

Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name	: Diploma In Printing Technology		
Programme Code	: PN	With Effect From Academic Year	: 2023-24
Duration Of Programme	: 6 Semester	Duration	: 16 WEEKS
Semester	: Fourth	NCrF Entry Level	: 3.5
		Scheme	: K

Sr No	Course Title	Abbreviation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Paper Duration (hrs.)	Assessment Scheme									
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week			Theory			Based on LL & TL				Based on Self Learning		Total Marks
						CL	TL	LL					FA-TH	SA-TH	Total	Practical		SLA				
																FA-PR	SA-PR	Max	Min	Max	Min	

(All Compulsory)

1	ENVIRONMENTAL EDUCATION AND SUSTAINABILITY	EES	VEC	314301	2	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125
2	RIGID PACKAGING	RPG	DSC	324318	2	4	-	4	-	8	4	3	30	70	100	40	25	10	25#	10	-	-	150
3	GRAVURE PRINTING PROCESS	GPP	DSC	324319	2	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
4	DIGITAL PRINTING	DGP	DSC	324014	-	2	-	2	2	6	3	-	-	-	-	50	20	50@	20	25	10	125	
5	PRINT ESTIMATING & COSTING	PEC	SEC	324015	-	2	-	4	-	6	3	-	-	-	-	50	20	50@	20	-	-	100	

Elective-I (Any - One)

6	DATA ANALYTICS USING EXCEL	DUE	GE	324320	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
	IOT IN PRINTING	IOP	GE	324321	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
	PRINTED ELECTRONICS	PRE	GE	324322	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
Total					6	18		16	6		20		120	280	400		175		175		100		850

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, 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.

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , Ability Enhancement Course (AEC) , Skill Enhancement Course (SEC) , Generic Elective (GE)

Programme Name/s	: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures
Programme Code	: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EP/ ET/ EX/ FC/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ SE/ TC/ TE/ TR/ TX
Semester	: Fourth
Course Title	: ENVIRONMENTAL EDUCATION AND SUSTAINABILITY
Course Code	: 314301

I. RATIONALE

The survival of human beings is solely depending upon the nature. Thus, threats to the environment directly impact on existence and health of humans as well as other species. Depletion of natural resources and degradation of ecosystems is accelerated due to the growth in industrial development, population growth, and overall growth in production demand. To address these environmental issues, awareness and participation of individuals as well as society is necessary. Environmental education and sustainability provide an integrated, and interdisciplinary approach to study the environmental systems and sustainability approach to the diploma engineers.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Resolve the relevant environmental issue through sustainable solutions

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 relevant Environmental issues in specified locality.
- CO2 - Provide the green solution to the relevant environmental problems.
- CO3 - Conduct SWOT analysis of biodiversity hotspot
- CO4 - Apply the relevant measures to mitigate the environmental pollution.
- CO5 - Implement the environmental policies under the relevant legal framework.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

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
				CL	TL	LL					FA-TH	SA-TH	Total	Practical				SLA			
														FA-PR	SA-PR	SLA					
Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min										
314301	ENVIRONMENTAL EDUCATION AND SUSTAINABILITY	EES	VEC	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125

Total IKS Hrs for Sem. : 2 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 :

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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	<p>TLO 1.1 Explain the need of studying environment and its components.</p> <p>TLO 1.2 Investigate the impact of population growth and industrialization on the relevant environmental issues and suggest remedial solutions</p> <p>TLO 1.3 Explain the Concept of 5 R w.r.t. the given situation</p> <p>TLO 1.4 Elaborate the relevance of Sustainable Development Goals in managing the climate change</p> <p>TLO 1.5 Explain the concept of zero carbon-footprint with carbon credit</p>	<p>Unit - I Environment and climate change</p> <p>1.1 Environment and its components, Types of Environments, Need of environmental studies</p> <p>1.2 Environmental Issues- Climate change, Global warming, Acid rain, Ozone layer depletion, nuclear accidents. Effect of population growth and industrialization</p> <p>1.3 Concept of 5R, Individuals' participation in i) 5R policy, ii) segregation of waste, and iii) creating manure from domestic waste</p> <p>1.4 Impact of Climate change, Factors contributing to climate change, Concept of Sustainable development, Sustainable development Goals (SDGs), Action Plan on Climate Change in Indian perspectives</p> <p>1.5 Zero Carbon footprint for sustainable development, (IKS-Environment conservation in vedic and pre-vedic India)</p>	Lecture Using Chalk-Board 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.
2	<p>TLO 2.1 Justify the importance of natural resources in sustainable development</p> <p>TLO 2.2 Explain the need of optimum use of natural resources to maintain the sustainability</p> <p>TLO 2.3 Differentiate between renewable and non-renewable sources of energy</p> <p>TLO 2.4 Suggest the relevant type of energy source as a green solution to environmental issues</p>	<p>Unit - II Sustainability and Renewable Resources</p> <p>2.1 Natural Resources: Types, importance, Causes and effects of depletion. (Forest Resources, Water Resources, Energy Resources, Land resources, Mineral resources), (IKS- Concepts of Panchmahabhuta)</p> <p>2.2 Impact of overexploitation of natural resources on the environment, optimum use of natural resources</p> <p>2.3 Energy forms (Renewable and non-renewable) such as Thermal energy, nuclear energy, Solar energy, Wind energy, Geothermal energy, Biomass energy, Hydropower energy, biofuel</p> <p>2.4 Green Solutions in the form of New Energy Sources such as Hydrogen energy, Ocean energy & Tidal energy</p>	Lecture Using Chalk-Board Presentations
3	<p>TLO 3.1 Explain the characteristics and functions of ecosystem</p> <p>TLO 3.2 Relate the importance of biodiversity and its loss in the environmental sustainability</p> <p>TLO 3.3 Describe biodiversity assessment initiatives in India</p> <p>TLO 3.4 Conduct the SWOT analysis of the biodiversity hot spot in India</p> <p>TLO 3.5 Explain the need of conservation of biodiversity in the given situation</p>	<p>Unit - III Ecosystem and Biodiversity</p> <p>3.1 Ecosystem - Definition, Aspects of ecosystem, Division of ecosystem, General characteristics of ecosystem, Functions of ecosystem</p> <p>3.2 Biodiversity - Definitions, Levels, Value, and loss of biodiversity</p> <p>3.3 Biodiversity Assessment Initiatives in India</p> <p>3.4 SWOT analysis of biodiversity hot spot in India</p> <p>3.5 Conservations of biodiversity - objects, and laws for conservation of biodiversity</p>	Lecture Using Chalk-Board Presentations Video Demonstrations
4	<p>TLO 4.1 Classify the pollution based on the given criteria</p> <p>TLO 4.2 Justify the need of preserving soil as a resource along with the preservation techniques</p> <p>TLO 4.3 Maintain the quality of water in the given location using relevant preventive measures</p> <p>TLO 4.4 State the significance of controlling the air pollution to maintain its ambient quality norms</p> <p>TLO 4.5 Compare the noise level from different zones of city with justification</p> <p>TLO 4.6 Describe the roles and responsibilities of central and state pollution control board</p>	<p>Unit - IV Environmental Pollution</p> <p>4.1 Definition of pollution, types- Natural & Artificial (Man- made)</p> <p>4.2 Soil / Land Pollution – Need of preservation of soil resource, Causes and effects on environment and lives, preventive measures, Soil conservation</p> <p>4.3 Water Pollution - sources of water pollution, effects on environment and lives, preventive measures, BIS water quality standards for domestic potable water, water conservation</p> <p>4.4 Air pollution - Causes, effects, prevention, CPCB norms of ambient air quality in residential area</p> <p>4.5 Noise pollution - Sources, effects, prevention, noise levels at various zones of the city</p> <p>4.6 Pollution Control Boards at Central and State Government level: Norms, Roles and Responsibilities</p>	Lecture Using Chalk-Board 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	<p>TLO 5.1 Explain Constitutional provisions related to environmental protection</p> <p>TLO 5.2 Explain importance of public participation (PPP) in enacting the relevant laws</p> <p>TLO 5.3 Use the relevant green technologies to provide sustainable solutions of an environmental problem</p> <p>TLO 5.4 Explain the role of information technology in environment protection</p>	<p>Unit - V Environmental legislation and sustainable practices</p> <p>5.1 Article (48-A) and (51-A (g)) of Indian Constitution regarding environment, Environmental protection and prevention acts</p> <p>5.2 Public awareness about environment. Need of public awareness and individuals' participation. Role of NGOs</p> <p>5.3 Green technologies like solar desalination, green architecture, vertical farming and hydroponics, electric vehicles, plant-based packaging</p> <p>5.4 Role of information technology in environment protection and human health</p>	<p>Lecture Using Chalk-Board Presentations Video Demonstrations</p>

