

Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY, BENGALURU

**COURSE PLAN**

Academic Year 2019 – 20

Program:	B E – MECHANICAL
Semester :	VIII
Course Code:	17ME554
Course Title:	Non Traditional Machining
Credit / L-T-P:	3 / 3-0-0
Total Contact Hours:	40
Course Plan Author:	SRIDHAR H S

Academic Evaluation and Monitoring Cell

#29, Hesaraghatta Main road, Chimney Hills, Chikkabanavara P.O.,
Bengaluru – 560090, Karnataka, INDIA
Phone / Fax :+91 80 23721477 -STD- 080 23721315

Table of Contents

A. COURSE INFORMATION.....	3
----------------------------	---

1. Course Overview	3
2. Course Content	3
3. Course Material	4
4. Course Prerequisites	5
5. Content for Placement, Profession, HE and GATE	5
B. OBE PARAMETERS	5
1. Course Outcomes.....	5
2. Course Applications.....	6
4. Mapping Justification	6
4. Articulation Matrix	7
5. Curricular Gap and Content.....	8
6. Content Beyond Syllabus	8
C. COURSE ASSESSMENT	9
1. Course Coverage.....	9
2. Continuous Internal Assessment (CIA)	9
D1. TEACHING PLAN - 1	9
Module - 1	9
Module – 2.....	10
E1. CIA EXAM – 1	11
a. Model Question Paper - 1	11
b. Assignment -1	11
D2. TEACHING PLAN - 2.....	13
Module – 3.....	13
Module – 4.....	14
E2. CIA EXAM – 2	15
a. Model Question Paper - 2	15
b. Assignment – 2	16
D3. TEACHING PLAN - 3.....	17
Module – 5.....	17
E3. CIA EXAM – 3	18
a. Model Question Paper - 3	18
b. Assignment – 3	18
F. EXAM PREPARATION	20
1. University Model Question Paper	20
2. SEE Important Questions	21
G. Content to Course Outcomes.....	22
1. TLPA Parameters	22
2. Concepts and Outcomes:	23

Note : Remove “Table of Content” before including in CP Book

Each Course Plan shall be printed and made into a book with cover page

Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	ME
Year / Semester :	5/V	Academic Year:	2018-19
Course Title:	Non Traditional Machining	Course Code:	17ME554
Credit / L-T-P:	3/3-0-0	SEE Duration:	3 hours

Total Contact Hours:	42	SEE Marks:	80Marks
CIA Marks:	20	Assignment	2/Module
Course Plan Author:	SHRIDHARA H S	Sign	Dt:
Checked By:		Sign	Dt:

2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute. Identify 2 concepts per module as in G.

Module	Module Content	Teaching Hours	Module Concepts	Bloom's Level
1	Introduction to Non-traditional machining: Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Nontraditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.	8	Non-traditional machining	L2
2	Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM. Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics - Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM. Water Jet Machining (WJM): Equipment & process, Operation, applications, advantages and limitations of WJM.	4 2 2	Ultrasonic Machining process. Abrasive Jet Machining process. Water Jet Machining process.	L2 L2 L2
3	Introduction, Principle of electro chemical machining: ECM equipment, elements of ECM Operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, Surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of Electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECM. CHM Elements of the process: Resists (maskants), Etchants. Types of chemical machining process chemical Blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy,	5 5	electro chemical machining process Chemical machining process	L2 L2

	surface finish, advantages, limitations and applications of chemical machining process.			
4	<p>Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (Relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.</p> <p>PLASMA ARC MACHINING (PAM) Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety Precautions, applications, advantages and limitations.</p>	4	Electrical Discharge machining process	L2
		5	Plasma arc machining process	L2
5	<p>LASER BEAM MACHINING (LBM) Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM Parameters and characteristics, Applications, Advantages & limitations.</p> <p>ELECTRON BEAM MACHINING (EBM) Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.</p>	4	Laser beam machining process	L2
		4	Electron beam machining process	L2

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).

1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

Module	Details	Available
A	Text books (Title, Authors, Edition, Publisher, Year.)	
1,2,3,4,5	Modern Machining Processes by P.C Panday and H. S Shah Tata McGraw-Hill Education, India Pvt.Ltd. 2000	In Lib
	Non Traditional Machining by Kestor Praveen Suggi publication 2018	In dept
B	Reference books (Title, Authors, Edition, Publisher, Year.)	
1,2,3,4,5	New Technology Dr. Amitabha Bhattacharyya, The Institute of Engineers 2000	In Lib
C	Concept Videos or Simulation for Understanding	
C1	http://videos.vtu.ac.in/video_groups.php?group=Mechanical%20Engineering	
C2	https://www.youtube.com/watch?v=qVcwT0FfAic	
C3	https://www.youtube.com/watch?v=pI1QGpmKqow	
C4	https://www.youtube.com/watch?v=QtJvJ3jscGA	
C5	https://www.youtube.com/watch?v=uA6wfkboWtg	
C6	https://www.youtube.com/watch?v=6ERbGtJFcBw	
C7	https://www.youtube.com/watch?v=EI2iakzRbeM	
C8	https://www.youtube.com/watch?v=IPMaASIBShA	
C9	https://www.youtube.com/watch?v=B-2nzWfJE-k	
C10	https://www.youtube.com/watch?v=dP2m7-WAdos	

D	Software Tools for Design	

4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content . . .

SNo	Course Code	Course Name	Module / Topic / Description	Sem	Remarks	Blooms Level
1	15ME35 A/45A	Machine Tool and Operation	1. Knowledge on marching operation	3/4	Plan Gap Course	L2

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.

Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Modules	Topic / Description	Area	Remarks	Blooms Level
1		Higher Study	Gap A seminar on PLCM model	Understand L2

B. OBE PARAMETERS

1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs. Identify a max of 2 Concepts per Module. Write 1 CO per Concept.

