Government of Karnataka
DEPARTMENT OF COLLEGIATE and TECHNICAL EDUCATION

Program	Mechanical Engineering	Semester	5
Course Code	20ME53I	Type of Course	L: T:P (104:52:312)
Specialization	Advanced Manufacturing Technologies	Credits	24
CIE Marks	240	SEE Marks	160

Introduction: Welcome to the curriculum for the Specialisation Pathway – **ADVANCED MANUFACTURING Technologies.** This specialisation course is taught in Bootcamp mode. Bootcamps are 12 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning.

Conventional manufacturing processes, have their inherent drawbacks which cannot be eliminated. In other words, due to their technological constraints, it is not always feasible to produce various components in terms of geometry, dimension, and strength, etc. CNC machining can have difficulties in machining complex shapes due to tool accessibility. High temperature and tool wear are other considerations while machining hard materials.

Advancement in manufacturing processes has drawn preeminent interest from researchers and industry. This makes the process of manufacturing more productive and highly efficient. Advancement of technology has been done by several approaches to combine different manufacturing processes with similar objectives of increasing material removal rate, improving surface integrity, reducing tool wear, reducing production time, and extending application areas. A combination of different processes opens new opportunities and applications for manufacturing various components that are not able to be produced economically by processes on their own.

In this course, you'll learn how to Select a suitable materials and Processes in Advanced manufacturing in accordance with the present Manufacturing Scenario.

Leading to the successful completion of this bootcamp, you shall be equipped to either do an **Internship** in an organisation working on Advanced Manufacturing solution or do a **Project** in the related field. After the completion of your Diploma, you shall be ready to take up Production Supervisor, Engineer, Production Manager and also can become Entrepreneur in the related field and more

This course will teach you about Advanced materials, Advanced Processes, Advanced Manufacturing,

Advanced Inspection and Diagnostics. Details of the curriculum is presented in the section below

Pre-requisite

Before the start of this specialisation course, you will have prerequisite knowledge gained in the first two years on the following subjects:

1st year -Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Electrical and Electronics Engineering, Project Management skills Engineering Materials and Mechanical Workshop

2nd year-Mechanics of Materials, Machine Tool Technology, Manufacturing Process, Fluid Power Engineering, Product Design and Development, Operations Management, CNC Machines and Elements of Industrial Automation

In this year of study, you shall be applying your previous years learning along with specialised field of study into projects and real-world applications.

Instruction to course coordinator

1. Each Pathway is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. Single faculty shall be the Cohort Owner.
3. This course shall be delivered in boot camp mode
4. The industry session shall be addressed by (in contact mode/online / recorded video mode) industry experts only.
5. The cohort owner shall identify experts from the relevant field and organize industry session as per schedule.
6. Cohort owner shall plan and accompany the cohort for industrial visits.
7. Cohort owner shall maintain and document the industrial assignments and weekly assessments, practices and mini project.
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table
9. The cohort owner along with classroom, can augment or use for supplementally teaching, on line courses available although reliable and good quality online platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademic, SWAYAM, etc.
10. Cohort owner shall guide the cohort for the execution of mini project

Course Outcomes: At the end of the Course, the student will be able to:

CO-01	Select suitable Non- Conventional Machining process with Process parameter and machine the component as per the given drawing.
CO-02	Prepare a given component by using 3D Printing manufacturing process.
CO-03	Check the components for Functionality and conformance to defined standards using Measuring instruments.
CO-04	Integrate Automation and IIOT in Advanced Manufacturing

