

MACHINE TOOL DESIGN**Course Code : 316358**

Programme Name/s : Production Engineering
Programme Code : PG
Semester : Sixth
Course Title : MACHINE TOOL DESIGN
Course Code : 316358

I. RATIONALE

This core production Engineering course focuses on machine tool design fundamentals, equipping production engineering students with the skills to develop efficient machine tool elements for manufacturing. It requires prior knowledge of Theory of Machines, Strength of Materials, and Mechanical Engineering Materials to ensure students can design effective machine tool elements to meet industry needs.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attain the following industry identified outcome through various teaching learning experiences: Student will be able to design basic machine tool elements.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify the general requirements for machine tool design and related processes.
- CO2 - Evaluate machine tool structure profiles, guideways and slideways.
- CO3 - Evaluate various spindle support designs considering structural diagrams for machine tool.
- CO4 - Diagnose the causes of vibration in given machine tools.
- CO5 - Suggest ergonomic and aesthetic considerations in the design of machine tools.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme													Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL				
															Practical								
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA				
Max	Max	Max	Min	Max	Min	Max	Min	Max	Min														
316358	MACHINE TOOL DESIGN	MTD	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175		

Total IKS Hrs for Sem. : Hrs

Abbreviations: CL- Classroom Learning, TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination, @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

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Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the concept and significance of machine tools in manufacturing. TLO 1.2 Describe the basic design requirements of machine tools. TLO 1.3 Describe key design factors influencing machine tool performance. TLO 1.4 Identify the general requirements for effective machine tool design.	Unit - I Fundamentals of Machine Tool Design 1.1 Introduction to machine tool. Comparison between machine & machine tools. 1.2 Basic design requirements, General design procedure. 1.3 Design factors - factor of safety, stress concentration factor and service factor, design for maintainability. 1.4 Classification, General requirements of machine tool design, Engineering design process applied to machine tools.	Lecture Using Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Describe the functions and essential requirements of machine tool structures. TLO 2.2 Identify different types and profiles of machine tool structures. TLO 2.3 Select appropriate materials for machine tool structures based on performance criteria. TLO 2.4 Analyze factors affecting the stiffness of machine tool structures. TLO 2.5 Explain various methods to improve the rigidity and stability of machine tool structures. TLO 2.6 Compare various types of guideways and slideways.	Unit - II Machine Tool Structure & Guides 2.1 Functions, requirements, and classifications of machine tool structures. 2.2 Different structural profiles and their applications. 2.3 Material selection for machine tool structures. 2.4 Factors influencing stiffness and methods for enhancing structural rigidity. 2.5 Functions, Classification, Shapes and materials of guideways. 2.6 Hydrostatic / hydrodynamic aerostatic slideways, Antifriction ways.	Lecture Using Chalk-Board Video Demonstrations Presentations
3	TLO 3.1 Explain the functions, materials and essential requirements of spindle units. TLO 3.2 Explain the requirements for spindle support design. TLO 3.3 Determine the appropriate range of spindle speeds based on machine requirements. TLO 3.4 Determine the number of speed steps in a given range. TLO 3.5 Analyze the feasibility of different structural formulae for speed regulation. TLO 3.6 Construct and interpret ray diagrams for machine tool speed regulation. TLO 3.7 Prepare a speed chart for given ray diagram.	Unit - III Spindle Unit in Machine Tool 3.1 Functions, Requirements and material of spindle unit. 3.2 Types of bearings used as spindle supports, Requirements of spindle supports. 3.3 Constraints, requirement for layout of a stepped drive, Selection of range of spindle speeds. 3.4 Geometric Progressive stepped regulation of speed, Advantages of G.P series. 3.5 Selection of value of common ratio, Number of steps in a speed range, Number of practical subdivisions. 3.6 Representation of speeds on structure diagram, Structural formulae, Feasibility of structural formula. 3.7 Ray diagram, Decision making for best ray diagram, Speed chart.	Lecture Using Chalk-Board Demonstration Presentations Flipped Classroom
4	TLO 4.1 Explain the sources and causes of vibrations in machine tools. TLO 4.2 Classify different types of vibrations, including free, forced, self-excited, and transient vibrations. TLO 4.3 Explain the effects of vibrations	Unit - IV Machine Tool Vibrations 4.1 Overview of machine tool vibrations and their causes. 4.2 Classification of vibrations: free, forced, self-excited, and transient. 4.3 Effects of vibrations on machining	Lecture Using Chalk-Board Demonstration Presentations