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

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

Assignment

- Suggest the steps to implement (or improve the implementation) of the 5R policy in your home/institute stating your contribution
- Draft an article on India's Strategies to progress across the Sustainable Development Goals
- Make a chart of Renewable and non-renewable energy sources mentioning the advantages and disadvantages of each source
- Conduct the SWOT analysis of biodiversity hotspot in India
- Prepare a mind-mapping for the zero carbon footprint process of your field
- Prepare a chart showing sources of pollution (air/water/ soil), its effect on human beings, and remedial actions
- Any other assignment on relevant topic related to the course suggested by the facilitator

UNICEF Certification(s)

- Students may complete the self-paced course launched by Youth Leadership for climate Exchange under UNICEF program on portal www.mahayouthnet.in . The course encompasses five Modules in the form of Units as given below:

- Unit 1: Living with climate change
- Unit 2 : Water Management and Climate Action
- Unit 3: Energy Management and Climate Action
- Unit 4 : Waste Management and Climate Action
- Unit 5 : Bio-cultural Diversity and Climate Action

If students complete all the five Units they are not required to undertake any other assignment /Microproject/activities specified in the course. These units will suffice to their evaluations under SLA component

Micro project

- Technical analysis of nearby commercial RO plant.
- Comparative study of different filters used in Household water filtration unit
- Evaluate any nearby biogas plant / vermicomposting plant or any such composting unit on the basis of sustainability and cost-benefit
- IKS-Study and prepare a note on Vedic and Pre-Vedic techniques of environmental conversion

Visit a local polluted water source and make a report mentioning causes of pollution
Any other activity / relevant topic related to the course suggested by the facilitator

Activities

- Prepare a report on the working and functions of the PUC Center machines and its relevance in pollution control.
- Prepare and analyse a case study on any polluted city of India
- Prepare a note based on the field visit to the solid waste management department of the municipal corporation / local authority
- Record the biodiversity of your institute/garden in your city mentioning types of vegetation and their numbers
- Visit any functional hall/cultural hall /community hall to study the disposal techniques of kitchen waste and prepare a report suggesting sustainable waste management tool
- Watch a video related to air pollution in India and present the summary
- Any other assignment on relevant topic related to the course suggested by the facilitator

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 may be considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Nil	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	Environment and climate change	CO1	8	4	4	4	12
2	II	Sustainability and Renewable Resources	CO2	10	4	4	8	16
3	III	Ecosystem and Biodiversity	CO3	8	4	4	4	12
4	IV	Environmental Pollution	CO4	12	4	8	6	18
5	V	Environmental legislation and sustainable practices	CO5	7	4	4	4	12
Grand Total				45	20	24	26	70

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

- Two-unit tests (MCQs) of 30 marks will be conducted and average of two-unit tests considered. Formative assessment of self learning of 25 marks should be assessed based on self learning activity such as UNICEF Certification(s)/Microproject/assignment/activities. (60 % weightage to process and 40 % to product)

Summative Assessment (Assessment of Learning)

- Online MCQ type Exam

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	-	1	-	-	3	2	3			
CO2	-	2	2	-	3	2	3			
CO3	-	-	-	-	3	1	2			
CO4	1	-	-	-	3	2	2			
CO5	1	-	2	-	3	2	3			

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	Y. K. Singh	Environmental Science	New Age International Publishers, 2006, ISBN: 81-224-2330-2
2	Erach Bharucha	Environmental Studies	University Grants Commission, New Delhi
3	Rajagopalan R.	Environmental Studies: From Crisis to Cure.	Oxford University Press, USA, ISBN: 9780199459759, 0199459754
4	Shashi Chawla	A text book of Environmental Science	Tata Mc Graw-Hill New Delhi
5	Arvind Kumar	A Text Book of Enviornmental science	APH Publishing New Delhi (ISBN 978-8176485906)

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://sdgs.un.org/goals	United Nation's website mentioning Sustainability goals
2	http://www.greenbeltmovement.org/news-and-events/blog	Green Belt Movement Blogs on various climatic changes and other issues
3	http://www.greenbeltmovement.org/what-we-do/tree-planting-for-watersheds	Green Belt Movement's work on tree plantation, soil conservation and watershed management techniques
4	https://www.youtube.com/@ierekcompany/videos	International Experts For Research Enrichment and Knowledge Exchange – IEREK's platform to exchange the knowledge in fields such as architecture, urban planning, sustainability
5	www.mahayouthnet.in	UNICEF Initiative for youth leadership for climate action