Detailed course plan

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	1		1	Present an overview on Conventional manufacturing process starting from procurement of raw materials to finished product and delivery to the customer			4	Present a Video on components manufactured in Modern manufacturing Industries Virtual tour on modern industries such as automobile sector, aviation sector, Fast Moving Consumer Goods (FMCG) sector etc Present an Overview on Need, Classification and Features of Advanced manufacturing technologies with respect to • Materials • Manufacturing Processes • Automation • Inspection and Quality • Information Technology	2		1
	1		2	• Discuss the Advancement in material technology leading to advancement in Manufacturing Process • Discuss the Properties and Characteristic features of Composite materials, Steel Alloys, Aluminum alloys, Polymers, Glass, Ceramics, Super Alloys	4			• Discuss and record the Application of these materials in making components used in Aircraft, Cutting tools, high temperature applications, Automobiles etc.,	2		1
	1		3	• Discuss the Need and significance of non-Conventional machining process • Discuss classification of non-Conventional machining process • Explain the Principle, Construction and Working of Ultrasonic Machining Process (USM) using Videos	2		2	• Explain Tool materials and their Properties, Tool wear Rate, Abrasive material and Slurry, Work materials used in USM • Discuss the Characteristics of USM • Calculate Metal removal Rate	2		1

				• Explain different Transducers used in USM and Present them using Videos • Discuss the criteria considered for selecting the right type of transducer for the given application • Explain the Process Parameters involved in USM				• Present a Video on the Applications of USM			
	1		4	Prepare a job using USM (ON Campus/ OFF Campus) • Study the component drawing • Select the process Parameter • Perform the process • Check for dimensional accuracies					3		**4**
			5	Developmental Weekly Assessment				Assessment Review and corrective action			3
			6	Industry Class - Use Cases on USM + Industry Assignment			5				
2	1		1	Tutorial (Peer discussion on Industrial assignment)		4		• Explain Principle, Construction and Working of Electro Chemical Machining (ECM) using videos • Discuss the Types of Electrolytes and its selection for different materials	2		1
	1		2	• Discuss types of Tool material, their properties and selection • Discuss the factors governing surface finish in ECM • Discuss the Characteristics of ECM	2		2	• Calculate Metal Removal rate • Present a Videos on the Application of ECM			**3**
	1		3	• Explain Principle, Construction and Working of Chemical Machining (CM) using videos • Types of Chemical machining- Milling, Blanking, Engraving	4			• Steps involved in Chemical machining- Clean, Mask, Scribe, Etch, Demask • Commonly used Etchants- • Applications of Chemical Machining	2		1
	1		4	Prepare a job using ECM (ON Campus/ OFF Campus) • Study the component drawing			**4**	Prepare a job by Chemical Machining (ON Campus/ OFF Campus) • Study the component drawing			**4**

				• Select the process Parameter • Perform the process • Check for dimensional accuracies				• Select the process Parameter • Perform Clean, Mask, Scribe, Etch, Demask • Check for dimensional accuracies			
			5	Developmental Weekly Assessment				Assessment Review and corrective action			3
			6	Industry Class - Use Cases on ECM + Industry Assignment			5				
3	1		1	Tutorial (Peer discussion on Industrial assignment)		4		• Explain the Principle, Construction and Working of Electrical Discharge Machining (EDM) using videos • Discuss types and functions of Dielectric Fluid	1		2
	1		2	• Discuss types of Tool material, their properties and selection • Calculate Metal Removing Rate- Factors affecting MRR	2		2	• Explain the Process Parameters involved in EDM • Discuss the Characteristics of EDM	3		
	1		3	• Discuss and Present a Video on spark Generating circuit/Process used in EDM • Applications of EDM	1		3	• Explain the Principle, Construction and Working of Wire cut electro-Discharge Machining (WCEDM) using videos • Discuss the Features of WCEDM	1		2
	1		4	Prepare a job using – EDM (ON Campus/ OFF Campus) • Study the component drawing • Select the process Parameter • Perform the process • Check for dimensional accuracies			4	Prepare a job using – WCEDM (ON Campus/ OFF Campus) • Study the component drawing • Select the process Parameter • Perform the process • Check for dimensional accuracies			3
			5	CIE 1– Written and practice test				Assessment Review and corrective action			3
			6	Industry Class - Use cases on EDM/WCEDM+ Industry Assignment			5				

