MACHINE MAINTENANCE AND SAFETY **Course Code : 314016**

Programme Name/s : **Production Engineering**
Programme Code : **PG**
Semester : **Fourth**
Course Title : **MACHINE MAINTENANCE AND SAFETY**
Course Code : **314016**

I. RATIONALE

Machine Maintenance and safety are vital for the smooth operation of machinery, the well being of employees, and overall business success. By prioritizing maintenance and safety protocols, organizations can enhance efficiency, reduce risks, and create a safer working environment for everyone.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Adapt maintenance and safety protocols fostering a safer and efficient working environment.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Select relevant maintenance procedure for machine maintenance.
- CO2 - Choose proper lubricants to reduce machine wear.
- CO3 - Evaluate faults in various tools, equipment and machines.
- CO4 - Communicate effectively regarding safety issues within the workplace.
- CO5 - Use the relevant method to handle hazardous materials efficiently .

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314016	MACHINE MAINTENANCE AND SAFETY	MTS	SEC	-	-	4	2	6	3	-	-	-	-	-	50	20	25@	10	25	10	100

Total IKS Hrs for Sem. : 0 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

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 Describe the importance of maintenance in industry. TLO 1.2 List the functions of maintenance department . TLO 1.3 Compare types of maintenance. TLO 1.4 Use relevant tools used for maintenance.	**Unit - I Fundamentals of Maintenance Engineering.** 1.1 Definition, concept of maintenance and aim of maintenance engineering. 1.2 Primary and secondary functions and responsibility of maintenance department. 1.3 Types of maintenance. 1.4 Types and applications of tools used for maintenance.	chart Model Demonstration Video Demonstrations Presentations
2	TLO 2.1 Explain various type of wear in machine /machine tools. TLO 2.2 Choose the relevant lubricants for machine and equipment with justification. TLO 2.3 Identify the relevant lubrication system for the machine with justification.	**Unit - II Methods of Lubrications** 2.1 Definition of wear, Primary wear processes-adhesive, abrasive, corrosive, reaction, plastic flow, pitting. 2.2 Lubricants-types ,properties ,selection and applications. 2.3 Lubrication methods-Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication and Ring lubrication.	Chart Presentations Model Demonstration Video Demonstrations

MACHINE MAINTENANCE AND SAFETY **Course Code : 314016**

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.
3	TLO 3.1 Explain the concept and importance of fault tracing in machine and equipment. TLO 3.2 Draw decision tree for the faults finding in machine and equipment. TLO 3.3 List sequence of fault finding activities in machines and equipment. TLO 3.4 Identify types of faults and their causes.	**Unit - III Fault Tracing** 3.1 Fault tracing-concept and importance. 3.2 Decision tree-concept, need and applications. 3.3 Sequence of fault finding activities, show as decision tree. 3.4 Draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment like: (Any one machine tool) Pump , Air compressor, Internal Combustion engine, Boiler, Electrical motors. 3.5 Types of faults in machine tools and their general causes.	Model Demonstration Video Demonstrations Presentations charts
4	TLO 4.1 Explain the importance of maintaining a safe work environment. TLO 4.2 Recognize causes and effects which lead to accidents. TLO 4.3 Follow safety practices to aviod accident. TLO 4.4 Prepare suitable first aid and PPE for given workshop. TLO 4.5 Choose appropriate fire extinguisher for the given situation with justification. TLO 4.6 Explain need of safety training.	**Unit - IV Industrial Safety** 4.1 Importance of Industrial Safety. 4.2 Accident: Causes, types ,effects and control. unsafe acts, unsafe conditions hazards. 4.3 Accident Prevention: Theories/models of accident occurrences, principles of accident prevention. 4.4 First Aid: First aid, personal protective equipment,(PPE) and safety policies. 4.5 Fire Equipment: Fire triangle, types of Extinguishers and its application. 4.6 Safety Education and Training,	Model Demonstration Video Demonstrations Charts Presentations

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.
5	TLO 5.1 Categorize different types of hazards. TLO 5.2 Identify fire hazards and their causes. TLO 5.3 Interpret types of chemical hazards and their control in given situation. TLO 5.4 Choose relevant method for risk assessment for given situation with justification. TLO 5.5 Explain handling and storage hazardous materials. TLO 5.6 List prohibited hazardous materials.	**Unit - V Hazard Identification and Management** 5.1 Types of hazards, hazard identification methods. 5.2 Fire hazard and their causes. 5.3 Classifications of Chemical hazards and their control. 5.4 Risk assessment methods- 1.Failure mode and effective analysis 2. Fault tree analysis 3.Event tree analysis. 5.5 Storage,handling,transportation of hazardous materials. 5.6 Prohibited and restricted hazardous materials.	Model Demonstration Video Demonstrations Presentations Charts