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

Sr.No	Link / Portal	Description
6	https://eepmoefcc.nic.in/index1.aspx?lsid=297&lev=2&lid=1180&langid=1	GOI Website for public awareness on environmental issues
7	https://egyankosh.ac.in/handle/123456789/61136	IGNOU's Initiative for online study material on Environmental studies
8	https://egyankosh.ac.in/handle/123456789/50898	IGNOU's Initiative for online study material on sustainability
9	https://sustainabledevelopment.un.org/content/documents/11803Official-List-of-Proposed-SDG-Indicators.pdf	Final list of proposed Sustainable Development Goal indicators
10	https://sustainabledevelopment.un.org/memberstates/india	India's Strategies to progress across the SDGs.
11	https://www.un.org/en/development/desa/financial-crisis/sustainable-development.html	Challenges to Sustainable Development
12	https://nptel.ac.in/courses/109105190	NPTEL course on sustainable development
13	https://onlinecourses.swayam2.ac.in/cec19_bt03/preview	Swayam Course on Environmental studies (Natural Resources, Biodiversity and other topics)
14	https://onlinecourses.nptel.ac.in/noc23_hs155/preview	NPTEL course on environmental studies which encompasses SDGs, Pollution, Climate issues, Energy, Policies and legal framework
15	https://www.cbd.int/development/meetings/egmbped/SWOT-analysis-en.pdf	SWOT analysis of Biodiversity
16	https://www.sanskrit.nic.in/SVimarsha/V2/c17.pdf	Central Sanskrit University publication on Vedic and pre Vedic environmental conservation
Note :		
<ul style="list-style-type: none"> Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students 		

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

Programme Name/s : Printing Technology

Programme Code : PN

Semester : Fourth

Course Title : DIGITAL PRINTING

Course Code : 324014

I. RATIONALE

Digital printing processes have helped printing sector to achieve consistency, accuracy, precision and reproducibility in handling smaller order sizes. In many cases digital printing processes are used in conjunction with conventional printing processes increasing quality, value and overall efficiency of the combined production process. The learner of printing technology having exposure of the Prepress in Digital Printing and Graphic Design Software courses will learn applications of digital printing in various stages of printing workflow of commercial printing and packaging industries.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Print on conventional and specialty substrates using different digital printing processes.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Illustrate applications of digital printing processes.
- CO2 - Operate digital printing press to print a given job.
- CO3 - Apply color management in digital printing processes.
- CO4 - Identify digital printing process for a given printing requirement.
- CO5 - Suggest embellishment for digitally printed products.

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			
				CL	TL	LL					Total	Practical		SLA							
												FA-TH	SA-TH	FA-PR	SA-PR	Max	Min				
324014	DIGITAL PRINTING	DGP	DSC	2	-	2	2	6	3	-	-	-	-	-	50	20	50@	20	25	10	125

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

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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 List application of digital printing technology. TLO 1.2 Identify the stages of digital printing process. TLO 1.3 Describe the factors that accelerate the development of digital printing technology.	Unit - I Development of Digital Printing 1.1 Definition, application, and factors that accelerated the use and development of digital printing technologies. 1.2 Comparative study of conventional & digital printing technology. 1.3 Advantage, limitation of digital printing techniques.	Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Describe direct imaging press. TLO 2.2 Compare computer to film, Computer to plate and computer to print TLO 2.3 Justify the need for Print-on-demand (POD), variable data printing (VDP) and customization.	Unit - II Digital Printing Machines 2.1 Direct imaging presses - Principle, types, and configurations. 2.2 Comparative study of computer-to-film, computer-to-plate, and computer to print. 2.3 Print-On-Demand (POD), variable data printing (VDP), distribute-and-print, remote publishing (Web2Print) and Customisation.	Chalk-Board Presentations Video Demonstrations
3	TLO 3.1 Describe the working of electro photography. TLO 3.2 Describe photo mechanics behind latent image formation in elect photography. TLO 3.3 List major components of dry and liquid toner and identify the application of ion deposition, electrostatic, & magnetographic digital printing.	Unit - III Toner based Digital Printing systems 3.1 Electro photography - working principle, stages, characteristics, types of photoconductor, construction of OPC drum, functions of charge generation material and charge transport material. 3.2 Photo-mechanics behind latent image formation in electro photography. 3.3 Types, requirements and the general composition of dry and liquid toner and Principle, Working, advantages, limitation, and application of ion deposition, electrostatic and magneto graphic toner-based digital printing system.	Chalk-Board Presentations Video Demonstrations
4	TLO 4.1 Classify an inkjet printer. TLO 4.2 Describe the working of thermal transfer printer. TLO 4.3 List substrate used for an inkjet and thermal transfer printing and compare the electro photography and an ink jet digital printing technology.	Unit - IV Ink Jet and Thermal Transfer Digital Printing systems 4.1 Inkjet Technology- Principle, classification, press configuration, ink types. 4.2 Thermal transfer- Principle, classification, press configuration, ink types. 4.3 Substrates and inks used for inkjet and thermal transfer digital printing system and comparative study of electro photography and inkjet digital printing technologies.	Presentations Chalk-Board Video Demonstrations
5	TLO 5.1 Explain troubles related to the toner based digital systems. TLO 5.2 Explain troubles related to the inkjet digital systems. TLO 5.3 Explain troubles related to the substrate and finishing operations.	Unit - V Troubleshooting 5.1 Drum charging, roller positioning, fusing, uneven transfer, colors not matching. 5.2 Clogging of ink heads, dot gain. 5.3 Dimensional instability, punching/ lamination/ foiling misregister.	Site/Industry Visit Collaborative learning Chalk-Board

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
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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Products of non-impact and impact printing technologies.	1	*Identify from given samples non-impact and impact printing technologies samples.	2	CO1
LLO 2.1 Print characteristics of printed products in impact and non-impact printing technologies.	2	Compare print characteristics of 2 samples printed from any one impact and non-impact printing technologies.	2	CO1
LLO 3.1 Grouping of printed samples digital printing technology.	3	Analyze and group given printed samples digital printing technology.	2	CO1
LLO 4.1 Trial print need on direct imaging press.	4	*Print test image on direct imaging press.	2	CO2
LLO 5.1 Use of Computer-to-Print technique.	5	Demonstrate Computer-to-Print technique.	2	CO2
LLO 6.1 Apply (POD) Print-On-Demand and (VDP) Variable Data Printing techniques.	6	*Print 2 jobs each using (POD) Print-On-Demand and (VDP) Variable Data Printing techniques.	2	CO2
LLO 7.1 Monochrome laser print of two types of originals.	7	*Print 2 line and 2 tone jobs on monochrome laser printer.	2	CO2
LLO 8.1 Monochrome ink-jet print on two types of original.	8	*Print 2 line and 2 tone jobs on monochrome ink-jet printer.	2	CO3
LLO 9.1 Use a digital image on any two ink jet printers.	9	Proof a digital images on any two ink jet printers.	2	CO3
LLO 10.1 Produce prints with thermal transfer printing process.	10	Print given 3 digital images using thermal transfer printing process.	2	CO3
LLO 11.1 Differentiate the soft proof from the hard proofs of color digital images.	11	*Compare the soft and hard proofs of a color digital images.	2	CO4
LLO 12.1 Print given 3 digital images using thermal wax printer.	12	Print given 3 digital images using thermal wax printer.	2	CO4
LLO 13.1 Calculate print contrast and grey level ability of given laser and ink jet printer.	13	*Calculate print contrast and grey level ability of given laser and ink jet printer.	2	CO4
LLO 14.1 Maintain composite toner for given color laser and inkjet printers.	14	Clean, replace composite toner for given color laser and inkjet printers.	2	CO5
LLO 15.1 Remedies for laser and ink jet printer problems.	15	Troubleshoot laser and ink jet printer problems.	2	CO5
LLO 16.1 Schedule preventive and corrective maintenance of digital press.	16	Undertake preventive and corrective maintenance of digital press.	2	CO5
LLO 17.1 Suggest resolutions of needed in digital presses	17	List resolutions of digital presses of any four applications.	2	CO5
LLO 18.1 Take textile prints on fabrics using dye sublimation, heat set and direct to fabric techniques.	18	*Print carrier sheet to print on different textile fabrics.Print carrier sheet to print on different textile fabrics.	2	CO3
Note : Out of above suggestive LLOs - <ul style="list-style-type: none"> *1 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

- Compare color and single color prints on at least four bases after printing them on laser and inkjet printers at separate resolutions.