#	Cos students should be able to...	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
15ME55 4.1	Student should be able to understand non traditional machining process and need for it.	8	Non-traditional machining	Lecture/Tutorial	Assignment	L2 Understand
15ME55 4.2	Student should be able to understand constructional features and performance of USM.	4	Ultrasonic Machining process.	Lecture/Tutorial	Assignment	L2 Understand
15ME55 4.3	Student should be able to understand constructional features and performance of AJM.	2	Abrasive Jet Machining process.	Lecture/Tutorial	Assignment	L2 Understand
15ME55 4.4	Student should be able to understand constructional features and performance of WJM.	2	Water Jet Machining process.	Lecture/Tutorial	Assignment	L2 Understand
15ME55 4.5	Student should be able to understand constructional features and performance of ECM.	5	Electro chemical machining process	Lecture/Tutorial	Assignment	L2 Understand
15ME554. 6	Student should be able to understand constructional features and performance of CHM.	5	Chemical machining process	Lecture/Tutorial	Assignment	L2 Understand
15ME554. 7	Student should be able to understand constructional features and performance of EDM.	4	Electrical Discharge machining process	Lecture/Tutorial	Assignment	L2 Understand

15ME554. 8	Student should be able to understand constructional features and performance of PAM.	4	Plasma arc machining process	Lecture/Tutorial	Assignment	L2 Understand
15ME554. 9	Student should be able to understand constructional features and performance of LBM.	4	Laser beam machining process	Lecture/Tutorial	Assignment	L2 Understand
15ME554. 10	Student should be able to understand constructional features and performance of EBM.	4	Electron beam machining process	Lecture/Tutorial	Assignment	L2 Understand
-	Total	42	-			

Note: Identify a max of 2 Concepts per Module. Write 1 CO per concept.

2. Course Applications

Write 1 or 2 applications per CO.

Students should be able to employ / apply the course learnings to . . .

Modules	Application Area Compiled from Module Applications.	CO	Level
1	Manufacturing industries	CO1	L2
2	Threading of various glass and ceramic material.	CO2	L2
3	Removing glue and paint from leather objectives	CO3	L2
4	Cleaning and descaling operation	CO4	L2
5	Facing and turning of 3D object.	CO5	L2
6	Grinding of carbide tool	CO6	L2
7	Turning of metallic object	CO7	L2
8	Arc spraying on surface	CO8	L2
9	Welding of material	CO9	L2
10	Finishing Injector nozzle of diesel engine	CO10	L2

4. Mapping Justification

Mapping		Justification	Mapping Level
CO	PO	-	-
CO1	PO1	Engineering Knowledge Acquisition of Engineering knowledge on fundamentals of traditional and non-traditional machining process. is essential to accomplish solutions to complex engineering problems in Machining process	L2
CO2	PO1	Engineering Knowledge Acquisition of Engineering knowledge on constructional features and performance of USM	L2
CO3	PO1	Engineering Knowledge Acquisition of Engineering knowledge on fundamentals of constructional features, performance parameters of AJM.	L2
CO4	PO1	Engineering Knowledge: Acquisition of Engineering knowledge on fundamentals of Constructional features and performance of WJM is essential to accomplish solutions to complex engineering problems in managing modern machining process.	L2
CO5	PO1	Engineering Knowledge Acquisition of Engineering knowledge on fundamentals of Constructional features and performance of ECM.	L2
CO5	PO6	understanding the Constructional features and performance of ECM and Educate students about environmental and safety issues.	L2
CO6	PO1	Engineering Knowledge Acquisition of Engineering knowledge on fundamentals of constructional features and performance of CHM.	L2
CO6	PO6	Educate students about environmental and safety issues of CHM.	L2
CO7	PO1	Engineering Knowledge Acquisition of Engineering knowledge on fundamentals of constructional features and performance of EDM using new technology.	L2

CO7	PO6	Educate students about environmental and safety issues. When performing the EDM process.	L2
CO8	PO1	Student should be able to understand constructional features and performance of PAM.	L2
CO8	PO6	constructional features and performance of PAM. by various approaches of product manufacturing.	L2
CO9	PO1	constructional features and performance of LBM by various approaches of product machining	L2
CO9	PO6	Educate students about environmental and safety issues when performing LBM machining process	L2
CO10	PO1	Engineering Knowledge Acquisition of Engineering knowledge on fundamentals of constructional features and performance of EBM. is essential to accomplish solutions to complex engineering problems in machining process	L2
CO10	PO6	Educate students about environmental and safety issues when performing EBM machining process	L2

Note: Write justification for each CO-PO mapping.

4. Articulation Matrix

(CO – PO MAPPING)

Modules	#	Course Outcomes COs	Program Outcomes															Level	
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3		
1	15ME554.1	Student should be able to understand non traditional machining process and need for it.	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L2
2	15ME554.2	Student should be able to understand constructional features and performance of USM.	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L2
3	15ME554.3	Student should be able to understand constructional features and performance of AJM.	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L2
4	15ME554.4	Student should be able to understand constructional features and performance of WJM.	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L2
5	15ME554.5	Student should be able to understand constructional features and performance of ECM.	√	-	-	-	-	√	-	-	-	-	-	-	-	-	-	-	L2
6	15ME554.6	Student should be able to understand constructional features and performance of CHM.	√	-	-	-	-	√	-	-	-	-	-	-	-	-	-	-	L2
7	15ME554.7	Student should be able to understand constructional features and performance of EDM.	√	-	-	-	-	√	-	-	-	-	-	-	-	-	-	-	L2
8	15ME554.8	Student should be able to understand constructional features	√	-	-	-	-	√	-	-	-	-	-	-	-	-	-	-	L2

		and performance of PAM.																	
9	15ME554-9	Student should be able to understand constructional features and performance of LBM.	√	-	-	-	-	√	-	-	-	-	-	-	-	-	-	-	L2
10	15ME554-10	Student should be able to understand constructional features and performance of EBM.	√	-	-	-	-	√	-	-	-	-	-	-	-	-	-	-	L2
-	15ME554	Average attainment (1, 2, or 3)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	PO, PSO	1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design																	

5. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	Digital machining process	1 day seminar on DMP			

Note: Write Gap topics from A.4 and add others also.