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 Select the various types of tools. LLO 1.2 Use of various types of tools.	1	*Various types of tools. (Fix spanners, box spanners, ring spanners, allen keys, types of pliers, screw drivers, bearing puller etc.).	4	CO1
LLO 2.1 Select proper tool for preventive maintenance of given equipment. LLO 2.2 Use Proper tool for preventive maintenance of given equipment.	2	Clean,degrease,repair of any available equipment in your laboratory and workshop.	2	CO1
LLO 3.1 Prepare preventive maintenance schedule for air compressors,Lathe machine, Milling Machine Drilling machine etc. LLO 3.2 Select tools for preventive maintenance for air compressors,Lathe machine, Milling Machine Drilling machine etc.	3	Preventive maintenance schedule of workshop having-air compressors, Lathe machine, Milling Machine Drilling machine etc.(Any one)	2	CO1

MACHINE MAINTENANCE AND SAFETY **Course Code : 314016**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Prepare preventive maintenance schedule for air compressors, Lathe machine, Milling Machine Drilling machine etc. LLO 4.2 Select tools for preventive maintenance for air compressors, Lathe machine, Milling Machine Drilling machine etc.	4	Preventive maintenance schedule of any workshop having- air compressors, Lathe machine, Milling Machine Drilling machine etc.(Any one)	2	CO1
LLO 5.1 Select proper lubricating equipment for given machine. LLO 5.2 Use proper lubricating equipment for given machine.	5	* Lubrication equipment likes oiling gun, greasing gun etc., Familiarization with different grades of lubricants. Joining a flexible pipe & Checking its leakages in any hydraulic /pneumatic circuit.	4	CO1 CO2
LLO 6.1 Collect the used lubricating oil samples of the given machine. LLO 6.2 Measure the viscosity of used lubricating oil .	6	*Viscosity of the used lubricating oil.	4	CO1 CO2
LLO 7.1 Identify type of wear. LLO 7.2 Evaluate the wear of given machine component. LLO 7.3 Take corrective action to reduce wear.	7	Wear of machine component any four available in your laboratory/workshop, and give suggestions to reduce wear.	2	CO1 CO2
LLO 8.1 Choose appropriate lubricant for the given machine. LLO 8.2 Use an appropriate lubricant for the given machine.	8	Replace lubricant of the lathe/drilling/milling/grinding/shaping machine.	4	CO1 CO2
LLO 9.1 Select proper tools for the required task. LLO 9.2 Change the lubricating oil of given system.	9	Drain out lubrication oil from the power transmission system.	2	CO1 CO2
LLO 10.1 Choose an appropriate tool. LLO 10.2 Find the faults arise in the machine tools. LLO 10.3 Conduct the break down maintenance of faulty machine.	10	*Fault carryout maintenance work and break down of different machineries/ equipment viz., shaper, surface grinding, drilling, lathe, milling, in the shop floor.Using appropriate tools & equipment.	4	CO1 CO2 CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Identify safety practices in given situation. LLO 11.2 Apply safety practices in given situation.	11	Safety practices related to the pumps, fans, blowers & compressors.	2	CO4
LLO 12.1 Identify safety practices in given situation. LLO 12.2 Apply safety practices in given situation.	12	Safety practices related to pipe fittings.	2	CO4
LLO 13.1 Identify different safety practices in given situation. LLO 13.2 Apply safety practices in given situation.	13	Safety practices related to welding.	2	CO4
LLO 14.1 Select proper fire fighting equipment. LLO 14.2 Use of fire frightening equipment. LLO 14.3 Select proper personal protective equipment in given situation. LLO 14.4 Use of personal protective equipment in given situation.	14	* Fire fighting equipment and personal protective equipment. (PPE).	4	CO5
LLO 15.1 Identify the mechanical hazards in laboratory / workshop. LLO 15.2 Take corrective action to reduce accidents.	15	Mechanical hazards in Laboratory/Workshop and suggest necessary provision to reduce accidents.	2	CO5
LLO 16.1 Identify the thermal hazards in laboratory / workshop. LLO 16.2 Take corrective action to reduce accidents.	16	Thermal hazards in Laboratory/Workshop and suggest necessary provision to reduce accidents.	2	CO5
LLO 17.1 Use FFA in given situation. LLO 17.2 Identify the causes of failure of the given machine component.	17	Fault free analysis to determine causes of failure of machine component.	2	CO5
LLO 18.1 Carry out safety audit. LLO 18.2 Prepare safety audit report of laboratory / workshop.	18	*Safety audit report for the laboratory/workshop.	4	CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 19.1 Choose proper tools for dismantling of lathe components. LLO 19.2 Choose proper tools for assembly. LLO 19.3 Apply safety practices. LLO 19.4 Inspect after cleaning the given machine.	19	*Maintenance of Mechanical Based Equipment/Device/Machine. Maintenance of any two from following. a. Head stock. b. Tail stock. c. apron. d. carriage. e. feed mechanism. (Dismantle of given case, observe rules, follow sequence of dismantling operations, cleaning, inspection, measuring deviations and recovery methods, testing and assembling).	4	CO1 CO2 CO3 CO4 CO5
LLO 20.1 Apply safety precautions in shop floor. LLO 20.2 Summarize safety precautions during examination of machine.	20	Safety precautions during examination of machines like lathe/drilling/milling/grinding/shaping.	2	CO4
LLO 21.1 Choose proper tools for dismantling of pneumatic/hydraulic components. LLO 21.2 Choose proper tools for assembly of given machine. LLO 21.3 Apply safety practices. LLO 21.4 Inspect after cleaning the given machine.	21	*Dismantle,replace and assemble different pneumatics and hydraulics components. [Different components – Compressor, Pressure Gauge, Filter Regulator Lubricator, Valves and Actuators.]	4	CO1 CO2 CO3 CO4 CO5
LLO 22.1 Choose proper tools for dismantling of grinding machine components. LLO 22.2 Choose proper tools for assembly of given machine. LLO 22.3 Inspect after cleaning the machine. LLO 22.4 Apply safety practices.	22	Preventive maintenance, perform dismantling & assembly of different components of grinding machine and test for accuracy. [Different components grinding head, lead screw, table, hydraulic cylinders]	4	CO1 CO2 CO3 CO4 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)