DIGITAL PRINTING**Course Code : 324014**

- Identify difficulties in disposing e-waste associated with digital presses as per the guidelines of the state government.
- Survey a local market for identifying motivation behind growth of digital printing.
- Classify digital and conventional printing presses on at least four bases after visiting them.

Assignment

- Prepare a short video of SOP for replacing composite toner and removing jammed paper in digital press.
- Prepare a detailed report on references available to learn the development of digital printing using library and internet sources.
- Estimate a mileage of a OEM and compatible composite toner for digital printing press.
- Publish a short movie interviewing random customers of digital prints about their opinions on digital prints.

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	Color appraisal viewing booth and digital magnifier	1,2,3
2	Thermal wax printer	12
3	Spectrophotometer for printing and publishing	13
4	Heating press for heat set and dye sublimation transfer printing.	18
5	Carrier sheet ink jet printing for transfer printing.	18
6	A4/A3 size Mono/ Inkjet Printer	4,5,7,8,9,10,11,14,15,16,17
7	A4/A3 size Mono/Laser Printer	4,5,7,8,9,10,11,14,15,17
8	Open source variable data printing software and access to e-commerce website	6
9	Computer (Windows 10 Pro, Intel® Core™i5, RAM 8GB, 64-bit operating system)	All
10	Broadband or Fiber-optic network	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	Development of Digital Printing	CO1	4	0	0	0	0
2	II	Digital Printing Machines	CO2	6	0	0	0	0
3	III	Toner based Digital Printing systems	CO3	8	0	0	0	0
4	IV	Ink Jet and Thermal Transfer Digital Printing systems	CO4	6	0	0	0	0
5	V	Troubleshooting	CO5	6	0	0	0	0
Grand Total				30	0	0	0	0

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Each practical will be assessed considering 60% weightage to process and 40% weightage to output.

Summative Assessment (Assessment of Learning)

- Actual performance in Internal Practical Examination of 50 marks.

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	3	3	3	3	1	1			
CO2	3	3	3	3	3	2	1			
CO3	3	3	3	3	3	1	1			
CO4	3	3	3	3	3	1	1			
CO5	3	3	3	3	3	2	1			

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	Prof. Dr.-Ing. habil. Helmut Kipphan	Handbook of Print Media	Springer-Verlag Berlin Heidelberg New York ISBN 3-540-67326-1
2	Jeff Schew	The Digital Print: Preparing Images in Light room and Photoshop for Printing	Peachpit Press, United states of America ISBN-13: 978-0-321-90845-2
3	Abhay Sharma	Understanding Color Management	Wiley and Sons Ltd, ISBN-9781119223689
4	Pentti Viluksela, Merja Kariniemi & Minna Nors	Environmental Performance of Digital Printing	VTT Technical Research Centre of Finland. ISBN 978-951-38-7630-2
5	Michael Barnard	Print and Production Manual	Pira International, United Kingdom ISBN 1 85802 238 X

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/GeoBU20MN68	HP Indigo Printing Technology Indigo Digital Presses HP
2	https://youtu.be/bcgRZ60wLe8	Offset Printing Vs Digital Printing: How Are They Different?
3	https://youtu.be/eeUDnikKBCY	Digital Textile Printing Process - Direct fabric printing and Sublimation Printing Step by Step Exp.
4	https://youtu.be/cxEqPKq5Se8	A complete process of digital textile printing solution Pretreatment Post Treatment Reactive
5	https://youtu.be/4jIS6qq6jSA	Variable Data Printing Using EFI Fiery RIP, Save Time and Money in Your Print Shop

Sr.No	Link / Portal	Description
6	https://youtu.be/V-ILkTe03yI	Computer-To-Plate (CTP) Image-Setter Process with Magnus 400 III Quantum Plate Setter. CTP machine
7	https://youtu.be/WP9IoxWNhZI	Top Print-on-Demand Supplier Fulfilment Companies for Indian eCommerce (in Hindi)
8	https://youtu.be/tDiHTK9nwYw	How do printers work? (Color Laser Printer & inkjet printer)
9	https://youtu.be/4jAzbRLWVMQ	Laser Printer 5 common problems in laser printer how to repair laser printer

Note :

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

PRINT ESTIMATING & COSTING**Course Code : 324015**

Programme Name/s : Printing Technology
Programme Code : PN
Semester : Fourth
Course Title : PRINT ESTIMATING & COSTING
Course Code : 324015

I. RATIONALE

The printing industry faces intense competition in its market, and the profitability of print processes is essential to the industry's long-term success and expansion. It is crucial to estimate and cost printing tasks and products in order to maintain the industry as a whole. This subject requires a thorough understanding of printing operations and procedures. The goal of the course is to improve students ability to estimate, control costs, schedule operations, and use resources efficiently. These acquired skills are expected to yield significant commercial benefits for the printing industry in the future.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Prepare a competitive quote for the given job of printing .