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P

4	1		1	Tutorial (Peer discussion on Industrial assignment)		4		• Explain the Principle, Construction and Working of Electron Beam Machining (EBM) using videos				3
	1		2	• Explain the Process Parameters that influence Beam intensity • Explain the Process Parameters that influence Metal Removal Rate	3			• Discuss the Characteristics of EBM • Calculate Metal Removal Rate • Present a Video on the Applications of EBM	2		1
	1		3	• Explain the Principle, Construction and Working of Laser Beam Machining (LBM) using videos • Discuss different Laser materials used in LBM	1		3	• Discuss the Characteristics of LBM • Calculate Metal Removal Rate • Present a Video on the Applications of LBM			3
	1		4	Prepare a job using EBM (ON Campus/ OFF Campus) • Study the component drawing • Select the process Parameter • Perform the process • Check for dimensional accuracies			4	Prepare a job using LBM (ON Campus/ OFF Campus) • Study the component drawing • Select the process Parameter • Perform the process • Check for dimensional accuracies			4
			5	Developmental Weekly Assessment				Assessment Review and corrective action			3
			6	Industry Class - use cases on EBM, LBM, PAM + Industry Assignment			5				
5	2		1	Tutorial (Peer discussion on Industrial assignment)		4		• Explain the General Overview on Additive Manufacturing (AM) • Present a Video on the evolution of AM, Need, Benefits • Present a Video on components made using AM	1		2
	2		2	Additive Manufacturing Technologies (AM)– Explain and Demonstrate the Additive Manufacturing Techniques- Liquid Based Additive Manufacturing 1.1 Melting 1.1.1 Fusion Deposit Modelling 1.2 Polymerization	2		2	3.0 Powder based Additive Manufacturing 3.1 Melting 3.1.1 Selective Laser Sintering 3.1.2 Electron Beam Sintering 3.1.3 Laser Engineered Net Shaping 3.2 Binding 3.2.1 3 – Dimensional Printing	1		2

				1.2.1 Stereolithography 1.2.2 Poly jet 2.0 Solid Based Additive Manufacturing 2.1 Laminated object manufacturing				3.2.2 Pro Metal (Binder Jetting)			
	2		3	Discuss the Bio-Medical, Aviation, Automobile Application of Additive Manufacturing			4	**Materials used in additive manufacturing-** Discuss the Properties and Applications of Additive manufacturing materials- • Ceramics • Plastics: Acrylonitrile Butadiene Styrene (ABS), Polylactide (PLA), Polyethylene Terephthalate (PET), Polycarbonate (PC) • Polymers	2		1
	2		4	Discuss the Properties and Applications of Additive manufacturing materials- • Metals and alloys- Cobalt based Alloys, Aluminum based Alloys, Nickel based Alloys, Stainless steel, Titanium alloys	3			Discuss the Properties and Applications of Additive manufacturing materials- • Composites- Polymer base, Metal based, Ceramic based • Smart materials- Shape memory Polymer and Alloys	3		
			5	CIE 2– Written and practice test				Assessment Review and corrective action			3
			6	Industry Class - Use case on Additive manufacturing techniques + Industry Assignment			5				

6	2		1	Tutorial (Peer discussion on Industrial assignment)		4		Binding Mechanisms/Techniques- 1) Discuss on Chemical induced Binding • Reactive binding • Polymerization	1		2
	2		2	2) Discuss on Secondary phase assisted binding • Adhesive Additives • Evaporation and Hydration Binding • Liquid Phase Sintering: In-Process, Post Process infiltration	1	2		3) Liquid Fusion • Low Viscous flow • Melting: Partial Melting, Full Melting 4) Solid State Sintering	1		2