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	on machining accuracy, tool life, and surface finish. TLO 4.4 Identify various methods for minimizing machine tool vibrations.	accuracy, tool life, and surface finish. 4.4 Various methods for minimizing machine tool vibrations.	
5	TLO 5.1 Explain the importance of ergonomics in the man-machine relationship. TLO 5.2 Apply ergonomic principles in designing control members such as push buttons, knobs, levers, cranks, and handwheels. TLO 5.3 Apply ergonomic principles for the optimal location and arrangement of displays. TLO 5.4 Describe key aesthetic characteristics such as shape, line, form, surface finish, and color. TLO 5.5 Apply compatibility principles to optimize design of control members.	Unit - V Ergonomic and Aesthetic Aspects in Machine Tools 5.1 Ergonomic considerations - man-machine relationship, anthropometric and functional anatomy data. 5.2 Ergonomic in design of control members - push button, knobs, levers, cranks and hand wheel. 5.3 Ergonomic considerations applied to types and location of display. 5.4 Compatibility in the design of control members. 5.5 Aesthetics - aesthetic characteristics - shape, line, form, surface finish and colour.	Lecture Using Chalk-Board Demonstration Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Describe the fundamental requirements of machine tool design.	1	General requirements of machine tool design	2	CO1
LLO 2.1 Draw and label the machine tool structure of a Lathe/Milling/Drilling machine with appropriate dimensions. LLO 2.2 Specify the materials used for different structural components and justify their selection based on mechanical properties.	2	*Illustration of machine tool structure used in a Lathe machine, Milling machine & Drilling machine.	4	CO2
LLO 3.1 Illustrate the guideways used in Lathe/Milling/Drilling machines with appropriate labeling. LLO 3.2 Identify and specify the materials used for different types of guideways, explaining their selection criteria. LLO 3.3 Compare various guideway shapes based on design, functionality, and performance characteristics.	3	*Comparison of different guideways and slideways based on given criteria.	4	CO2
LLO 4.1 Identify various types of bearings used in machine tools, including their functions and applications. LLO 4.2 Compile a detailed report comparing different bearings based on design, material, load capacity, and suitability for specific machine tool components.	4	Preparation of report on different types of bearings used in machine tools.	2	CO3
LLO 5.1 Develop a ray diagram to represent the available speed range of a given machine tool. LLO 5.2 Evaluate the speed distribution in the ray diagram to ensure proper selection and sequencing of speed steps.	5	*Selection and sequencing of speed steps using ray diagram for given machine	2	CO3
LLO 6.1 Determine the required speed steps based on the given machine tool operating	6	*Construction of structural diagram using speed steps for given machine	2	CO3

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
conditions. LLO 6.2 Construct a structural diagram to represent the calculated speed steps effectively.		tool.		
LLO 7.1 Develop a speed chart based on the given experimental setup of Sr No. 5, accurately representing speed variations. LLO 7.2 Evaluate the speed chart to ensure proper sequencing and distribution of speed steps for optimal machine performance.	7	Sequencing & distribution of speed steps on speed chart for a given experimental setup of Sr No 5.	2	CO3
LLO 8.1 Determine the required speed steps based on the given machine tool operating conditions. LLO 8.2 Construct a structural diagram to represent the calculated speed steps effectively.	8	Representation of calculated speed steps on structural diagram for given machine tool conditions.	2	CO3
LLO 9.1 Develop a speed chart based on the given experimental setup of Sr No. 8, accurately representing speed variations. LLO 9.2 Evaluate the speed chart to ensure proper sequencing and distribution of speed steps for optimal machine performance.	9	Sequencing & distribution of speed steps on speed chart for a given experimental setup of Sr No 8.	2	CO3
LLO 10.1 Identify the sources of vibrations in the given machine tools and their impact on performance. LLO 10.2 Describe effective methods for minimizing vibrations to enhance machine tool stability and precision.	10	*Identification of vibration sources in the given machine tools.	4	CO4
LLO 11.1 Evaluate the ergonomic and aesthetic features of a Lathe/Milling/Drilling machine based on design, user comfort, and operational efficiency. LLO 11.2 Prepare a detailed report highlighting the impact of ergonomic and aesthetic considerations on machine performance and user experience.	11	Ergonomic and aesthetic analysis of Lathe, Milling, and Drilling machines available in the Workshop.	4	CO5
Note : Out of above suggestive LLOs - • '*' Marked Practicals (LLOs) Are mandatory. • Minimum 80% of above list of lab experiment are to be performed. • Judicial mix of LLOs are to be performed to achieve desired outcomes.				