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Elaborate the scope of estimation and costing in printing.
- CO2 - Examine the variables influencing printing cost and estimation.
- CO3 - Calculate the approximate number of pre-printing steps required for the given task.
- CO4 - Estimate the amount of raw materials required for the job at work.
- CO5 - Estimate the jobs finishing and shipping expenses.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH	Theory			Based on LL & TL				Based on SL						
				CL	TL	LL			Total			Practical		SLA								
												FA-TH	SA-TH	FA-PR	SA-PR	Max	Min					
324015	PRINT ESTIMATING & COSTING	PEC	SEC	2	-	4	-	6	3	-	-	-	-	-	50	20	50@	20	-	-	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 Elaborate difference between costing and estimating, types of cost. TLO 1.2 Select the relevant type of rate system according to job.	Unit - I Fundamentals of estimation and costing 1.1 Introduction to book keeping and accountancy. Definition of cost- Elements of cost, cost control of labour, material and allocation of overheads. Types of cost, factory cost and prime cost, examples of process cost for printing industry, difference between costing and estimating. 1.2 Major factors in determination of Selling Price of product, Factors affecting profitability. 1.3 Depreciation – meaning and types, simple numerical on depreciation. 1.4 Concept of labour hour rate and machine hour rate, Time rate and Work rate system, major factors in determining hourly rate of operations in printing.	Lecture Using Chalk-Board Presentations Case Study
2	TLO 2.1 Identify technical specifications of various jobs. TLO 2.2 Select appropriate cost elements according to job.	Unit - II Formats for job instructions and basics of tendering. 2.1 Works Instruction Ticket or Job Card. Preparing job cards for various jobs. 2.2 GST – meaning and rates for raw materials, print services. 2.3 Tender document – meaning, types contents, and examples of tenders (print production related).	Lecture Using Chalk-Board Presentations Site/Industry Visit
3	TLO 3.1 Select operations according to job. TLO 3.2 Plan schedule of operations for maximum utilization of resources.	Unit - III Job planning, sequencing and operations. 3.1 Identify the raw material processing, operations required and stages in sequence for various print jobs. Examples - bookwork by offset, book on demand by digital printing, label printing by flexography and Sachet printing on polymer by gravure printing, newspaper printing by web offset. 3.2 Determine the significance of job sequencing and planning according to number of operations.	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study
4	TLO 4.1 Estimate paper and film required for job. TLO 4.2 Elaborate factors affecting estimation of job. TLO 4.3 Calculate ink consumption.	Unit - IV Estimation of substrate and ink 4.1 Estimation of paper- Paper size (British & ISO), Multiples and sub-divisions, Ream, Quire, Gross, wastage allowance. 4.2 Calculation of weight of web & sheets, calculation of number of pages, reams, reels, plates, impressions, time and cost required for printing and plate making. 4.3 Polymer film roll weight calculations when material density and thickness, calculating number of rolls required. 4.4 Ink consumption - SPANKS formula with detailed values for all the elements.	Lecture Using Chalk-Board Presentations Case Study Flipped Classroom
5	TLO 5.1 Estimating Flexo plate making charges. TLO 5.2 Gravure cylinder making charges. TLO 5.3 Estimation for post press operations. TLO 5.4 Calculate transportation cost.	Unit - V Estimation of printing finishing and transportation cost 5.1 Considerations related to costs of flexography plates making. 5.2 Considerations related to costs for plating of gravure cylinder. 5.3 Post printing operations - binding material calculation - cloth, board, lamination film, case making. Factors affecting output rate of machines used for finishing operations. 5.4 Transportation: Containers, type of containers, pallets, factors to consider for transportation cost.	Lecture Using Chalk-Board Presentations Demonstration Case Study Flipped Classroom

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 Calculate Depreciation by multiple methods.	1	<p>* Calculate the depreciation by straight-line method and reducing balance method for 5 years. The cost of the machine is Rs. 20 lakhs and the depreciation percentage is 5% per year</p> <p>ABC Company purchases a printing machine to print flyers for Rs. 4,00,000 with a useful life of 18,00,000 units and a residual value is Rs. 40,000. The units produced is 40,000 Flyers. Find the depreciation by unit cost of production method.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO1
LLO 2.1 Calculate direct labour cost.	2	<p>A Printing company had factory overheads for the year 2011-2012, of Rs. 40,000 and direct labour cost of Rs. 1,20,000. Find the percentage overhead using percentage of direct labour cost method.</p> <p>Also If production order had a direct labour cost of Rs. 600, find the overhead cost for the production order.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO1
LLO 3.1 Calculate hourly charge for perfect binding machine	3	<p>* Calculate the hourly charge for the perfect binding machine operating 6-8 hours per day. The machine incurs monthly expenses, including labor 3500-5500 Rs. rent 960-1700 Rs. and electricity 1850-2500 Rs. The in-house price of the machine falls within the range of 25,03,500 - 33,65,400 Rs + GST. Additional monthly costs consist of consumables (35,800-45,000 Rs) and AMC for the machine (1,25,000-1,55,000 Rs).</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO1
LLO 4.1 Prepare a job card	4	<p>* Create a job card specification utilizing the JOB Ticket template for the production of a commercial book using the Offset Printing Method, ranging from 100 to 350 copies. Prepare a job card specification using the JOB Ticket template for the production of Shrink Sleeve Labels using the Flexography method.</p>	4	CO2
LLO 5.1 Analyze and Prepare a sales report	5	<p>Analyze and Prepare a sales report format considering a Company is working in the Commercial Printing Sector / Flexible Packaging Sector.</p>	4	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Calculate the cost estimation for banner printing	6	<p>Calculate the cost estimation for banner printing with dimensions ranging from 3.8 to 6 meters in width and 9 to 18 meters in length. The printing is done on a Flex Printing machine with hourly operating charges of 120 to 160 Rs/hour and a printing speed of 80 to 95 sqft/hour. The cost of the media used is 9 to 12 Rs/sqft.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO3
LLO 7.1 Determine the job sequencing for given job	7	* Determine the optimal sequence of operation required to print a book by an Offset printing method and binding with the perfect binding method.	4	CO3
LLO 8.1 Analyze and Prepare a sales report	8	<p>Calculate the cost of plate making for a job involving an A4 to A6 size book with a page count ranging from 164 to 960 pages, to be printed on a 28-inch x 40-inch machine. The book consists of 128 to 360 pages in four colors, and the printing is done on a 20 x 30-inch machine. The rate for the plate set is 800 to 950 Rs for black and white sets and 2650 to 2800 Rs for four-color sets.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO4
LLO 9.1 Calculate the number of rolls and the weight of the roll.	9	<p>Calculate the number of rolls and the weight of the roll containing paper ranging from 5000 to 6000 meters and weighing 65 to 95 gsm. This paper is utilized for printing A4 to A6 size books with a page count ranging from 128 to 360 pages on a web-fed 24 to 28-inch machine with a cut-off of 598 to 656 mm. The total number of books required falls within the range of 1.25 to 2.24 lakh.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO4
LLO 10.1 Calculate the cost of a Flexo plate	10	<p>* Calculate the cost of a Flexo plate set for an 8-color setup with an image size ranging from 6 x 9 to 15 x 18 inches. The negative cost is between 1.5 to 1.95 Rs/Inch, and the plate processing cost is 15 to 18 Rs/Inch.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Calculate the cost of plating for a Gravure Cylinder	11	<p>Calculate the cost of plating a Gravure Cylinder with a diameter ranging from 8 to 15 inches and a width of 28 to 36 inches. The nickel thickness varies from 800 to 1600 microns, copper thickness ranges between 3000 to 6000 microns, and chrome thickness is between 1500 to 2500 microns.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO4
LLO 12.1 Estimate the cost of ink consumption for printing	12	<p>* Estimate the cost of ink consumption for printing 4-inch x 3-inch sticker labels in quantities ranging from 1.5 to 2.5 lakh. The labels are printed in 6 to 8 colors for the text matter on a Flexo machine and 2 to 3 colors for solid patches on a Screen printing machine.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO4
LLO 13.1 Calculate the cost of binding operations	13	<p>Calculate the cost of binding operations for a quantity of 5000 to 7500 units of an India Map Book, ranging from 64 to 240 pages and containing 24 to 48 insertion maps. The chosen binding method is Hard Bind Jacket Case Binding, involving manual labor operations such as case making, folding, insertions, etc. Consider manual labor charges of 0.85 to 1.15 Rs per operation per unit.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO5
LLO 14.1 Compute the cost of Universal Cartons	14	<p>Compute the cost of Universal Cartons with dimensions ranging from 8-12 x 8-10 x 8-14 inches, manufactured from 5-7 layer C Type Board, with a board span of 18-24 inches. The quantity of cartons is between 1.25 to 2.15 lakh. The rate for box stitching and cutting is 230 to 280 Rs per 1000 units, and the rate for C Type boards is 8 to 12 Rs per sqft.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO5
LLO 15.1 Calculate the cost of the binding operation	15	<p>Calculate the cost of the binding operation for 5000 books, each consisting of 128 pages of A5 size. The inner text pages are printed on 70 GSM A2 size map litho paper, and the cover is made of 210 GSM A2 size art card. The perfect binding method is employed, with charges of Rs. 4 per book, and folding charges amounting to Rs. 30 per fold per 1000 folds.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 16.1 Calculate the cost of lamination	16	<p>* Calculate the cost of laminating a 12 x 18-inch cover with matte lamination on both sides for a quantity ranging from 1500 to 2800 units. The lamination roll, with a width of 20 to 36 inches and a length of 50 to 100 meters, is priced between 2850 to 5840 Rs.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO5
LLO 17.1 Estimate the cost of ink consumption	17	<p>* Calculate the cost of pelleting for 1500-1800 boxes, each with dimensions of 6-9 x 8-12 x 4-8 inches and weighing between 2.5-3.5 kg. Each pallet has a maximum carrying capacity of 750-900 kg, and the pelleting charge is 580-640 Rs per pallet.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO5
LLO 18.1 Calculate the cost of shipping	18	<p>Calculate the cost of shipping in a 40-20 ft. container with a maximum 75-80% floor loading and a tier capacity of 26.8 tons. Pelleting is required for 15,000-18,000 boxes, each measuring 6-8 x 9-8 x 6-12 inches, with a weight range of 5.5-6.5 kg. Each pallet can carry a maximum of 750-900 kg, and the pelleting charge is 580-640 Rs per pallet. Pallet stacking is allowed for a 1 + 1 combination. The container charges range from 20,000 to 35,000 Rs per consignment.</p> <p>Calculate the cost of shipping in a 20 ft. container with a maximum 75- 85% floor loading and a tier capacity of 16.8-17.6 tons. Pelleting is required for reams with a size of 36x78 inches, weighing between 380- 480 kg. Each pallet can carry a maximum of 850-970 kg, and the pelleting charge is 650-780 Rs per pallet. Pallet stacking is allowed for a 1 + 0 combination. The container charges range from 12,000 to 15,000 Rs per consignment.</p> <p>In the provided example, the range of values aligns with the industry's prevailing standards. The subject teacher is required to adjust these values within a specified range for each group of students to enhance the comprehension of the course.</p>	4	CO5
<p>Note : Out of above suggestive LLOs -</p> <ul style="list-style-type: none"> • '* 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