	2		3	**Explain Generic AM Process** 1. 3D CAD Modelling 2. STL File Conversion 3. File transfer to machine 4. Machine Set up 5. Part building 6. Part Removing 7. Post- Process			3	• Introduction to 3 - D Printing • Discuss and demonstrate the working principle and Construction of 3-D Printing Machine • Interface CAD Software with Machine • 3-D Scanning and transferring the file to 3-D Printing machine			3
	2		4	Develop an AM Process required to produce the given Component on a 3-D Printing machine • Prepare a Solid model and convert to STL File • Select a suitable material for the given model • Perform Machine setting and upload STL file • Feed the Raw material • Develop the Model and check for accuracies					2		5
			5	Developmental Weekly Assessment				Assessment Review and corrective action			3
			6	Industry Class - Use case on prototype models prepared on 3-D Printing +Industry Assignment			5				
7	2		1	Tutorial (Peer discussion on Industrial assignment)		4		Develop an AM Process required to produce the given Component on a 3-D Printing machine • Prepare a Solid model and convert to STL File • Select a suitable material for the given model • Perform Machine setting and upload STL file • Feed the Raw material • Develop the Model and check for accuracies	3		
	2		2	Develop an AM Process required to produce the given Component on a 3-D Printing machine					2		5

				• Prepare a Solid model and convert to STL File • Select a suitable material for the given model • Perform Machine setting and upload STL file • Feed the Raw material • Develop the Model and check for accuracies							
	2		3	Develop an AM Process required to produce the given Component on a 3-D Printing machine • Prepare a Solid model and convert to STL File • Select a suitable material for the given model • Perform Machine setting and upload STL file • Feed the Raw material • Develop the Model and check for accuracies					2		5
	2		4	Develop an AM Process required to produce the given Component on a 3-D Printing machine • Prepare a Solid model and convert to STL File • Select a suitable material for the given model • Perform Machine setting and upload STL file • Feed the Raw material • Develop the Model and check for accuracies					2		5
			5	CIE 3– Written and practice test				Assessment Review and corrective action			3
			6	Industry Class on Reverse engineering and Modelling + Industry Assignment			5				

Week	CO	PO	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
8	2		1	Tutorial (Peer discussion on Industrial assignment)		4		Develop an AM Process required to produce the given Component on a 3-D Printing machine • Prepare a Solid model and convert to STL File • Select a suitable material for the given model • Perform Machine setting and upload STL file	3		

								• Feed the Raw material • Develop the Model and check for accuracies				
	2		2	Develop an AM Process required to produce the given Component on a 3-D Printing machine • Prepare a Solid model and convert to STL File • Select a suitable material for the given model • Perform Machine setting and upload STL file • Feed the Raw material • Develop the Model and check for accuracies					2		5
	2		3	Develop an AM Process required to produce the given Component on a 3-D Printing machine • Prepare a Solid model and convert to STL File • Select a suitable material for the given model • Perform Machine setting and upload STL file • Feed the Raw material • Develop the Model and check for accuracies					2		5
	2		4	Develop an AM Process required to produce the given Component on a 3-D Printing machine • Prepare a Solid model and convert to STL File • Select a suitable material for the given model • Perform Machine setting and upload STL file • Feed the Raw material • Develop the Model and check for accuracies					2		5
			5	Developmental Weekly Assessment				Assessment Review and corrective action			3
			6	Industry Class -Use case on AM + Industry Assignment			5				
9	3		1	Tutorial (Peer discussion on Industrial assignment)		4		Discuss Latest Technologies used in Inspection and Quality control	3		

	3		2	Perform measurement with desired accuracy to check the components for Functionality and conformance to defined standards using different instruments like Vernier caliper, Vernier height gauge, Micrometer, Depth Gauge, Bevel Protractor, Sine bar, Dial Indicator						2		5
	3		3	Perform measurement with desired accuracy to check the components for Functionality and conformance to defined standards using different instruments like Vernier caliper, Vernier height gauge, Micrometer, Depth Gauge, Bevel Protractor, Sine bar, Dial Indicator						2		5
	3		4	Demonstrate the construction and working Principle of Profile Projector Check the Dimensional Accuracies of the Models using Profile Projector						4		3
			5	CIE 4– Written and practice test				Assessment Review and corrective action				3
			6	Industry Class on used cases on Inspection and Quality control + Industry Assignment			5					