6. Content Beyond Syllabus

Modu les	Gap Topic	Area	Actions Planned	Schedule Planned	Resources Person	PO Mapping
3	Machining Quality analysis process	GATE, Higher Study, Entrepreneurship.	1 day workshop			

Note: Anything not covered above is included here.

C. COURSE ASSESSMENT

1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Mod ule #	Title	Teaching Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Introduction to Non-traditional machining	8	2	-	-	1	1	2	CO1,	L2
2	Ultrasonic Machining(USM), Abrasive Jet Machining (AJM), Water Jet Machining (WJM):	8	2	-	-	1	1	2	CO2, CO3, CO4	L2
3	Electrochemical Machining(ECM) Chemical Machining(CHM)	10	-	2	-	1	1	2	CO5, CO6	L2
4	Electrical Discharge machining(EDM)	8	-	2	-	1	1	2	CO7, CO8	L2

	PLASMA ARC MACHINING (PAM)									
5	LASER BEAM MACHINING (LBM) ELECTRON BEAM MACHINING (EBM)	8	-	-	4	1	1	2	CO9, CO10	L2
-	Total	42	4	4	4	5	5	10	-	-

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	15	CO1, CO2, CO3, CO4	L2
CIA Exam – 2	15	CO5, CO6, CO7, CO8	L2
CIA Exam – 3	15	CO9, CO10	L2
Assignment - 1	05	CO1, CO2, CO3, CO4	L2
Assignment - 2	05	CO5, CO6, CO7, CO8	L2
Assignment - 3	05	CO9, CO10	L2
Other Activities – define – Slip test			
Final CIA Marks	20	-	-
Seminar - 3	-	-	-
Other Activities define – Slip test			
Final CIA Marks	20	-	-

D1. TEACHING PLAN - 1

Module - 1

Title:	Management, Planning	Appr Time:	10 Hrs
a	Course Outcomes	-	Blooms Level
-	The student should be able to:	-	Level
1	Student should be able to understand non traditional machining process and need for it.	CO1	L2
b	Course Schedule	-	-
Class No	Module Content Covered	CO	Level
1	Introduction to Non-traditional machining	CO1	L2
2	Need for Non-traditional machining process,	CO1	L2
3	Comparison between traditional and non-traditional machining,	CO1	L2
4	General classification Nontraditional machining processes,	CO1	L2
5	Classification based on nature of energy employed in machining	CO1	L2
6	Selection of non-traditional machining processes,	CO1	L2
7	Specific advantages, limitations	CO1	L2
8	Applications of non-traditional machining processes	CO1	L2
c	Application Areas	CO	Level
1	Manufacturing industries	CO1	L2

d	Review Questions	-	-
1	Justify the need of unconventional manufacturing process in today industries.	CO1	L2
2	Differentiate between conventional and Non-conventional manufacturing process .	CO1	L2
3	Explain how the non- conventional machining processes are classified.	CO1	L2
4	List and explain the various factors to be considered for selection of machining processes .	CO1	L2
5	Make a comparison between traditional and non- traditional machining process in terms of cost ,application, scope, machine time and limitations.	CO1	L2
e	Experiences	-	-
1			

Module – 2

Title:	Organizing And Staffing	Appr Time:	10 Hrs
a	Course Outcomes	-	Blooms Level
-	The student should be able to:	-	
1	understand constructional features and performance of USM	CO2	L2
2	understand constructional features and performance of AJM.	CO3	L2
3	understand constructional features and performance of WJM.	CO4	L2
b	Course Schedule	-	-
Class No	Module Content Covered	CO	Level
1	Ultrasonic Machining (USM): Introduction, Equipment and material process,	CO2	L2
2	Effect of process parameters: Effect of amplitude and frequency	CO2	L2
3	Effect of abrasive grain diameter, effect of slurry, tool & work material.	CO2	L2
4	Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.	CO2	L2
5	Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD).	CO3	L2
6	Process characteristics- Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.	CO3	L2
7	Water Jet Machining (WJM): Equipment & process,	CO4	L2
8	Operation, applications, advantages and limitations of WJM	CO4	L2
c	Application Areas	CO	Level
1	Threading of various glass and ceramic material.	CO2	L2
2	Removing glue and paint from leather objectives	CO3	L2
3	Cleaning and descaling operation	CO4	L2
d	Review Questions	-	-
6	Explain with help of a neat sketch the working principle of ultra-sonic machining process, and also mention its advantages.	CO2	L2
7	Explain how various process parameters influences the material removal rate in ultra-sonic machining process	CO2	L2
8	What are the advantages and disadvantages of USM	CO2	L2
9	Explain with graph the effect of various parameters on material removal rate in USM process	CO2	L2
10	State and explain the working and principle of AJM	CO2	L2
11	List the application of AJM	CO2	L2

12	Explain the desired properties of abrasive material used in abrasive jet machining	CO2	L2
13	Explain how following parameters influences the material removal rate in abrasive jet machining process i) Nozzle tip distance ii) Velocity of abrasive iii) abrasive flow rate iv) Gas pressure	CO2	L2
14	What are the different types of abrasives used in ASM	CO3	L2
15	How does ASM differ from conventional sand blasting process	CO3	L2
16	Mention the advantages and disadvantages of WJM	CO4	L2
17	Which are the abrasive materials used in water jet machining	CO4	L2
e	Experiences	-	-
1			
2			
5			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	15ME554	Sem:	V	Marks:	30	Time:	75 minutes	
Course:	Non Traditional Machining							
-	-	Note: Answer any 2 questions, each carry equal marks.				Marks	CO	Level
1	a	Justify the need of unconventional machining manufacturing process in today's industries.				7	CO1	L2
	b	What are the difference between conventional and non conventional machining process.				8	CO1	L2
OR								
2	a	Explain with neat diagram construction and working of USM processes.				7	CO2	L2
	b	Write a note on process capability of USM.				8	CO2	L2
OR								
3	a	With neat sketch explain the working of abrasive jet machining.				8	CO3	L2
	b	What are the process variables that affect the performance of abrasive jet machining?				7	CO3	L2
OR								
4	a	With neat sketch explain the working principle of water jet machining.				8	CO4	L2
	b	What are the advantages and disadvantages of water jet machining.				7	CO4	L2