- Compile information on the specifications and demands of the tenders for the purchase of office files, note books, and A4 paper, among other stationery goods used by the institute.
- Analyze the costs of at least five different kinds of paper, boards, ink, chemicals, and other consumables that are accessible locally or online for the procurement process, then compile your findings into a survey report.

- Create an Excel spreadsheet for job costing to ensure that anyone can estimate the cost of each product that is printed locally.
- Evaluate label stock and lamination rolls available locally and online, then compile a report that is easy to understand for users in local area.
- Survey the types of containers and the costs associated with delivering finished goods in the local area.

Assignment

- Compile the technical expenses related to different substrates based on their type and size from local sources, and present the information in a report.
- Give a seminar on the complete steps and associated costs for Book Printing through the Offset process, including a discussion on appropriate binding methods.
- Observe and document both the direct and indirect costs linked to a Publication house, presenting the findings in a detailed report.
- Collect GST rates in Maharashtra for various raw materials connected with Printing, along with their corresponding HSN Codes.

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	Non programmable calculator	All
2	Scale	All
3	Open source software for data handling	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 estimation and costing	CO1	5	0	0	0	0
2	II	Formats for job instructions and basics of tendering.	CO2	5	0	0	0	0
3	III	Job planning, sequencing and operations.	CO3	4	0	0	0	0
4	IV	Estimation of substrate and ink	CO4	8	0	0	0	0
5	V	Estimation of printing finishing and transportation cost	CO5	8	0	0	0	0
Grand Total				30	0	0	0	0

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

- Each practical will be assessed considering 60% weightage to process and 40% weightage to output.

Summative Assessment (Assessment of Learning)

- Actual performance in internal practical examination of 50 marks.

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	1	2	1	2	2	3			
CO2	3	3	2	1	2	2	3			
CO3	3	2	3	2	2	2	2			
CO4	3	3	2	2	2	2	2			
CO5	3	3	2	2	2	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	B.D. Mendiratta	Printer's Costing & Estimating	Arihant Prakashan Pvt. Limited, ISBN - 8190982877, 9788190982870
2	Philip Kent Ruggles	Printing Estimating	Delmar Publishers, 1996 ISBN : 0827364393, 9780827364394
3	Hugh M. Speirs.	Print Estimator's Handbook	Pira International Ltd., 2004 ISBN: 85802 922 8

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=v93S3WLYNZE	Introduction to Estimating and Costing
2	https://www.youtube.com/watch?v=kor-0DFEpuI	How to calculate cost of any job work
3	https://www.youtube.com/watch?app=desktop&v=UqWtCjFAXLc	Bill Book Costing
4	https://www.youtube.com/watch?app=desktop&v=oKO3VOsrmsA	Calculate Printing Cost
5	https://www.youtube.com/watch?app=desktop&v=PoYrPOHt0DA	Large Format Print Estimating Software
6	https://www.youtube.com/watch?app=desktop&v=-aJnyfccfrQ	Printing Paper Costing

Note :

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

RIGID PACKAGING**Course Code : 324318**

Programme Name/s : Printing Technology
Programme Code : PN
Semester : Fourth
Course Title : RIGID PACKAGING
Course Code : 324318