10	3		1	Tutorial (Peer discussion on Industrial assignment)		4		Demonstrate the construction and working Principle of Co-Ordinate Measuring Machines (CMM) using videos.	3		
	3		2	Check the Dimensional Accuracies of the Models using CMM for different Components (ON Campus/ OFF Campus)					2		5
	3		3	Check the Dimensional Accuracies of the Models using CMM for different Components (ON Campus/ OFF Campus)					2		5
	3		4	Discuss and Demonstrate different Non-Destructive testing Methods (ON Campus/ OFF Campus) • Radiography Testing • Ultrasonic Testing • Magnetic Particle Testing			4	Discuss and Demonstrate different Non-Destructive testing Methods (ON Campus/ OFF Campus) • Penetrant Testing • Visual Testing • Electromagnetic testing	1		2
			5	Developmental Weekly Assessment				Assessment Review and corrective action			3
			6	Industry Class on Non-Destructive testing + Industry Assignment			5				

Week	CO	PO	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
11	4		1	Tutorial (Peer discussion on Industrial assignment)		4		Discuss the Role of Automation in Advanced Manufacturing Process Present an Overview on the Levels of Automation-	3		

								• Device level • Machine Level • Cell Level • Plant Level • Enterprise Level Role of CAM (Computer Aided Manufacturing) in Advanced Manufacturing Role of CAPP (Computer Aided Process Planning) in Advanced Manufacturing				
	4		2	Material handling in Advanced Manufacturing: a) Automated Guided Vehicle (AGV)- • Overview on AGV • Working Principle • Applications of AGV's • Types of AGV • AGV Navigation			4	b) Automated storage and Retrieval System (AS/RS) • Overview on AS/RS • Working Principle • Types of AS/RS • Application of AS/RS	1		2
	4		3	Robots in Advanced Manufacturing • Concepts of Industrial Robots • Impacts of Robots in Manufacturing • Application of Robots Types of Robots • Articulated Robots • SCARA Robots • Cartesian Robots • Delta Robots	1		3	Demonstration - Future of Robots in Manufacturing • Lights-Out Manufacturing • Internet of Things Capability • Transformations in Cybersecurity • Collaborative Industrial Robots- Cobots	1		2
	4		4	Visit an Industry which is adopting Automation and Robotic control in Manufacturing					2		5
			5	CIE 5– Written and practice test				Assessment Review and corrective action				3
			6	Industry Class on Robots in Manufacturing + Industry Assignment			5					

12	4		1	Tutorial (Peer discussion on Industrial assignment)		4		**Overview and Video Presentation on** • Industry 4.0 Technologies • Benefits of Industry 4.0 in Manufacturing	3			
	4		2	• Convergence of IT (Information Technology) and OT (Operation Technology) • Technologies which bring Convergence of OT and IT ➢ No code Application ➢ Digital Twins ➢ Augmented Reality ➢ Edge computing	1		3	• Concepts of IIOT (Industry Internet of Things)- How it Works • IIOT – Analytics and Data Management				**3**
	4		3	Demonstrate Adoption of IIOT Technology • Predictive maintenance. • Remote Production Control. • Asset tracking. • Logistics management.	1		3	Demonstrate IIOT for • Sustainability Assessment of Manufacturing Industry • Lean Production System • Smart Factories	1			**2**
	4		4	Visit a Manufacturing Firm which is adopting IIOT					2			**5**
			5	Developmental Weekly Assessment				Assessment Review and corrective action				**3**
			6	Industry Class on Industry IIOT+ Industry Assignment			5					
13			**Internship** **1 Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship.** **2 Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies.** **3 Prepare for an internship interview to highlight your interests, areas of study, career aspirations**					**Project** **Internship/Project Total = 40Hrs** **1 Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective.** **2 Design and develop the project solution or methodology to be used to**			**40Hrs**

			and personnel competence – including the areas of learning you expect to learn during internship.	**solve at least one of the problems identified.** **3 Prepare a project plan that will include a schedule, WBS Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome.**	

