January 15, 2020

SECOND SEMESTER 2020-2021

Course Handout (Part II)

In addition to the part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No.: ME F425
Course Title: Additive Manufacturing
Instructor-in-Charge: Radha Raman Mishra

1. Course Description

Additive manufacturing is an emerging manufacturing technology that can create a paradigm shift in complex parts production. In this course, the basic principles of Additive Manufacturing (AM), generalized AM process and process chain, modelling of AM processes, transport phenomena models, molten pool formation, and use of different materials in AM will be discussed. Various AM processes such as vat polymerization processes, powder-based AM processes, extrusion-based AM processes, sheet lamination processes and micro- and nano-additive manufacturing processes will be covered with their mechanics of operation. Moreover, selected case studies for modelling of AM processes will be analysed, and applications of AM in industries such as Aerospace, Automotive, Electronics and Biomedical applications will be discussed.

2. Scope and Objective of the Course

The present course introduces theoretical and analytical knowledge about common additive manufacturing processes. Moreover, it enables learners to understand the process and material selection, design of AM processes and industrial applications of AM technologies.

3. Text Books

- Ian Gibson, David W. Rosen, Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing Springer, 2010. **(T1)**
- Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011. **(T2)**

4. Reference Books

1. C. K. Chua, K. F. Leong and C. S. Lim, Rapid Prototyping: Principles and Applications, World Scientific Publishing Company, 3rd Edition, 2010. **(R1)**
- J. O. Milewski, Additive Manufacturing of Metals, Springer Series in Materials Science, ISBN 978-3-319-58205-4 (eBook), 2017. **(R2)**
- S.M. Thompson, L. Bian, N. Shamsaei, & A. Yadollahi, An overview of Direct Laser Deposition for additive manufacturing; Part I & II. Additive Manufacturing, 2015. **(R3)**

5. Course Plan

Module No.	Lecture Session	Reference	Learning outcomes
M1	**L (1-2):** Introduction to AM, concepts of reverse engineering, traditional manufacturing, computer-aided design (CAD) and computer-aided manufacturing (CAM) and AM	T1 and T2	• To understand the basic concepts of AM • To learn principles of different AM processes
	L (3): AM process chain and application levels: direct and indirect processes	T1 and T2	
	L (4): Different AM processes and relevant process physics	T1, R1 and R2	
M2	**L (5-6):** Different materials used in AM, use of multiple materials, multifunctional and graded materials in AM	T1, T2 and R2	• To understand the uses of various materials in AM processes • To analyse solidification rate vis-à-vis microstructure of additively manufactured products
	L (7): Role of solidification rate and evolution of non-equilibrium structure	T1, R2 and R3	
	L (8): Structure-property relationship: grain structure and microstructure	T1, R2 and R3	
M3	**L (9-20**): Various AM processes and their mechanics of operation: Vat Photopolymerization Processes, Powder Bed Fusion Processes, Extrusion-Based Systems, Material Jetting, Binder Jetting, Sheet Lamination Processes, Directed Energy Deposition Processes, Direct Write Technologies	T1and R2	• To learn process fundamentals, systems used and working of various AM processes • To know the basics of micro and nano-AM processes
	L (21): Micro- and nano-additive manufacturing processes	Lecture notes	
M4	**L (22-25):** Modelling in Additive Manufacturing, Transport phenomena models: temperature and fluid flow, molten pool formation	T1 and R3	• To understand various fundamentals of modelling of AM processes and apply them to analyze the different AM processes
	L (26-31): Various case studies - modelling of fusion-based AM process, powder bed melting based process, droplet-based printing process	T1 and R3	

M5	**L (32):** Selection of AM Process	T1 and T2	• To understand the Process selection, planning, control for AM • To learn different applications and parts manufactured by AM technologies in various industries
	L (33-34) Post-processing and software issues for AM	T1, R1 and R2	
	L (35-36): Design for Additive Manufacturing	T1	
	L (37-40): Applications of Additive Manufacturing in Aerospace, Automotive, Electronics industries and Biomedical applications.	T1, T2, R1 and R2	

6. Evaluation Scheme

Components	Duration (minutes)	Weightage (%)	Date	Remarks
Mid Semester Test	90	25	Will be announced by AUGSD-AGSRD	OB
Assignments/Projects/Seminars/ Quiz	-	35	To be announced in the class	OB
Comprehensive Examination	120	40	Will be announced by AUGSD-AGSRD	CB/OB

7. Chamber Consultation Hour

To be announced in the first class.

8. Notices

All notices regarding the course will be sent through the email/Nalanda/Google classroom.

9. Make-up Policy

Make-up will be granted **ONLY in genuine cases** with PRIOR permission as per the institute rules.

Instructor-in-Charge
ME F425