I. RATIONALE

Packaging is becoming one of the large segments of printing and related industry. The demand for packaging materials and packages is experiencing growth on account of increasing demand for consumer, logistics and industrial sectors. This course therefore appropriately introduced to deal with additional knowledge of packaging requirements such as variety of substrates, finishing operations, conversion, etc.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply packaging knowledge to printing production.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Suggest packaging method for the given product.
- CO2 - Identify various carton styles.
- CO3 - Select appropriate packaging material for given job.
- CO4 - Identify operation sequence of basic packaging machines.
- CO5 - Identify environmental issues related to packaging material.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH			Theory			Based on LL & TL		Based on SL					
				CL	TL	LL					FA-TH	SA-TH	Total	Practical		SLA					
														FA-PR	SA-PR	Max	Min	Max	Min		
324318	RIGID PACKAGING	RPG	DSC	4	-	4	-	8	4	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 2 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 State different types of packaging functions. TLO 1.2 Classify packaging techniques. TLO 1.3 List packaging and cushioning materials.	Unit - I Overview of rigid packaging 1.1 Packaging Functions – Primary - preserve, protect, present. Secondary - inform, identify, sell, marketing. Challenges in packaging – storage, transportation, chemical, climatic, biological. 1.2 Classifications–Primary/ Secondary/ Tertiary, Unit/ Intermediate/ Bulk. 1.3 Applications and characteristics of Packaging materials - Paper Board, Plastics, Wood, Metals, Glass, Textile and Comparison between flexible and rigid packaging material. Cushioning Materials – Plastic sheets, Fiber Foam, Sponge, Grass, Ancillary Materials. IKS: Ancient Indian practices to store grains, clothes during all seasons. Use of Jute, Hemp, 'Bhurjapatra' for covering and securing.	Presentations Lecture Using Chalk-Board Model Demonstration
2	TLO 2.1 List properties and applications of boards. TLO 2.2 List types and applications of cartons. TLO 2.3 Explain punch making and gluing machine techniques.	Unit - II Paper and Board used in packaging 2.1 Boards - Type of Boards, properties and applications, Multiply boards, food grade boards and corrugated boards. Corrugated board manufacturing process, types of flutes. 2.2 Carton - Functions, types, applications, international standards for cartons such as FEFCO, ECMA. Carton making / designing – considerations while designing, information on carton styles – STE, RTE, display carton, hanging, CB. Software used for carton designing and it's advantages. 2.3 Die making – punch making for single die, jigged die. rotary die making, punching machine, carton making for universal cartons, stitching machine, scoring machine, automatic gluing machine, types of glue applicators, box making machine.	Lecture Using Chalk-Board Presentations Model Demonstration
3	TLO 3.1 List applications of metals used in packaging. TLO 3.2 Discuss the conversion of metals. TLO 3.3 Quality check for metal containers and cans.	Unit - III Metals used in packaging 3.1 Metals used in packaging, advantages, applications, characteristics of – Aluminum, Stainless Steel, Galvanized Steel. 3.2 Conversion of Metal – Cans - Three piece & Two piece Cans, Walled iron Cans - Welded & Seamless Cans. Tubes – collapsible tube manufacturing process, design, advantages & disadvantages of metal collapsible tubes, Aerosol containers - classification of aerosols – manufacturing process, advantages & disadvantages of aerosols. Foils – Process and Properties. 3.3 Quality check for metal containers and cans - anti-corrosion techniques, specifications, problems.	Site/Industry Visit Lecture Using Chalk-Board Presentations Model Demonstration
4	TLO 4.1 List types of glass bottle. TLO 4.2 Describe glass bottle manufacturing process. TLO 4.3 List quality control measures.	Unit - IV Glass used in packaging 4.1 Types of Glass bottle, properties, advantages, disadvantages, applications. 4.2 Manufacturing Process - Bottle manufacturing and post manufacturing treatments. 4.3 Quality control and specifications in glass packaging materials.	Video Demonstrations Presentations Lecture Using Chalk-Board

RIGID PACKAGING**Course Code : 324318**

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 Discuss packaging life cycle. TLO 5.2 Name factors in costing in packaging. TLO 5.3 List the tests performed on packages.	Unit - V Circular economy and tests related to packaging 5.1 Packaging Life cycle – Recovery, Recycle, Reuse concept in packaging. Use of sustainable materials. 5.2 Costing of carton making, printing process, inline process for packaging. Use of AI, IoT in packaging, CAP, MAP. 5.3 Tests performed on packages - Physical tests on package for transportation – physical damage, stack test, drop test, sealing strength, rolling test, crush resistance, Water Vapour Transmission Rate (WVTR) test.	Video Demonstrations Presentations Lecture Using Chalk-Board

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 Identify packaging method and function of collected samples.	1	*Identify packaging methods and functions of collected samples. (Minimum 3)	4	CO1
LLO 2.1 Collect and measure the thickness of flexible packaging material preferably with micrometer or suitable instrument.	2	Collection and measuring the thickness of flexible packaging material preferably with micrometer or suitable instrument. (Minimum 3)	4	CO1
LLO 3.1 Collect and analyze the cushioning materials.	3	Collection and analysis of minimum 3 cushioning materials.	4	CO1
LLO 4.1 Design and prepare universal carton.	4	*Designing and preparing universal carton.	4	CO2
LLO 5.1 Design and prepare Reverse Tuck end Carton.	5	*Designing and preparing Reverse Tuck end Carton.	4	CO2
LLO 6.1 Design and prepare Straight Tuck end Carton.	6	*Designing and preparing Straight Tuck end Carton.	4	CO2
LLO 7.1 Prepare FEFCO Carton using software	7	Preparing FEFCO Carton using software.	4	CO3
LLO 8.1 Measure thickness of 2 and 3 ply corrugated board.	8	*Measure thickness of 2 and 3 ply corrugated board.	4	CO3
LLO 9.1 Measure thickness and analyse the layers of laminated material.	9	Measuring thickness and analysis of layers of laminated material.	4	CO3
LLO 10.1 Segregate the extruded plastic bottles according to the recycling numbers.	10	*Segregation of extruded plastic bottles according to the recycling numbers.	4	CO3
LLO 11.1 Compare the bottles and closures based on weight.	11	Comparison of bottles and closures based on weight.	4	CO4
LLO 12.1 Shrink wrapping of small products.	12	Shrink wrapping of small products.	4	CO4
LLO 13.1 Stretch wrapping manually or mechanically.	13	Stretch wrapping manually or mechanically.	4	CO4
LLO 14.1 Separate the layers of an aseptic carton.	14	*Separating the layers of an aseptic carton.	4	CO5
LLO 15.1 Perform drop test for 2 different products.	15	*Perform drop test for 2 different products.	4	CO5
LLO 16.1 Perform tensile strength of 2 different board samples.	16	Perform tensile strength of 2 different board samples.	4	CO5
LLO 17.1 Demonstration of compression test on box.	17	Demonstration of compression test on box.	4	CO5

RIGID PACKAGING**Course Code : 324318**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
Note : Out of above suggestive LLOs -				
<ul style="list-style-type: none"> • '*1 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

- Compare various plastics used for packaging.
- Compare cost of same product with different quantity.
- Compare cost of same product with different packaging material.
- Collect information about export requirement of boxes in different countries.
- Collect information about MAP and CAP and units established in nearby area.
- Collect different packaging materials and analyze printing method used for it.

Assignment

- Visit packaging setups in Local area to learn workflow of production.
- Visit Packaging testing lab in Local area to learn different test performed on package.
- Visit segregation or recycling setups in Local area to learn workflow of Packaging Life Cycle.