Note: Saturday session from 9 AM -2 PM

References:

1. Andreas Gebhardt "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing" Hanser Gardner Publication
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer
3. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press
4. Tom Page "Design for Additive Manufacturing" LAP Lambert Academic Publishing
5. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third edition, World Scientific Publishers
6. Ian Gibson, David W. Rosen, Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer
7. Rapid Prototyping: Laser-based and Other Technologies, Patri K. Venuvinod and Weiyin Ma, Springer, 2004.
8. Electron Beam welding, Schultz H., Woodhead Publishing, 1994
9. Principles of Plasma Discharge and Materials Processing, Lieberman M.A. and Lichtenberg A. J., Wiley Interscience, 1994.

10. Additive Manufacturing of Metals: The Technology, Materials, Design and Production, Li Yang · Keng Hsu · Brian Baughman Donald Godfrey · Francisco Medina Mamballykalathil Menon · Soeren Wiener, Springer, 2017.

11. Laser Additive Manufacturing of High-Performance Materials, Dongdong Gu, Springer, 2015

12. An Introduction to MEMS, Published in 2002 by PRIME Faraday Partnership

13. Unconventional Machining Process by Dr N Senthil Kumar, ARS Publications

14. Unconventional Machining Processes by Dr S Senthil, Suchithra Publications

15. Benedict. G.F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 1987.

16. Mc Geough, "Advanced Methods of Machining", Chapman and Hall, London, 1998.

17. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, "Material and Processes in Manufacturing" Prentice Hall of India Pvt. Ltd., 8thEdition, New Delhi , 2001.

18. IIoT A Complete Guide - 2021 Edition by Gerardus Blokdyk
19. A Practical Guide for IoT Solution Architects By Dr Mehmet Yildiz
20. The Second Machine Age: Work, Progress and Prosperity in a Time of Brilliant Technologies by Erik Brynjolfsson and Andrew McAfee.

CIE and SEE Assessment Methodologies

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1– Written and practice test	4	30
Week 5	CIE 2– Written and practice test	4	30
Week 7	CIE 3– Written and practice test	4	30
Week 9	CIE 4– Written and practice test	4	30
Week 11	CIE 5– Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
TOTAL CIE MARKS (A)			**240**
SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks		**3**	**60**
SEE 2 – Practical		**3**	**100**
TOTAL SEE MARKS (B)			**160**
TOTAL MARKS (A+B)			**400**

* The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods

Assessment framework for CIE (1 to 5)
CIE 1- Model Question Paper

Note: Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam – 4 hours

Programme	**Mechanical Engineering**	**Semester**	**V**		
Course	**Advanced Manufacturing Technologies**	**Max Marks**	**30**		
Course Code	**20ME53I**	**Duration**	**4 hours**		
Name of the course coordinator					
Note: Answer one full question from each section.					
Qn.No	**Question**	**CL L3/L4**	**CO**	**PO**	**Marks**
	Section-1 (Theory) – 10 marks				
1.a)	The materials used in the manufacturing of aircraft have changed significantly from the construction of the first aircraft. With its objective of flying using air support while, resisting gravitational forces, the materials used for the construction of aircraft must have some specific characteristics. Which are the advanced materials used in aircraft and what specific characteristics are present in these materials?	L3	01		05
b)	For the following application, identify one or more non-traditional machining processes that might be used, and present arguments to support your selection. Assume that either the part geometry or the work material (or both) prevents the use of conventional machining. • An engraved aluminium printing plate is to be used in an offset printing press to make 275 x 350 mm (11 x 14 in) posters of Independence Day. The engraving is as follows:" 75 Years of India's Independence"	L4			05
2.a)	Superalloys are used in the most important temperature-limited applications. Specifically, they are usually used for turbine blades. Why are Superalloys important and also, Special?	L3			05