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)**Micro project**

- Conduct a comparative study of the Lathe and Milling machine structures available in the workshop, focusing on their profiles and materials.
- Document the specifications of spindles for the Lathe, Milling, and Drilling machines in the workshop.
- Prepare a detailed report on the ergonomic and aesthetic considerations of the Lathe machine.
- Compare the cutting tool holding arrangements in a General Lathe, Milling, and Drilling Machine.

Assignment

- Sketch various slideway profiles of any two machine tools available in the workshop.
- Draw the structural diagram and ray diagram of a Lathe machine.
- Prepare a Comprehensive Report on the Impact of Lubrication, Temperature, Vibration, and Machining Forces on

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Machine Tool Performance and Guideway Wear.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Centre lathe machine. (Length between centers 1000 mm, swing 500 mm,) Chucking Diameter Range 25-200 mm,	All
2	Milling machine, minimum 500 mm longitudinal traverse, with required indexing head, set of work holding devices, cutting tools, accessories, and tool holders.	All
3	CNC Turning 250 with standard accessories and multi controller changing facility with simulated control panel and related software. Training or Productive type minimum diameter 25 mm, Length 120 mm with ATC, (Suggested)	All
4	CNC Milling 250 with standard accessories and multi-controller changing facility with simulated control panel and related software. Training or Productive type-X axis travel - 225 mm, Y axis travel - 150 mm, Z axis travel - 115 mm, with ATC. (Suggested)	All
5	Drilling Machine (drill diameter up to 40 mm).	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of Machine Tool Design	CO1	8	6	4	0	10
2	II	Machine Tool Structure & Guides	CO2	16	4	8	4	16
3	III	Spindle Unit in Machine Tool	CO3	18	6	8	8	22
4	IV	Machine Tool Vibrations	CO4	8	4	2	4	10
5	V	Ergonomic and Aesthetic Aspects in Machine Tools	CO5	10	4	4	4	12
Grand Total				60	24	26	20	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Tests
- Term Work

Summative Assessment (Assessment of Learning)

- End term exam- Theory
- End term exam- Practical

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Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	-							
CO2	3	2	3	2						
CO3	3	2	3	2						
CO4	3	2	-	-						
CO5	3	2	-	2						

Legends :- High:03, Medium:02,Low:01, No Mapping: -
 *PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	N. K. Mehta	Machine Tool Design	Tata McGraw Hill Publishing Co. Ltd, 2nd edition, ISBN: 0-07-462237-4
2	S. K. Basu, D. K. Pal	Design of Machine Tools	Oxford & IBH Publishing Company Pvt. Limited, Fifth Edition, ISBN:9788120417212, 8120417216
3	G. C. Sen., A. Bhattacharya	Principles of Machine Tools	New Center Book Agency (P) Ltd. Calcutta, 2nd edition, ISBN:9788173811555, 8173811555
4	Prakash Hiralal Joshi	Machine Tools Handbook	McGraw Hill LLC, ISBN:9780071510653, 0071510656
5	V. B. Bhandari	Design of Machine Elements	Tata McGraw-Hill, ISBN:9780070681798, 0070681791
6	P. C. Sharma	A Textbook of Production Engineering	S. Chand Limited,ISBN:9788121901116, 8121901111

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=hWNpID0TWYU	Basics of Vibrations
2	https://www.vssut.ac.in/lecture_notes/lecture1424895069.pdf	Principle of Machine Tools
3	https://archive.nptel.ac.in/courses/107/103/107103004/	Ergonomics for beginners: Industrial design perspective

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students