Assignment

- Visit any Industry for machine maintenance and safety. and prepare the report. Report consisting of following points 1. Types of maintenance 2. Types of safety practices in industry.
- Undertake a market survey of local dealers for tools, fire safety equipment, personal protective equipment's. Prepare a report.
- Prepare/Download a specifications of followings: 1. Tools and equipment in the machine maintenance . ii. Fire safety equipment's /personal protective equipment's.
- Prepare a journal based on practical conducted in a laboratory/workshop/industry. Journal consists of drawing, observations, required tools, safety practices, equipment, date of performance with teacher signature.

Micro project

- Visit to websites of reputed fire and safety equipment supplier‘s and study of features of their equipment/instruments/tools.
- Collect a samples of used lubricant oils from various machine from workshops and industries and do the oil analysis and write a report.
- Visit different industries and workshops (at least 3) and study various control measures used to avoid different types of hazards and submit a report.
- Collect failure data of machine components from hoc industry anal perform reliability analysis using various techniques.

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 judicial 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	Lubrication equipment likes oiling gun-(Flow rate: 0.3–8 GPM (1–30 LPM) Pressure: Up to 1000 PSI (70 BAR) Working temperature range: -5°C–50°C (23°F–122°F) Inlet: 1/2 inch (F) Accuracy: ±0.50% Repeatability: 0.20% Minimum preset quantity: 0.10 units Maximum preset quantity: 99.9 units), greasing gun -(Pressure: 12,000 PSI (830 BAR) high pressure Volume: 2,000 PSI (130 BAR) high volume Stroke: 0.6 gm per stroke (1 oz) Filling options: Cartridge, filler pump, suction, bulk Barrel diameter: 2-1/4" (57.15 mm) Catridge capacity: 400 gm (14 oz)).	2,3,4,5,6,7,8,9,10,20,21,22
2	Different types of lubricants. (Specifications of Grease -Grade No.000,00,1,2,3,4,5,6),Lubricating oil-SAE 10W,15W,20W,30W.	2,3,4,5,6,8,9,10,20,21,22
3	Old components/equipment's.	2,3,4,7,8,9,20,18,21,22
4	Redwood Viscometer.(Capacity : 1 Sample At A Time. Temperature Controller : By Energy Regulator Which Will Turn On & Off Heater As Time Switch. Input Power Supply : 230 V Ac, 50 Hz, 1 Phase With 6 Amp Current Rating. Heating Load : 1 Kw).	6

