GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester -V

Course Title: Preventive Maintenance
(Course Code: 4355803)

Diploma programmes in which this course is offered	Semester in which offered
Printing Technology	5th Semester

1. RATIONALE

With the ongoing continuous advancements in Printing Technology, advanced and sophisticated machines involving huge investments are being used by the industry. Productivity can be improved by maintaining high standards of preventive maintenance of these machines along with reliability and safety. Preventive maintenance makes economic sense as it may reduce or potentially eliminate the need for, and the extent of, major repair projects.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Prepare appropriate preventive maintenance schedule for printing machines.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Identify the importance and types of maintenance in printing industry.
b) Describe the types of wear its causes and remedies.
c) Explain various kinds of corrosion and corrosion prevention methods.
d) Identify types of faults in machine and suggest ways to solve it with preventive maintenance.
e) Discuss various safety procedures and safety aids used in printing industry.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	-	-	3	30*	70	00	00	100

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs.*Some of the **PrOs** marked **'*'** (in approx. Hrs column) are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	Not Applicable		
	Total		

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *The following are some **sample** 'Process' and 'Product' related skills(more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
	Not Applicable.	
Total		

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical's in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO.No.
	Not Applicable	

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow safety practices.
c) Adopt Ethical Practices.
d) Manage Time
e) Practice environmental friendly methods and processes.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Introduction of Maintenance**	1a. Understand need and importance of Maintenance. 1b. Explain objective of maintenance for given situation. 1c. Suggest suitable type of Maintenance for given situation with justification.	1.1 Meaning of maintenance and its importance. 1.2 Objective of maintenance 1.3 Primary and secondary functions of maintenance department. 1.4 Responsibilities of maintenance department 1.5 Types of maintenance: 1.5.1 Capital Replacement 1.5.2 Breakdown Maintenance 1.5.3 Corrective Maintenance 1.5.4 Scheduled Maintenance 1.5.5 Preventive Maintenance 1.5.6 Planned Maintenance 1.5.7 Productive Maintenance 1.5.8Predictive Maintenance 1.5.9 Modular Maintenance
Unit – II **Wear in Printing Equipment**	2a. Obtaining complete knowledge of Wear and types of wear. 2b. Explain causes of wear and their remedies. 2c. State the effects of friction in printing equipment and the steps to reduce it. 2d. State the characteristics of lubricants 2e. Compare the features of the lubricating methods	2.1 Meaning of wear and types of wear. 2.2 Causes of wear and effects of wear. 2.3 Wear reduction methods. 2.4 Meaning of Friction, Types of Friction and effects of Friction. 2.5 Purpose of Lubrication and Methods of Lubrication. 2.6 Characteristics of Lubricants. 2.7 Use of Lubricants as per manufacturing service manual. 2.8 Lubrication schedule for daily, weekly, monthly and yearly maintenance.
Unit– III **Corrosion and its prevention**	3a. Compare the features of the different types of corrosion 3b. Describe the factors affecting corrosion. 3c. Compare the different types of corrosion prevention methods.	3.1 Meaning of Corrosion and Surface Corrosion. 3.2 Factors affecting corrosion. 3.3 Types of Corrosion: 3.3.1 Uniform Corrosion 3.3.2 Pitting Corrosion 3.3.3 Stress Corrosion 3.3.4 Biological Corrosion

		3.3.5 High temperature Corrosion 3.3.6 Galvanic Corrosion 3.3.7 Selective Corrosion 3.3.8 Erosion Corrosion 3.3.9 Fretting Corrosion 3.4 Corrosion prevention methods.
Unit– IV Faults in Printing Machines	4a. Describe types of faults in machines. 4b. Need and Importance of Periodic Inspection. 4c. Compare the features of Repair complexity and Repair Cycle 4d. Sustainable Maintenance management	4.1 Types of Faults in Machine 4.2 Causes of Faults in Machine: 4.3 Meaning of Periodic Inspection 4.4 Factors to be considered in Periodic Inspection 4.5Meaning of Repair Complexity 4.6Stages of Repairing Scheme or Repairing Cycle
Unit– V Preventive Maintenance of Printing Equipment	5a. Understand need and importance of Preventive Maintenance. 5b. Describe Frequency Cycle	5.1 Need of Preventive Maintenance 5.2 Advantages of Preventive Maintenance 5.3Major divisions of Preventive Maintenance activities 5.4Meaning of Frequency Cycle 5.5 VEIN Analysis(method of scheduling) 5.6 schedule for Preventive Maintenance: Daily, Weekly, Monthly and yearly.
Unit– VI Safety and Hazards in printing Industry	6a. Define safety and state unsafe situations / locations in printing processes and equipment. 6b. Define hazards and state the types of hazards 6c. State the steps to prevent accidents 6d. Describe the safety procedures to be followed in printing press	6.1 Meaning of Safety 6.2 Meaning of Accident and Causes of Accident 6.3 Types of Accidents and Results of Accident 6.4 Factors related to Control the Accident 6.5Safety Color Code 6.6 Mechanical Hazards and Electrical Hazards 6.7 Methods of Safe guarding machine and equipment 6.8 Safety Precautions in Printing Industry

