple fitting operations like filing, chipping, hacksawing, threading, taping, grinding, drilling • Identify, select and use appropriate tools, equipment to carry out operations like cutting, bending, flaring, swaging, pinching, brazing of copper tubes • Identify, select and use appropriate hand tools and carry out simple sheet metal operations like marking, cutting, bending, folding • Identify, select and use appropriate electrical tools and instruments, measure electrical parameters (like voltage, current, resistance, earth resistance, insulation, continuity) • Identify electronic components like transistors, resistors, capacitors, diodes, S.C.R, U.J.T, ICs used in refrigerators and air conditioners. • Identify, select and use appropriate tools, equipment, consumables and carry out simple gas welding operations. • Carry out brazing of copper-to-copper, copper to MS • Identify, select and use appropriate hand tools and carry out simple carpentry operations like planing, sawing, chiselling and drilling. 	
Practical	(144 Hours)
Theory	(32 Hours)
Safety Familiarization with workshop machinery. Safety precautions.	(12 hours)
Safety General safety precautions and first aids	(4 hours)
Fitting Familiarization with tools, equipment and measuring instruments used in fitting. Practice marking / layout as per specifications, filing, chipping, hacksawing, threading, taping, grinding, drilling.	(20 hours)
Fitting Study different types of tools, equipment and measuring instruments used in fitting, their specifications, functions, working and uses; care and maintenance.	(4 hours)
Practice working on soft copper tubing like, cutting, bending, flaring, swaging, pinching.	(20 hours)
Sheet Metal Working Familiarization with tools, measuring instruments used in sheet metal. Practice marking / layout / development as per specifications, cutting, bending, and folding.	(20 hours)
Sheet Metal Working Study different types of tools, equipment and measuring instruments used in sheet metal working, their specifications, functions, working and uses; care and maintenance.	(4 hours)
Electrical Familiarization with electrical tools; practice wire joint, verification of Ohm's law,	
Electrical Study electrical terms such as AC and DC supply, voltage, current, resistance, power,	

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<p>Identification of phase and neutral of AC supply, measurement of voltage, current, resistance, power, frequency and energy consumed in an electrical circuit, selection of wires and cables as per load, measurement of earth resistance. Insulation and continuity test, detection of current leakage, short circuit.</p> <p style="text-align: right;">(20 hours)</p>	<p>Energy, frequency etc. Series and parallel circuits, Concept of single phase and three phase supply, Safety precautions to be observed while working on electricity, conductors and insulators. Study of measuring Instruments such as voltmeter, ammeter, ohm meter, watt meter, energy meter and frequency meter. Earthing and its importance, insulation and continuity test</p> <p style="text-align: right;">(4 hours)</p>
<p>Electronics Identification of electronic components, tools and instruments, colour coding of resistors, identification of transistors, resistors, capacitors, diodes, S.C.R, U.J.T, I.Cs. used in refrigeration and air conditioning, working of remote control.</p> <p style="text-align: right;">(20 hours)</p>	<p>Electronics Introduction to electronics, basic principles of semiconductors, application of diodes, rectification, Zener diode as voltage regulator – transistors parameters- CB, CE, CC, configuration, amplification. SCR.</p> <p style="text-align: right;">(4 hours)</p>
<p>Welding and Brazing Familiarization with tools, equipment, instruments and consumables for gas welding and brazing, practice simple gas welded joints, brazing copper-to-copper, copper to MS.</p> <p style="text-align: right;">(20 hours)</p>	<p>Welding and Brazing Introduction to gas welding, equipment (like cylinders, regulators, blowpipes, nozzles etc.) used, their specifications, working, functions, types of flames, consumables used, safety precautions, care and maintenance, different welded joints. Introduction to brazing, equipment and consumables used, importance and use of brazing in refrigeration and air conditioning</p> <p style="text-align: right;">(4 hours)</p>
<p>Carpentry Familiarization with simple carpentry tools and practice operations like planning, sawing, chiselling and drilling.</p> <p style="text-align: right;">(12 hours)</p>	<p>Carpentry Introduction to simple carpentry tools, their types, specifications, working, functions, safety precautions, care and maintenance.</p> <p style="text-align: right;">(4 hours)</p>

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Laboratory and practical work
- Report writing
- Viva-voce
- Workshop job

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**Subject Code: CMEE3-107P
INDUSTRIAL TRAINING – I (4 Weeks)**

The purpose of industrial training is to:

- Develop understanding regarding the size and scale of operations and nature of industrial/field work in which students are going to play their role after completing the courses of study.
- Develop confidence amongst the students through firsthand experience to enable them to use and apply institute based knowledge and skills to perform field activities
- Develop special skills and abilities like interpersonal skills, communication skills, attitudes and values.

It is needless to emphasize further the importance of Industrial Training of students during their one-year certificate programme. It is industrial training, which provides an opportunity to students to experience the environment and culture of world of work. It prepares students for their future role as skilled person in the world of work and enables them to integrate theory with practice.

An external assessment of 100 marks have been provided in the study and evaluation scheme of 1st Semester. Evaluation of professional industrial training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engage in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations.