b. Assignment -1

Model Assignment Questions								
Crs Code:	15ME554	Sem:	5	Marks:	5 /	Time:	90 – 120 minutes	
Course:	Non Traditional Machining							
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.								
SNo	USN	Assignment Description				Marks	CO	Level
1		Justify the need of unconventional manufacturing process in today industries.				5	CO1	L2
2		Differentiate between conventional and Non-conventional manufacturing process .				5	CO2	L2
3		Explain how the non- conventional machining processes are classified.					CO2	L2
4		List and explain the various factors to be considered for selection of machining processes .				5	CO1	L2
5		Make a comparison between traditional and non- traditional machining process in terms of cost ,application, scope, machine time and limitations.				5	CO1	L2
6		Explain with help of a neat sketch the working principle of ultra-sonic machining process, and also mention its advantages.				8	CO2	L2
7		Explain how various process parameters influences the material removal rate in ultra-sonic machining process				5	CO2	L2

8	What are the advantages and disadvantages of USM	5	CO2	L2
9	Explain with graph the effect of various parameters on material removal rate in USM process	5	CO2	L2
10	State and explain the working and principle of AJM	8	CO3	L2
11	List the application of AJM	5	CO3	L2
12	Explain the desired properties of abrasive material used in abrasive jet machining	5	CO3	L2
13	Explain how following parameters influences the material removal rate in abrasive jet machining process i) Nozzle tip distance ii) Velocity of abrasive iii) abrasive flow rate iv) Gas pressure	5	CO3	L2
14	What are the different types of abrasives used in ASM	5	CO3	L2
15	How does ASM differ from conventional sand blasting process	5	CO3	L2
16	Mention the advantages and disadvantages of WJM	5	CO4	L2
17	Which are the abrasive materials used in water jet machining	5	CO4	L2
18	Justify the need of unconventional manufacturing process in today industries.	5	CO1	L2
19	Differentiate between conventional and Non-conventional manufacturing process .	5	CO2	L2
20	Explain how the non- conventional machining processes are classified.		CO2	L2
21	List and explain the various factors to be considered for selection of machining processes .	5	CO1	L2
22	Make a comparison between traditional and non- traditional machining process in terms of cost ,application, scope, machine time and limitations.	5	CO1	L2
23	Explain with help of a neat sketch the working principle of ultra-sonic machining process, and also mention its advantages.	8	CO2	L2
24	Explain how various process parameters influences the material removal rate in ultra-sonic machining process	5	CO2	L2
25	What are the advantages and disadvantages of USM	5	CO2	L2
26	Explain with graph the effect of various parameters on material removal rate in USM process	5	CO2	L2
27	State and explain the working and principle of AJM	8	CO3	L2
28	List the application of AJM	5	CO3	L2
29	Explain the desired properties of abrasive material used in abrasive jet machining	5	CO3	L2
30	Explain how following parameters influences the material removal rate in abrasive jet machining process i) Nozzle tip distance ii) Velocity of abrasive iii) abrasive flow rate iv) Gas pressure	5	CO3	L2
31	What are the different types of abrasives used in ASM	5	CO3	L2
32	How does ASM differ from conventional sand blasting process	5	CO3	L2
33	Mention the advantages and disadvantages of WJM	5	CO4	L2
34	Which are the abrasive materials used in water jet machining	5	CO4	L2
35	Justify the need of unconventional manufacturing process in today industries.	5	CO1	L2
36	Differentiate between conventional and Non-conventional manufacturing process .	5	CO2	L2
37	Explain how the non- conventional machining processes are classified.		CO2	L2
38	List and explain the various factors to be considered for selection of machining processes .	5	CO1	L2
39	Make a comparison between traditional and non- traditional machining process in terms of cost ,application, scope, machine time and limitations.	5	CO1	L2
40	Explain with help of a neat sketch the working principle of ultra-sonic machining process, and also mention its advantages.	8	CO2	L2
41	Explain how various process parameters influences the material removal rate in ultra-sonic machining process	5	CO2	L2
42	What are the advantages and disadvantages of USM	5	CO2	L2
43	Explain with graph the effect of various parameters on material removal rate in USM process	5	CO2	L2

44		State and explain the working and principle of AJM	5	CO3	L2
45		List the application of AJM	5	CO3	L2
46		Justify the need of unconventional manufacturing process in today industries.	5	CO3	L2
47		Differentiate between conventional and Non-conventional manufacturing process .	5	CO3	L2

D2. TEACHING PLAN - 2

Module – 3

Title:	Introduction	Appr Time:	10 Hrs
a	Course Outcomes	-	Blooms
-	The student should be able to:	-	Level
1	Understand constructional features and performance of ECM.	CO5	L2
2	Understand constructional features and performance of CHM.	CO6	L2
b	Course Schedule		
Class No	Module Content Covered	CO	Level
1	Introduction, Principle of electro chemical machining: ECM equipment, elements of ECM Operation, Chemistry of ECM.	C5	L2
2	ECM Process characteristics: Material removal rate, accuracy, Surface finish.	C5	L2
3	Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of Electrolytes.	C5	L2
4	ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM:	C5	L2
5	Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECM	C5	L2
6	CHM Elements of the process: Resists (maskants), Etchants.	C6	L2
7	Types of chemical machining process chemical Blanking process,	C6	L2
8	chemical milling process.	C6	L2
9	Process characteristics of CHM: material removal rate, accuracy, surface finish	C6	L2
10	advantages, limitations and applications of chemical machining process	C6	L2
c	Application Areas	CO	Level
1	Facing and turning of 3D object.	CO5	L2
2	Grinding of carbide tool	CO6	L2
d	Review Questions	-	-
1	With suitable sketches, explain the material removal mechanisms in electro chemical grinding	CO5	L2
2	Why electro chemical machining considered as chip less machining? Explain the mechanisms of metal removal on both cases and compare it with conventional grinding process	CO5	L2
3	What are the advantages and disadvantages of ECM	CO5	L2
4	What are the factors that influences oxidation of ECM	CO5	L2
5	Explain the principle of electro chemical grinding, with neat sketch	CO5	L2
6	Explain with diagram, working of electro chemical grinding	CO5	L2
7	Explain in brief the following in chemical machining processes i. Maskants ii. Etchants	CO6	L2
8	With the help of neat sketches, explain the different steps involved in chemical blanking.	CO6	L2
9	Explain the principle steps involved in chemical milling to produce pockets and contours	CO6	L2
10	List out the advantages and disadvantages of chemical machining	CO6	L2

