Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2021-2022
COURSE HANDOUT (PART-II)

Date: 10/08/2021

In addition to Part-I (General Handout for all courses appended to the timetable), this portion gives further specific details regarding the course.

Course Code : ME G532
Name of the Course : Machine Tool Engineering
Instructor-In-Charge : Dr. Kundan Kumar Singh

Description : Design principles of machine tools; stiffness and rigidity of separate construction elements and their combined behaviour under load; design of stepped and stepless drives; electrical, mechanical and hydraulic drives; design of bearings and sideways; machine tool controls; machine tool dynamics; recent developments in machine tool design

Scope and Objective of the Course: The course is intended to instruct and explain the concepts and practices of design, analysis and development of different types of Machine Tools. The course covers introduction to machine tool drives and mechanisms - general principles of machine tool design, regulation of speed and feed rates, design of machine tool structures, prime movers, electrical and hydraulic/pneumatic system, design of guideways and power screws, design of spindles and spindle supports, dynamics of machine tools, control systems in machine tools. The approach for modelling the sub-components of a machine tool structure will also be taught in the class, which will help in selecting the most efficient sub-component shape and materials. The static and dynamic methods for analysis of a machine tool system will be covered in the course.
The students are encouraged to select seminar topics of current interest and developments in the fields of technology of construction of Machine Tools and present them in the class apart from the regular classroom learning.

Text Books

[1] N.K. Mehta,"Machine Tool Design and Numerical Control", second Edition, Tata McGraw Hill book Company, (2011)

Reference Books

[2] S. K. Basu, and D. K. Pal, "Design of Machine Tools", Oxford & IBH Publication Co Pvt Ltd, New Delhi (1995).

[3] A.B. Chattopadhyay, "Machining and Machine Tools", Wiley-India (2011)

[4] Suk-Hwan Suh, Seong-Kyoon Kang, Dae-Hyuk Chung, Ian Stroud, "Theory and Design of CNC Systems", Springer-Verlag London Limited.

[5] Donaldson C, LeCain GH, Goold VC, Ghose J. Tool design. Tata McGraw- Hill Education; 2012.

Course Contents

Lecture No.	Learning Objectives	Topic to be covered	Chapter in the text book
1-3	Recap for basics of manufacturing/machining process	Machining principles, different forces during machining process, Surface generation mechanism, power and torque calculation	Class notes and [1]-1
4-5	Student will learn the basics of machine tool	Definition, application, different types of machine tool, different components of ma- chine tool and its function, selection of different ma- chine tools	Class notes and [1]-1
6-8	The motion mechanisms and configuration of speed gear box of machine tool	Requirement, design of speed box and feed box, layout of spindle speeds, gear box design	Class notes and [1]-1
9-14	Understanding the working principles of stepless drives, and select them based on application parameters	Objectives of step-less speed regulation, various electrical drives, prime movers for MT: Electrical drives, types, working principle, and selection, hydraulic and pneumatic drives, Transmission systems for MT.	Class notes and [1]-2

15-20	Design of machine tool structure and its components	Requirement, design of lathe bed and its sub-components; static and dynamic stiffness, Design of machine tool guide-ways, beds, tables and columns, consideration of surface generation error modeling for different tool posts.	[1]-3, [2]-6,7
21-23	Design of cutting tool	Requirement, different parts of cutting tool and its functions, different configuration of cutting tool, effect of cutting tool materials, special consideration in modeling for efficient tool	[1]-3, [2]-6,7
24-28	Design of spindle	Requirement, different components of spindle, spindle material, designing approach and different cooling mechanism	[1]-4, [2]-8, 9
34-38	Understanding the basics of vibration and methods for dynamic analysis of a machine tool structure	Single and multi-degree of freedom system modeling, eigen value analysis, modal analysis theory	Class notes and [1]-6, [2]-16, 23
41-42	Student will be able to learn the selection criteria for selecting the best suitable machine tool design	Design selection criteria, effect of different configurations on machine tool response, stability analysis for machine tools	Class notes
42-43	Design features of automated CNC machine tools and select modern machine tools for intended application	Recent developments in ma-chine tool design, automation in machine tools, Design of CNC machines and selection	Class notes and [2]-17,[3]

List of Experiments

Week	Experiment	Experiment details

	No.	
1	1	E1: Explaining the different machine tools through video
	2	E2: Machining experiment on lathe (recap)
2	1	E3: Detailed gear train observation/report for machine tools shown in video
	2	E4: Approach for modeling in Abaqus (Introduction to Abaqus tool)
3	1	E5: Gear modeling: Theoretical Design, Solid modelling, Different materials
	2	E6:Gear simulation: deflection and Stress values
4	1	E7: Modeling approach for lathe machine tool bed
	2	E8: Simulation for dynamic response of modeled lathe bed
5	1	E9: Explaining the step-less drive by performing experiments
	2	E10: Demonstration of surface generation error through experiments
6	1	E11: Design and modeling approach for cutting tool
	2	E12: Method for modal analysis of a cutting tool
7	1	E13: Modal analysis of a cutting tool in Abaqus
	2	E14: Modal analysis through experiments (Theory part)
8	1	E15: Modal analysis of Cutting tool post (Lathe)
	2	E16: Modal analysis of Cutting tool (milling)
9	1	E17: Modal analysis of Workpiece
	2	E18: Modal analysis of a machine tool structure
10	1	E19: Demonstration of vibration measurement using sensor
	2	E20: Vibration measurement of cutting tool & workpiece
11	1	E21: Introduction to CNC Programming
	2	E22: Generating CNC codes for machining various profiles (CNC code for turning and CNC code for milling)
12	1	Phase 1: Literature review and modelling
	2	
13	1	Phase 2: Presentation
	2	
14	1	Phase 3: Report submission
	2	
15	1	Lab exam and viva
	2	Buffer slot

Evaluation Scheme and Schedule

Component	Duration	Weightage(%)	Date & Time	Nature of Component
Mid Sem. Test	90 Min.	30	To be announced.	Open Book

Quiz	–	10	To be announced in class	Open Book
Project/case study	–	10	–	Open Book
Laboratory	-	15	To be announced.	Open Book
Comprehension examination	2 Hrs.	35	27/12 FN	Open Book

VI. Chamber Consultation Hour: To be announced in the class
VII. Notices concerning the course: All notices concerning the course will be displayed on the CMS notice board.

VIII. Make-up Policy: Make-up will be permitted only in genuine cases with prior permission.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

NOTE: The border cases in final grading will be decided based on mainly classroom attendance and attentiveness in the classroom.

Instructor-In-Charge
ME G532