b)	A metal removal rate of 0.01 in3 /min is achieved in a certain EDM operation on a pure iron work part. What metal removal rate would be achieved on nickel in this EDM operation if the same discharge current were used? The melting temperatures of iron and nickel are 2802°F and 2651°F, respectively.	L4			05
Section-2 (Practical) - 20 marks					
3)	Prepare a job using – EDM • Study the component drawing • Select the process Parameter • Perform the process • Check for dimensional accuracies	L4	01		20
4)	Prepare a job by Chemical Machining • Study the component drawing • Select the process Parameter • Perform Clean, Mask, Scribe, Etch, Demask • Check for dimensional accuracies	L4			20

Note : Theory questions shall be aligned to practical questions

Scheme of Evaluation for Practical question- Section 2

Sl. No	Description	Marks: 20
1	Analyze the given drawing and select the process parameter	07
2	Prepare the component by machining	07
3	Check for Dimensional accuracies	04
4	Suggest any innovating changes that can be incorporated	02
	Total	**20**

Assessment framework for SEE 1 (Theory)

Programme	: **Mechanical Engineering**	**Semester**	: **V**
Course	: **Advanced Manufacturing Technologies**	**Max Marks**	: **100**
Course Code	: **20ME53I**	**Duration**	: **3 Hrs**

Instruction to the Candidate: Answer one full question from each section.

Q.No	Question	CL (L3/L4)	CO	Marks
	Section-1			
1.a)	Back in the days, aircraft were constructed using wood and fabrics. But aircraft that are made up of wood and fabric were subject to rapid deterioration and high maintenance. Thus, the search for better materials began. Now, aluminium, steel, titanium and composite materials are preferred in the construction of aerospace structures. Why such materials are used in Aerospace structures? Where else do you find the application of these materials?	L4	01	10
b)	For the following application, identify one or more non-traditional machining processes that might be used, and present arguments to support your selection. Assume that either the part geometry or the work material (or both) prevents the use of conventional machining. The application is a through-hole in the shape of the letter L in a 12.5 mm (0.5 in) thick plate of glass. The size of the "L" is 25 x15 mm (1.0x 0.6 in) and the width of the hole is 3 mm (1/8 in).	L4		10
2.a)	A furniture company that makes chairs and sofas must cut large quantities of fabrics. Many of these fabrics are strong and wear-resistant, which make them difficult to cut. What non-traditional process(es) would you recommend to the company for this application? Justify your answer by indicating the characteristics of the process that make it attractive.	L4		10