11	List out major applications of CHM. Further process application related to improving the surface characteristics	CO6	L2
12	Explain the elements of chemical machining process	CO6	L2
13	Explain the mechanisms of metal removal on both cases and compare it with conventional grinding process	CO6	L2
14	Explain the principle steps involved in chemical milling to produce pockets and contours	CO6	L2
15	Why chemical machining considered as chip less machining?	CO6	L2
e	Experiences	-	-
1			
2			
3			
4			
5			

Module – 4

Title:	Present, future and annual worth and rate of returns	Appr Time:	10 Hrs
a	Course Outcomes	-	Blooms
-	The student should be able to:	-	Level
1	Understand constructional features and performance of EDM.	CO7	L2
2	Understand constructional features and performance of PAM.	CO8	L2
b	Course Schedule		
Class No	Module Content Covered	CO	Level
1	Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (Relaxation type),	CO7	L2
2	dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM	CO7	L2
3	process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone.	CO7	L2
4	Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.	CO7	L2
5	PLASMA ARC MACHINING (PAM) Introduction, non-thermal generation of plasma,	CO8	L2
6	equipment mechanism of metal removal, Plasma torch,	CO8	L2
7	process parameters, process characteristics.	CO8	L2
8	Safety precautions. Safety Precautions, applications, advantages and limitations.	CO8	L2
c	Application Areas	CO	Level
1	Turning of metallic object	CO7	L2
2	Arc spraying on surface	CO8	L2
d	Review Questions	-	-
1	Discuss the factors influencing the choice of electrode material in EDM	CO7	L2
2	Explain with help of a neat sketches any two types of flushing methods used in EDM	CO7	L2
3	Explain with help of neat sketches the mechanisms of metal removal in EDM process, and also mention its advantages and disadvantages	CO7	L2
4	Name some of the dielectric fluids commonly used in EDM. Name some of the tool material used in EDM	CO7	L2
5	What are the basic requirements of the dielectric fluid used in EDM	CO7	L2
6	With the help of neat sketch, explain wire cut electrical discharge machining	CO7	L2
7	With a neat sketch explain the Plasma arc machining (PAM) process and also mention its applications	CO8	L2
8	Which are the important considerations are to be made in the design of plasma torch	CO8	L2

9	Mention any two advantages and disadvantages of plasma arc machining	CO8	L2
10	Explain the basic principal of PAM	CO8	L2
11	Write the application of plasma arc machining	CO8	L2
e	Experiences	-	-
1			
2			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	15ME554	Sem:	V	Marks:	30	Time:	75 minutes	
Course:	Non Traditional Machining							
-	-	Note: Answer any 2 questions, each carry equal marks.				Marks	CO	Level
1	a	Explain with help of a neat sketches any two types of flushing methods used in EDM				8	CO7	L2
	b	Explain with help of neat sketches the mechanisms of metal removal in EDM process, and also mention its advantages and disadvantages				7	CO7	L2
		OR						
2	a	What are the basic requirements of the dielectric fluid used in EDM				7	CO7	L2
	b	With the help of neat sketch, explain wire cut electrical discharge machining				8	CO7	L2
		OR						
3	a	With a neat sketch explain the Plasma arc machining (PAM) process and also mention its applications				8	CO8	L2
	b	Which are the important considerations are to be made in the design of plasma torch				7	CO8	L2
		OR						
4	a	Mention any two advantages and disadvantages of plasma arc machining				8	CO8	L2
	b	Explain the basic principal of PAM				7	CO8	L2

b. Assignment – 2

Model Assignment Questions								
Crs Code:	15ME554	Sem:	5	Marks:	5 /	Time:	90 – 120 minutes	
Course:	Non Traditional Machining							
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.								
SNo	USN	Assignment Description				Marks	CO	Level
1		Discuss the factors influencing the choice of electrode material in EDM				5	CO7	L2
2		Explain with help of a neat sketches any two types of flushing methods used in EDM				5	CO7	L2
3		Explain with help of neat sketches the mechanisms of metal removal in EDM process, and also mention its advantages and disadvantages				5	CO7	L2
4		Name some of the dielectric fluids commonly used in EDM. Name some of the tool material used in EDM				5	CO7	L2
5		What are the basic requirements of the dielectric fluid used in EDM				5	CO7	L2
6		With the help of neat sketch, explain wire cut electrical discharge machining				5	CO7	L2
7		With a neat sketch explain the Plasma arc machining (PAM) process and also mention its applications				5	CO8	L2
8		Which are the important considerations are to be made in the design of plasma torch				5	CO8	L2
9		Mention any two advantages and disadvantages of plasma arc machining				5	CO8	L2
10		Explain the basic principal of PAM				5	CO8	L2
11		Write the application of plasma arc machining				5	CO8	L2
12		Discuss the factors influencing the choice of electrode material in EDM				5	CO7	L2