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction of Maintenance	08	2	4	4	10
II	Wear in Printing Equipment	08	4	6	3	13
III	Corrosion and its prevention	07	3	8	4	15
IV	Faults in Printing Machines	07	2	6	4	12
V	Preventive Maintenance of Printing Equipment	06	3	3	4	10
VI	Safety and Hazards in printing Industry	06	3	3	4	10
Total		**42**	**17**	**30**	**23**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of theUOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may varyslightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Write assignments based on the theory taught in classrooms. Assignments consist of ten questions having long answers including charts, symbols, drawing, observations etc.
b. Prepare/Download information about various Maintenance activities.
c. Visit to any Manufacturing industry and prepare a report consisting of:
    i. Organization structure and Centralized Maintenance Process.
    ii. Safety measures taken in Industry.
    iii. Mechanism to handle the breakdowns.
    iv. Any specific observation you have noticed.
d. Give seminar on relevant topic.
e. Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.

d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Demonstrate students thoroughly before they start doing the practice.
g) Encourage students to refer different websites to have deeper understanding of the subject.
h) Observe continuously and monitor the performance of students in Lab.
i) Demonstrate students thoroughly before they start doing the practice.
j) Encourage students to refer different websites to have deeper understanding of the subject.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14**-**16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a. Prepare a report on different lubricating systems used on different printing machines.
b. Prepare a report on power transmission devices such as shafts, belt and pulleys, chain and sprockets, and cams used on different printing machines.
c. Prepare a report on preventive maintenance schedule used on different printing machines.
d. Prepare a report on different types of bearings used on different printing and allied machines.
e. Make a Report on"Proactive Print Solutions: Preventive Maintenance for Sustainable Operations"
f. Make a Report on "Evaluating the Impact of Preventive Maintenance on Print Quality in the Printing Industry"
g. Prepare a report on "Assessing the Role of Lubrication in Preventive Maintenance of Printing Machinery"
h. Prepare a report on "Green Maintenance: Implementing Sustainable Preventive Maintenance in Printing Operations"
i. Collect Data on"Energy Efficiency in Preventive Maintenance: Sustainable Solutions for Printing Equipment"

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	"Preventive Maintenance for Industrial Control Systems: A Systems Approach"	Robert Charette	Auerbach Publications, USA, ISBN-13: 978-1498738997
2	"Maintenance Planning and Scheduling Handbook"	Doc Palmer	McGraw-Hill Education, New York,ISBN-13: 978-0071784115
3	"Maintenance Management for Printers"	D.J. Lansdowne	Graphic Arts Technical Foundation,Pittsburgh,ISBN-13: 978-0883621489
4	Business organization and Management	S. A. Shekahr	Himalaya Publication, India, 2016 ISBN : 978-9352021864

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=4ZXfpfs09g8 – types of maintenance
b. https://www.youtube.com/watch?v=TsDsE9fePLk – preventive maintenance
c. https://www.youtube.com/watch?v=7XBeRGmpLrE&list=PLLy_2iUCG87Bhld-RXqBIAwKCLaLjOzX – types of wear
d. https://www.youtube.com/watch?v=S7-uSTKY-W0 – types of corrosion
e. PrintPlanet - printplanet.com
f. youtube.com/user/PrintPlanetForum

15. PO-COMPETENCY-CO MAPPING

Semester V	Preventive Maintenance (Course Code: 4355803)									
	POs and PSOs									
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design / development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability &	PO 6 Project Management	PO 7 Life-long learning	PSO 1 Design and develop the product and process for the need of the industri	PSO 2 Analyze and improve productivity, quality and cost effectiveness for the various pre-press, press and post press process involved in printing to meet the	PSO 3 (If needed)

					environment			es and society.	industries requirement.	
Competency	**Prepare appropriate preventive maintenance schedule for printing machines.**									
Course Outcomes CO a) Identify the importance and types of maintenance in printing industry.	3	-	-	-	-	-	2	-	-	
CO b) Describe the types of wear its causes and remedies.	3	2	2	-	-	-	-	-	-	
CO c) Explain various kinds of corrosion and corrosion prevention methods.	3	2	2	-	-	-	-	-	-	
CO d) Identify types of faults in machine and suggest ways to solve it with preventive maintenance.	3	3	2	-	2	2	2	-	2	
CO e) Discuss various safety procedures and safety aids used in printing industry.	3	-	-	-	-	2	-	-	2	

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	V. B. Patel	R. C. Technical Institute, Sola, Ahmedabad	9825219434	vinita_printing@yahoo.com
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NITTTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1				
2				