The instructor along with one industrial representative from the concerned trade will conduct performance assessment of students. The components of evaluation will include the following:

- | | |
|-------------------------------|-----|
| a) Punctuality and regularity | 20% |
| b) Industrial training report | 50% |
| c) Presentation and viva-voce | 30% |

**MRSPTU SKILL CERTIFICATE COURSE IN ADDITIVE MANUFACTURING
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UNIT – 2.1 Subject Code: CMEE3-208 BASIC SCIENCES	
LEARNING OUTCOMES: After undergoing this unit, the students will be able to: <ul style="list-style-type: none"> • Apply the basic principles of maths in solving the basic problems of the trade. • Apply the basic principles of physics in solving the basic problems of the trade. 	
Practical	Theory (48 Hours)
	Mathematics <ul style="list-style-type: none"> • Basic Algebra – algebraic formula. Simultaneous equation – quadratic equations (4 hours) • Simultaneous linear equation in two variables (3 hours) • Arithmetic and geometric progression, sum of n-terms, simple calculations. (3 hours) • Mensuration – Find the area of regular objects like triangle, rectangle, square and circle; volumes of cube, cuboid, sphere cylinder (6 hours) • Trigonometry - Concept of angle, measurement of angle in degrees, grades and radians and their conversions, T-Ratios of Allied angles (3 hrs) • Co-ordinate Geometry - Cartesian and polar coordinates, conversion from cartesian to polar coordinates (2 hrs) • Concept of Differentiation and Integration (3 hrs)
	Physics <ul style="list-style-type: none"> • FPS, CGS, SI units, dimensions and conversions (2 hours) • Force, speed, velocity and acceleration – Definition, units and simple problems (3 hours) • Stress and strain, modulus of elasticity (2 hours) • Heat and temperature, its units and specific heat of solids, liquids and gases (4 hours) • Electricity and its uses, basic electricity

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	<p>terms and their units, D.C. and A.C., positive and negative terminals, use of switches and fuses, conductors and insulators (5 hours)</p> <ul style="list-style-type: none">• Work, Power and Energy-Definition, units and simple problems (4 hours)• Concept of force, Inertia, Newton's First law of motion; momentum and Newton's second law of motion; Impulse; Newton's third law of motion. (2 hrs)• Friction and Lubrication (1 hour)• Law of conservation of energy (1 hour)
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Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Model/prototype making

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Unit: 2.2	
Subject Code: CAMFS1-201	
AUTOCAD LAB	
LEARNING OUTCOMES: After undergoing this unit, students will be able to: <ul style="list-style-type: none">• Drawing practice for various types of AutoCAD toolbars.• Draw sketches of various kinds of objects.• Apply different dimensioning methods on drawing of objects.	
Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids	50 hrs
Consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles	50 hrs
Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques	44 hrs

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Viva-voce
- Sketching
- Drawing

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Unit: 2.3	
Subject Code: CAMFS1-202	
ADDITIVE MANUFACTURING- II	
LEARNING OUTCOMES: After undergoing this unit, students will be able to: <ul style="list-style-type: none">• Understand various types of engineering materials.• Understand various types of material testing methods.• Understand the use of various types of slicing parameters.• Understand various Post processing techniques used for 3D printed parts.	
Introduction to materials, classification of materials, material properties, selection process of materials.	4 hrs
Material testing methods such as hardness, impact strength, tensile strength, flexural strength.	6 hrs
Slicing software, slicing parameters such as material selection, nozzle size, pattern, infill density, raster angle, layer width. Layer thickness etc.	10 hrs
Surface roughness techniques, Post processing techniques in additive manufacturing, process parameters.	10 hrs

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Viva-voce

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Unit: 2.4	
Subject Code: CAMFS1-203	
ADDITIVE MANUFACTURING LAB	
LEARNING OUTCOMES: After undergoing this unit, students will be able to: <ul style="list-style-type: none">• Understand and select various types of slicing parameters.• Set FDM printer.• Print 3D parts.	
Listing the computer technologies that impact on 3D printing, Transfer of CAD file into .stl file format. Demonstrating knowledge of the theory of slicing software and slicing parameters such as: material selection, nozzle size, pattern, infill density, raster angle, layer width. Layer thickness etc.	50 hrs
FDM printer setting, bed levelling, nozzle setting, feedstock filament loading/unloading	50 hrs
3D printing of parts, post processing of printed parts.	44 hrs

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Viva-voce
- 3D printing

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Unit: 2.5	
Subject Code: CAMFS1-204	
INSPECTION AND QUALITY CONTROL	
LEARNING OUTCOMES: After undergoing this unit, students will be able to: <ul style="list-style-type: none">• Understand metrology and standard of measurement.• Understand the working of various types of inspection instruments.• Understand the concept of surface roughness and its measurement.	
Define Metrology, Inspection, Accuracy and Precision, Standards of measurements.	4 hrs
Vernier calliper, micrometre, height gauge, filler gauges, sine bars, Screw Thread Measurement: Errors in threads, screw thread gauges, measurement of element of the external and internal threads, thread caliper gauges.	6 hrs
Metrology of Surface finish: Surface Metrology Concepts and terminology, Analysis of surface traces, Specification of surface Texture characteristics, and Method of measuring surface finish: Stylus system of measurement, Stylus probe instruments, methods for measuring surface roughness	6 hrs
Miscellaneous Metrology: Precision Instrumentation based on Laser Principals, Coordinate measuring machines: Structure, Modes of Operation, Probe, Operation and applications.	8 hrs
Optical Measuring Techniques: Tool Maker's Microscope, Profile Projector, Optical Square. Optical Interference and 8. Interferometry, Optoelectronic measurements.	8 hrs

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Viva-voce

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Unit: 2.6	
Subject Code: CAMFS1-205	
INSPECTION AND QUALITY CONTROL LAB	
LEARNING OUTCOMES: After undergoing this unit, students will be able to: <ul style="list-style-type: none">• Use the inspection instruments.• Understand the selection of instrument for particular job.• Carry out the maintenance of the instruments.	
Use of various inspection instruments such as vernier calliper, micro-meter, surface roughness tester, height gauge, tool maker microscope, optical microscope, sine bars, filler gauges, thread gauges and Surface plate. Maintenance of instruments.	80 hrs

Means of Assessment

- Assignments and quiz/class tests
- Mid-term and end-term written tests
- Viva-voce