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
5	Wear measurements device. Abrasion Tester-Load: 100 N to 300 N (automatic) Speed: Up to 250 rpm Friction Force: up to 300 N Duration 999,999 rev (Max),Digital corrosion measuring gauge-Measuring Accuracy: ± 0.01 MM. Measuring Depth of small groove and hole. Resolution: 0.01mm/0.0005" Measuring reference base: 65 MM X 7 MM Buttons: On/Off, set, mm/inch, present (+, -) Automatic power off, move the digital unit to turn on power. Battery: CR2032.	7,20,21,22
6	Various types of tools. (Fix spanners, box spanners, ring spanners, allen keys, types of pliers, screw drivers, bearing puller etc.).	All
7	Fire extinguisher - a) DCP type - 1, 2, 5 or 10 Kg, operation upright. ISS-2171. Class B and C fire b) CO2 type, A, B, C type, Dry chemical powder type c) foam type- 9 litre, operation - inverted, ISS-93 , Class B fire.	All
8	Safety goggles, face screens, Industrial safety helmets, hair nets and fire fighting helmets, Ear plugs, earmuffs, Gloves, Safety boots and shoes with protective toecaps and penetration - resistant, Apron, Chemical suit etc;	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- · For laboratory learning term work -25 Marks · For Self Learning 25 Marks

Summative Assessment (Assessment of Learning)

XI. SUGGESTED COS - POS MATRIX FORM

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	2	2	3	3	2	2			
CO2	3	2	2	3	3	2	2			
CO3	3	2	2	3	3	2	2			
CO4	3	2	2	3	3	2	2			
CO5	3	2	2	3	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	Higgins & Morrow	Maintenance Engineering Handbook	McGraw Hill Education, New Delhi, Publication date 2014, ISBN-13: 978-0-07-182661-7, ISBN: 0-07-182661-0
2	Garg H P.	Industrial Maintenance	S. Chand & Co. Ramnagar, New Delhi. Publication date 2012, ISBN No: 81-219-0168-5
3	Sushil kumar Srivastava	Maintenance Engineering	S. Chand & Co. Ramnagar, New Delhi. Publication Date 2018, ISBN No: 9788121926447
4	L.M.Deshmukh	Industrial Safety Management: Hazard Identification and Risk Control, 1st Edition	Publication Date & Copyright: 2017,McGraw Hill Education (India) Private Limited, ISBN-13 ? : ? 978-0070617681
5	Daniel Crowl, Joseph Louvar	Chemical Process Safety: Fundamentals with Applications	Pearson Publication ,Edition 4 Date10 July 2020 -ISBN-13: 978-0-13-485777-0
6	Das, Akhil kumar	Principles Of Industrial Safety Management.	PHI Learning Pvt. Ltd. Publication date 01/01/2020, Print Book ISBN : 9789389347449 ,eBook ISBN : 9789389347456
7	R.K. Jain and Prof. Sunil S. Rao	Industrial Safety, Health and Environment Management Systems	Khanna publishers, 4th edition, publication year 2018,ISBN: 978-81-7409-210-6
8	Er.S.N.Bhattacharya	Installation Servicing and Maintenance	S. Chand and company , Publication date 1/11/2013 ,ISBN;978-81-219-2913-4

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/W1aTPgySqy4	Repair and Maintenence of tools.
2	https://youtu.be/UoXCczbnOMQ	preventive maintenance of Lathe
3	https://youtu.be/s25Aijw3HLI	Safety of grinding machines
4	https://youtu.be/PQV71INDaqY	Use of fire Extinguishers
5	https://youtu.be/EvBMa7UJx38	Machine shop safety
6	https://youtu.be/TFb1iXz-K6w	Use of redwood viscometer
7	https://youtu.be/GkQpDR8Lhes	Types of Mechanical machine tools
8	https://youtu.be/xns8RUxQVDU	Maintain tools and equipments
9	https://youtu.be/f58SW0Hwcf0	Principles of Maintenance Engineering.
10	https://youtu.be/RDRmFz-PAOk	Machinery Fault Diagnosis
11	https://youtu.be/v-eltsixu4I	Industrial safety
12	https://youtu.be/DMBrRNV9Hrk	Personal Protective Equipment's.
13	https://youtu.be/5iVfwyoXKr0	Measure viscosity of oil.
14	https://youtu.be/RBUZJ3DpbMo	Regular maintenance of Lathe machine

Note :

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

MACHINE MAINTENANCE AND SAFETY **Course Code : 314016**

MSBTE Approval Dt. 21/11/2024 **Semester - 4, K Scheme**