13	Explain with help of a neat sketches any two types of flushing methods used in EDM	5	CO7	L2
14	Explain with help of neat sketches the mechanisms of metal removal in EDM process, and also mention its advantages and disadvantages	5	CO7	L2
15	Name some of the dielectric fluids commonly used in EDM. Name some of the tool material used in EDM	5	CO7	L2
16	What are the basic requirements of the dielectric fluid used in EDM	5	CO7	L2
17	With the help of neat sketch, explain wire cut electrical discharge machining	5	CO7	L2
18	With a neat sketch explain the Plasma arc machining (PAM) process and also mention its applications	5	CO8	L2
19	Which are the important considerations are to be made in the design of plasma torch	5	CO8	L2
20	Mention any two advantages and disadvantages of plasma arc machining	5	CO8	L2
21	Explain the basic principal of PAM	5	CO8	L2
22	Write the application of plasma arc machining	5	CO8	L2
23	Discuss the factors influencing the choice of electrode material in EDM	5	CO7	L2
24	Explain with help of a neat sketches any two types of flushing methods used in EDM	5	CO7	L2
25	Explain with help of neat sketches the mechanisms of metal removal in EDM process, and also mention its advantages and disadvantages	5	CO7	L2
26	Name some of the dielectric fluids commonly used in EDM. Name some of the tool material used in EDM	5	CO7	L2
27	What are the basic requirements of the dielectric fluid used in EDM	5	CO7	L2
28	With the help of neat sketch, explain wire cut electrical discharge machining	5	CO7	L2
29	With a neat sketch explain the Plasma arc machining (PAM) process and also mention its applications	5	CO8	L2
30	Which are the important considerations are to be made in the design of plasma torch	5	CO8	L2
31	Mention any two advantages and disadvantages of plasma arc machining	5	CO8	L2
32	Explain the basic principal of PAM	5	CO8	L2
33	Write the application of plasma arc machining	5	CO8	L2
34	Discuss the factors influencing the choice of electrode material in EDM	5	CO7	L2
35	Explain with help of a neat sketches any two types of flushing methods used in EDM	5	CO7	L2
37	Name some of the dielectric fluids commonly used in EDM. Name some of the tool material used in EDM	5	CO7	L2
38	What are the basic requirements of the dielectric fluid used in EDM	5	CO7	L2
39	With the help of neat sketch, explain wire cut electrical discharge machining	5	CO7	L2
40	With a neat sketch explain the Plasma arc machining (PAM) process and also mention its applications	5	CO8	L2
41	Which are the important considerations are to be made in the design of plasma torch	5	CO8	L2
42	Mention any two advantages and disadvantages of plasma arc machining	5	CO8	L2
43	Explain the basic principal of PAM	5	CO8	L2
44	Write the application of plasma arc machining	5	CO8	L2
45	Discuss the factors influencing the choice of electrode material in EDM	5	CO7	L2
46	Explain with help of a neat sketches any two types of flushing methods used in EDM	5	CO7	L2
47	Explain with help of neat sketches the mechanisms of metal removal in EDM process, and also mention its advantages and disadvantages	5	CO7	L2

D3. TEACHING PLAN - 3

Module – 5

Title:	Costing and depreciation	Appr Time:	10 Hrs
a	Course Outcomes	-	Blooms

-	The student should be able to:	-	Level
1	understand constructional features and performance of LBM.	CO9	L2
2	understand constructional features and performance of EBM.	CO10	L2
b Course Schedule			
Class No	Module Content Covered	CO	Level
1	LASER BEAM MACHINING (LBM)Introduction, generation of LASER,	CO9	L2
2	Equipment and mechanism of metal removal,	CO9	L2
3	LBM Parameters and characteristics,	CO9	L2
4	Applications, Advantages &limitations.	CO9	L2
5	ELECTRON BEAM MACHINING (EBM)Introduction,	CO10	L2
6	Principle, equipment .	CO10	L2
7	Mechanism of metal removal,	CO10	L2
8	Applications advantages and limitations.	CO10	L2
c Application Areas			
1	Welding of material.	CO10	L2
2	Finishing Injector nozzle of diesel engine.	CO9	L2
d Review Questions			
			L2
1	With a neat sketch, explain the mechanism of metal removal in LBM process.	CO9	L2
2	list out the commonly used gasses in LBM.	CO9	L2
3	What are the advantages and application of LBM.	CO9	L2
4	Explain typical laser system adopted for machining processes.	CO9	L2
5	Explain how the electron beam is generated in EBM process.	CO10	L2
6	What are the important characteristics required for electron beam in electron beam machining.	CO10	L2
7	Explain with a neat sketch, EBM and list out its advantages.	CO10	L2
8	State the advantages and application of EBM.	CO10	L2
9	Write the application of EBM.	CO10	L2
e Experiences			
1		-	-

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	15ME554	Sem:	V	Marks:		Time:	75 minutes	
Course:	Non Traditional Machining							
-	-	Note: Answer any 2 questions, each carry equal marks.				Marks	CO	Level
1	a	With a neat sketch, explain the mechanism of metal removal in LBM process.				8	CO9	L2
	b	list out the commonly used glasses in LBM.				7	CO9	L2
OR								
2	a	What are the advantages and application of LBM.				7	CO9	L2
	b	Explain typical laser system adopted for machining processes.				8	CO9	L2
OR								
3	a	What are the important characteristics required for electron beam in electron beam machining.				8	CO10	L2
	b	Explain with a neat sketch, EBM and list out its advantages.				7	CO10	L2
OR								
4	a	State the advantages and application of EBM.				8	CO10	L2
	b	Write the application and disadvantages of EBM.				7	CO10	L2