b)	An electric discharge machining operation is being performed on two work materials: tungsten and zinc. Determine the amount of metal removed in the operation after 1 hour at a discharge amperage = 20 amps for each of these metals. Express the answer in in^3 /hr. The melting temperatures of tungsten and zinc are 6170°F and 420°F, respectively.	L4		10
	Section-2			
3.a)	Uniform Wares explores the advantages of additive manufacturing (AM) technology, pushing the boundaries of design in an industry traditionally centred around heritage. What benefits exist in additive manufacturing? Differentiate the technologies available in Additive manufacturing and list their applications?	L3	02	10
b)	In additive manufacturing, the material properties are being established alongside the geometry of the part. There are different classes of materials used in additive manufacturing. Differentiate these different materials used in Additive manufacturing with respect to their Properties and Applications?	L4		10
4.a)	The Airbus Helicopters cabin ventilation distributor was originally made by using composite of 7 separate parts. The objective was to minimize the final delivery time by dramatically reducing manufacturing time through 3D printing, using sintering technology, also ensuring lower manufacturing costs. Illustrate how this Process can be achieved?	L3		10
b)	Selective laser sintering (SLS) and 3D printing (3DP) are two powerful and versatile AM techniques which are applicable to powder-based material systems. Differentiate and suggest the best technique among the two. Present arguments to support your selection	L4		10
	Section- 3			
5.a)	Additive Manufacturing (AM) components are known to have various internal defects, such as balling, porosity, internal cracks and thermal/internal stress, which can significantly affect the quality, mechanical properties and safety of final parts. Therefore, inspection methods are important for reducing manufactured defects and improving the surface quality and mechanical properties of AM components. Discuss different inspection methods adopted in AM with their merits and demerits?	L3	03	10
b)	AM-produced parts are being used by NASA in mission-critical situations and in the aviation and power industries where safety and reliability are of prime importance. These parts are tested using Non-Destructive testing methods. Suggest the best Non-Destructive testing method used in this case. Present arguments to support your selection	L4		10
6.a)	3D printing is finally crossing that threshold from prototype to production. However, there are still a few challenges that hold AM back such as quality measures and quality control. These	L3		10

	are essential for repeatability, consistency, scalability, and overall confidence in the process. Discuss different Quality control methods adopted in AM with their merits and demerits?			
b)	NDT methods are used for inspecting Manufactured parts. Why is Non-Destructive Testing (NDT) Important? What Tests are Available? What criterions are considered in selection of these NDT methods?	L4		10
	Section-4			
7.a)	Automation in manufacturing is the process of using production management software or robotic tools to operate a factory when making a physical product. Discuss the various levels of Automation in Advanced Manufacturing.	L4	04	10
b)	Driverless vehicles and navigation systems are improving day after day and are contributing to boost the AGV (Automated guided Vehicle) Market worldwide. Illustrate the working principle of AGV.	L3		10
8.a)	Automated Storage and Retrieval Systems (ASRS or AS/RS) are used in applications where high volumes of inventory move in-and-out of manufacturing or distribution operations. Illustrate how an automated storage and retrieval systems work?	L3		10
b)	Modern organizations engage with two worlds. There is the traditional physical world composed of machines, electromechanical devices, and manufacturing systems. Then, there is the more recent digital world using servers, storage, networking and other devices used to run applications and process data. Does convergence of these two-world beneficial in Advanced manufacturing? Justify your argument with Illustration.	L4		10
	Section-5			
9.a)	Laser Beam machining (LBM) is a well-established machining option for manufacturing geometrically complex or hard material parts that are extremely difficult-to-machine by conventional machining processes. Discuss the process parameters required in LBM process? Suggest a suitable process parameter that need to be considered for this case and justify.	L4	01	10
b)	Illustrate the Working of Electron Beam Machining process	L3		10
10.a)	Ultrasonic machining offers a solution to the expanding need for machining brittle materials such as single crystals, glasses and polycrystalline ceramics, and for increasing complex operations to provide intricate shapes and workpiece profiles. Illustrate the working of USM	L3		10
b)	Electrical discharge machining (EDM) is a well-established machining option for manufacturing geometrically complex or hard material parts that are extremely difficult-to-machine by conventional machining processes. Discuss the process parameters required in an EDM process? Suggest a suitable process parameter that need to be considered for this case and justify	L4		10

Scheme of Evaluation for SEE 2

Sl. No	Description	Marks
Problem statement	Prepare a job using – 3D Printing • Study the component drawing • Select the process Parameter • Perform the process • Check for dimensional accuracies	**100**
1	Prepare a Solid model and convert to STL File	30
2	Select a suitable material for the given model, Perform Machine setting and upload the STL file	20
3	Feed the Raw material and Develop the Model	40
4	Perform measurement with desired accuracy to check the components for Functionality and conformance to defined standards using different instruments.	10
Total		**100**