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions

Crs Code:	15ME554	Sem:	5	Marks:	5 /	Time:	90 – 120 minutes
Course:	Non Traditional Machining						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							
SNo	USN	Assignment Description	Marks	CO	Level		
1		With a neat sketch, explain the mechanism of metal removal in LBM process.	5	CO9	L2		
2		list out the commonly used gasses in LBM.	5	CO9	L2		
3		What are the advantages and application of LBM.	5	CO9	L2		
4		Explain typical laser system adopted for machining processes.	5	CO9	L2		
5		Explain how the electron beam is generated in EBM process.	5	CO10	L2		
6		What are the important characteristics required for electron beam in electron beam machining.	5	CO10	L2		
7		Explain with a neat sketch, EBM and list out its advantages.	5	CO10	L2		
8		State the advantages and application of EBM.	5	CO10	L2		
9		Write the application of EBM.	5	CO10	L2		
10		With a neat sketch, explain the mechanism of metal removal in LBM process.	5	CO9	L2		
12		What are the advantages and application of LBM.	5	CO9	L2		
13		Explain typical laser system adopted for machining processes.	5	CO9	L2		
14		Explain how the electron beam is generated in EBM process.	5	CO10	L2		
15		What are the important characteristics required for electron beam in electron beam machining.	5	CO10	L2		
16		Explain with a neat sketch, EBM and list out its advantages.	5	CO10	L2		
17		State the advantages and application of EBM.	5	CO10	L2		
18		Write the application of EBM.	5	CO10	L2		
19		With a neat sketch, explain the mechanism of metal removal in LBM process.	5	CO9	L2		
20		list out the commonly used gasses in LBM.	5	CO9	L2		
21		What are the advantages and application of LBM.	5	CO9	L2		
22		Explain typical laser system adopted for machining processes.	5	CO9	L2		
23		Explain how the electron beam is generated in EBM process.	5	CO10	L2		
24		What are the important characteristics required for electron beam in electron beam machining.	5	CO10	L2		
25		Explain with a neat sketch, EBM and list out its advantages.	5	CO10	L2		
26		State the advantages and application of EBM.	5	CO10	L2		
28		With a neat sketch, explain the mechanism of metal removal in LBM process.	5	CO9	L2		
29		list out the commonly used gasses in LBM.	5	CO9	L2		
30		What are the advantages and application of LBM.	5	CO9	L2		
31		Explain typical laser system adopted for machining processes.	5	CO9	L2		
32		Explain how the electron beam is generated in EBM process.	5	CO10	L2		
33		What are the important characteristics required for electron beam in electron beam machining.	5	CO10	L2		
34		Explain with a neat sketch, EBM and list out its advantages.	5	CO10	L2		
35		State the advantages and application of EBM.	5	CO10	L2		
36		Write the application of EBM.	5	CO10	L2		
37		With a neat sketch, explain the mechanism of metal removal in LBM process.	5	CO9	L2		
38		list out the commonly used gasses in LBM.	5	CO9	L2		
39		What are the advantages and application of LBM.	5	CO9	L2		
40		Explain typical laser system adopted for machining processes.	5	CO9	L2		
41		Explain how the electron beam is generated in EBM process.	5	CO10	L2		
42		What are the important characteristics required for electron beam in electron beam machining.	5	CO10	L2		
43		Explain with a neat sketch, EBM and list out its advantages.	5	CO10	L2		
44		State the advantages and application of EBM.	5	CO10	L2		
46		With a neat sketch, explain the mechanism of metal removal in LBM process.	5	CO9	L2		

F. EXAM PREPARATION

1. University Model Question Paper

Course:		Non Traditional Machining				Month / Year	M /2018		
Crs Code:		15ME554	Sem:	v	Marks:	80	Time:	180 minutes	
	Note	Answer all FIVE full questions. All questions carry equal marks.					Marks	CO	Level
1	a	Define and Classify Non –Traditional machining process					6	CO1	L2
	b	Explain the need of Non –Traditional machining process.					5	CO1	L2
	c	List the advantages and disadvantages of Non –Traditional machining process.					5	CO1	L2
OR									
-	a	Enumerate the physical parameters of the Non–Traditional machining process					6	CO1	L2
	b	Discuss the process capability of any two Non –Traditional machining process.					5	CO1	L2
	c	Differentiate Traditional and Non –Traditional machining process.					5	CO1	L2
2	a	Sketch and explain Ultrasonic machining process.					6	C02	L2
	b	Explain the influence of various process parameters on MRR in USM.					5		L2
	c	Explain, how does abrasive jet machining differ from conventional sand blasting process?					5	C02	L2
OR									
-	a	What are the different types of abrasives used in AJM? Explain any two.					6	CO3	L2
	b	With neat sketch explain the working principle of Abrasive Jet machining process.					5	CO3	L2
	c	With the help of neat sketch explain Water Jet Machining process.					5	CO4	L2
3	a	Explain different elements of electro chemical machining process.					6	CO5	L2
	b	Sketch and explain the electro chemical grinding operation.					5	CO5	L2
	c	With neat sketch, explain the working principle of ECM process.					5	CO5	L2
	d								
OR									
-	a	Sketch and explain different steps involved in the chemical machining process.					6	CO6	L2
	b	Explain in brief the following in chemical machining process: i) Maskants, ii) Etchants					5	CO6	L2
	c	List the advantages, limitations and applications of chemical machining process.					5	CO6	L2
4	a	Sketch and explain the electrode feed control used in EDM process.					6	CO7	L2
	b	Explain with sketch the travelling wire EDM process.					5	CO7	L2
	c	Sketch and explain various die electric flow patterns of EDM process					5	CO7	L2
OR									
-	a	Explain with sketch the principle of working of plasma arc machining process.					8	CO8	L2
	b	List the safety precautions, advantages, limitations and applications of PAM process					8	CO8	L2
5	a	Sketch and explain Laser beam machining process.					6	CO9	L2
	b	Discuss various process parameters of LBM process.					5	CO9	L2
	c	List the advantages, limitations and applications of LBM process.					5	CO9	L2
OR									
	a	Explain with sketch the principle of working of Electron beam machining process.					6	CO10	L2
	b	State the advantages and limitations of EBM process					5	CO10	L2
	c	Describe the apparatus used to generate the Laser.					5	C010	L2

2. SEE Important Questions

Course:		Non Traditional Machining				Month / Year	May /2018		
Crs Code:		15ME554	Sem:	V	Marks:	80	Time:	180 minutes	
	Note	Answer all FIVE full questions. All questions carry equal marks.					-	-	
Modul	Qno.	Important Question					Marks	CO	Year

e					
1	1	Differentiate between conventional and Non-conventional manufacturing process .	5	C01	2015
	2	List and explain the various factors to be considered for selection of machining processes .	6	C01	2015
	3	Explain how the non- conventional machining processes are classified.	6	C01	2016
	4	List and explain the various factors to be considered for selection of machining processes .	5	C01	2016
	5	Make a comparison between traditional and non- traditional machining process in terms of cost ,application, scope, machine time and limitations.	5	C01	2017
2	1	Explain with neat diagram construction and working of USM processes.	5	C02	2014
	2	Explain with graph the effect of various parameters on material removal rate in USM process.	6	C02	2016
	3	Explain with neat diagram construction and working of AJM processes.	5	C03	2015
	4	Explain with neat diagram construction and working of WJM processes.	8	C04	2017
	5	Mention the advantages and disadvantages of WJM	5	C04	2016
3	1	Why electro chemical machining considered as chip less machining? Explain the mechanisms of metal removal on both cases and compare it with conventional grinding process	8	C05	2016
	2	With suitable sketches, explain the material removal mechanisms in electro chemical grinding	5	C05	2015
	3	Explain the principle of electro chemical grinding, with neat sketch	6	C05	2016
	4	List out major applications of CHM. Further process application related to improving the surface characteristics	7	C06	2017
	5	Explain the principle steps involved in chemical milling to produce pockets and contours .	7	C06	2016
4	1	Explain with help of a neat sketches any two types of flushing methods used in EDM.	7	C07	2015
	2	What are the basic requirements of the dielectric fluid used in EDM	6	C07	2014
	3	With the help of neat sketch, explain wire cut electrical discharge machining	5	C07	2016
	4	Explain the basic principal of PAM	5	C08	2015
	5	Which are the important considerations are to be made in the design of plasma torch	6	C08	2017
5	1	With a neat sketch, explain the mechanism of metal removal in LBM process. What are the advantages and application of LBM.	7	C09	2016
	2	Explain typical laser system adopted for machining processes.	5	C09	2017
	3	Explain how the electron beam is generated in EBM process.	5	C010	2016
	4	What are the important characteristics required for electron beam in electron beam machining.	6	C010	2015
	5	Explain with a neat sketch, EBM and list out its advantages.	5	C010	2016

G. Content to Course Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Module- #	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
-----------	---	------------------------	-------------------------------------	---------------------	--------------------------------------	----------------------------------	--

A	B	C	D	E	F	G	H
1	Introduction to Non-traditional machining: Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Nontraditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.	8	- L1 - L2	L2	Understd the concept of NTM process	Lecture/T utorial	Assignment
2	Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM	4	- L1 - L2	L2	UnderstUS M Machining	Lecture/T utorial	Assignment
2	Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics - Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.	2	- L1 - L2	L2	UnderstAJ M Machining	Lecture/T utorial	Assignment
2	Water Jet Machining (WJM): Equipment & process, Operation, applications, advantages and limitations of WJM.	2	- L1 - L2	L2	UnderstW JM Machining	Lecture/T utorial	Assignment
3	Introduction, Principle of electro chemical machining: ECM equipment, elements of ECM Operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, Surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of Electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECM.	5	- L1 - L2	L2	UnderstEC M Machining	Lecture/T utorial	Assignment
3	CHM Elements of the process: Resists (maskants), Etchants. Types of chemical machining process chemical Blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.	5	- L1 - L2	L2	UnderstC HM Machining	Lecture/T utorial	Assignment
4	Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (Relaxation type), dielectric medium - its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge	4	- L1 - L2	L2	UnderstE DM Machining	Lecture/T utorial	Assignment

	grinding, Traveling wire EDM.						
4	PLASMA ARC MACHINING (PAM) Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety Precautions, applications, advantages and limitations.	5	- L1 - L2	L2	UnderstPAM Machining	Lecture/Tutorial	Assignment
5	LASER BEAM MACHINING (LBM) Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM Parameters and characteristics, Applications, Advantages & limitations.	4	- L1 - L2	L2	UnderstILBM Machining	Lecture/Tutorial	Assignment
5	ELECTRON BEAM MACHINING (EBM) Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.	4	- L1 - L2	L2	UnderstEBM Machining	Lecture/Tutorial	Assignment

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Module #	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome Student Should be able to ...
A	I	J	K	L	M	N
1	-	-	Product Life cycle model	field of Product Life cycle model	- Understand - field of Product Life cycle model	Understand the field of Product Life cycle model
1	-	-	Product Data	the Product data management	- Understand -the Product data management	Understand the Product data management
2	-	-	Product design and Planning	the process of planning and design of product model	- Understand - the process of planning and design of product model	Understand the process of planning and design of product model
2	-	-	selection techniques for PDM	Recycling and simulation for PDM Techniques	- Understand - Recycling and simulation for PDM Techniques	Understand the knowledge for selecting the techniques to recycling and simulation for PDM
3	-	-	Production Control techniques	new product development through controlled techniques	- Understand - new product development through controlled techniques	Understand the concept of new product development through controlled techniques
3	-	-	new product Building	structure of the new product to build	- Understand - structure of the new product to build	Understand a concept of structure of the new product to build
4	-	-	development approaches	product development approaches	- Understand - product development approaches	Understand techniques of product development approaches
4	-	-	Methods and tools of Forecasting	different methods and tools of Forecasting	- Understand - different methods and tools of Forecasting innovations	Understand different methods and tools of Forecasting innovations
5	-	-	Product	product building	- Understand	Understand the product

	-	-	configurations	configurations	- product building configurations	configurations to build new product
5			Product Structure	analysis of product structure	- Understand - analysis of product structure	Understand the analysis of product structure