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	Stretch wrapping machine	11,12,13
2	Carton designing software	2,3
3	Tensile strength tester	4,5,6
4	Shrink wrapping machine	7,8,9,10
5	Drawing board and drawing equipment	All
6	Micrometer Screw Gauge - 25 mm, analog, LC - 0.01mm	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	Overview of rigid packaging	CO1	10	4	4	2	10
2	II	Paper and Board used in packaging	CO2	14	4	4	8	16

RIGID PACKAGING

Course Code : 324318

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
3	III	Metals used in packaging	CO3	12	4	4	6	14
4	IV	Glass used in packaging	CO4	12	4	4	6	14
5	V	Circular economy and tests related to packaging	CO5	12	4	4	8	16
Grand Total				60	20	20	30	70

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

- Each practical will be assessed considering 60% weightage to process and 40% weightage to output.
- Two unit tests of 30 marks each and average of two unit tests out of 30 marks.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks through offline examination.
- Actual performance in external practical examination of 25 marks.

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	2	2	2	2	2	2	1			
CO2	3	2	3	2	3	2	2			
CO3	2	3	3	2	3	2	1			
CO4	2	3	3	2	3	2	1			
CO5	3	3	3	2	3	3	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	S. P. Athavale	Hand Book of Printing, Packaging and Lamination: Packaging Technology	Notion Press ISBN 1644292505
2	Mark J. Kirwan	Handbook of Paper and Paperboard Packaging Technology	Wiley Blackwell ISBN 978-0-470-67066-8
3	Susan E.M. Selke	Plastics Packaging: Properties, Processing, Applications, and Regulations	Hanser Publications ISBN 1569903727
4	Walter Soroka	Fundamentals of Packaging Technology	Institute of Packaging Professionals ISBN 1930268289

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
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RIGID PACKAGING**Course Code : 324318**

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=Z3sz7bHs3c0&list=PLvRSdDKXp2SoL-JMt2POgPP4C7twqCfsy	Packaging design tutorials by Adobe AI
2	https://www.youtube.com/watch?v=ARxFwDnj_2c	What is Packaging Technology? by Printpack Katta
3	https://www.youtube.com/watch?v=H3rCA23ebok	Packaging in Marketing Management, type of packaging, Functions of Packaging, Level of packaging
4	https://www.youtube.com/watch?v=WIoQ8jHLHsg	Labelling on Marketing, function of labelling, labelling in marketing management, labelling meaning
5	https://www.youtube.com/watch?v=eijE5H2VatM	Product Life Cycle in marketing management
6	https://www.youtube.com/watch?v=Ay-EPRMiv7U	The Art of Packaging Production From Start To Finish
7	https://www.youtube.com/watch?v=zLAFblG8srM	Behind the Packaging Box
8	https://www.youtube.com/watch?v=ldD0ydEKez4	Esko ArtiosCAD - Structural Design Application For Packaging
9	https://www.youtube.com/watch?v=27Pru21te2s	Modified Atmosphere Packaging (MAP)
10	https://www.youtube.com/watch?v=0CaKyyNGQC4	Difference in CAP AND MAP food packaging
11	https://www.youtube.com/watch?v=4taev4EY-ZI	Controlled atmosphere storage and modified atmosphere storage
12	https://www.youtube.com/watch?v=W_FZ1TmuRzY	Sustainable Packaging for a Circular Economy - Dassault Systèmes
13	https://www.youtube.com/watch?v=Qv6E7LZyapA	10 Sustainable Food Packaging Companies To Support
14	https://www.youtube.com/watch?v=njhhVnvQz-0	The Future of the Packaging Industry Trends & Sustainability McKinsey & Company

Note :

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

MSBTE Approval Dt. 21/11/2024

Semester - 4, K Scheme

GRAVURE PRINTING PROCESS**Course Code : 324319**

Programme Name/s : Printing Technology
Programme Code : PN
Semester : Fourth
Course Title : GRAVURE PRINTING PROCESS
Course Code : 324319

I. RATIONALE

Gravure printing process is often used for printing on flexible packaging materials. Throughout the course, students will acquire an in-depth knowledge of each element of gravure printing image reproduction. Students completing this course will be prepared for the necessary operations, equipment, and problem-solving techniques on shop floor.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Prepare the image carrier and print a given job using the gravure printing process.

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 products suitable for printing with gravure process.
- CO2 - Compare gravure image carrier making methods.
- CO3 - Set the gravure press to print a given job.
- CO4 - Select gravure press configuration for a given job.
- CO5 - Illustrate the new trends in gravure printing process.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH			Theory			Based on LL & TL				Based on SL			
				CL	TL	LL					Total	Practical		SLA							
												FA-TH	SA-TH	FA-PR	SA-PR	Max	Min				
324319	GRAVURE PRINTING PROCESS	GPP	DSC	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 2 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	<p>TLO 1.1 List the application area of gravure printing.</p> <p>TLO 1.2 Suggest appropriate image carrier construction.</p> <p>TLO 1.3 List variables in electroplating of cylinder.</p>	<p>Unit - I Gravure cylinder preparation</p> <p>1.1 Gravure printing and its application areas. Quality features of gravure printing. Methods of artwork preparation for gravure printing.</p> <p>1.2 Construction of gravure image carrier and its comparison with image carrier other printing processes.</p> <p>1.3 Construction, working principle of electroplating unit and variables associated with it. Procedure of reclaiming electroplated layer. IKS: Ancient Indian practices of sub-surface image transfer. Use of sustainable water resistant colorants.</p>	<p>Video Demonstrations Lecture Using Chalk-Board Site/Industry Visit</p>
2	<p>TLO 2.1 Explain cylinder making by chemical etching process.</p> <p>TLO 2.2 Explain cylinder making by electronic engraving process.</p> <p>TLO 2.3 Describe process of cylinder making by laser engraving.</p>	<p>Unit - II Gravure image carrier making</p> <p>2.1 Working principle of chemical etching, materials and chemicals used. Methods and variables of chemical etching. Proofing method and drawbacks of chemical etching.</p> <p>2.2 Working principle of electronic engraving, construction of unit, Speed, cell geometry and angle of engraving. Proofing method and drawbacks of electronic engraving.</p> <p>2.3 Methods and working principle of laser engraving. Types and required properties of laser. Surface preparation for laser engraving. Proofing method and drawbacks of laser engraving.</p>	<p>Video Demonstrations Site/Industry Visit Lecture Using Chalk-Board</p>
3	<p>TLO 3.1 Set doctor blade assembly unit.</p> <p>TLO 3.2 Select impression roller for a printing.</p> <p>TLO 3.3 Set unwinder and winder units.</p> <p>TLO 3.4 Arrange auxiliary systems on printing units.</p>	<p>Unit - III Printing press units</p> <p>3.1 Doctor blade and its functions, types, materials and properties. Assembly, forward angle and pressure setting. Printing troubles, causes and remedies.</p> <p>3.2 Types, properties and functions of impression roller covering. Pressure setting, dynamic balance, deflection compensation methods. Wrap angle, cuts. Printing troubles, causes and remedies.</p> <p>3.3 Types and setting of winders and unwinders, web guiders, web turners. Types of rollers on printing machine and their powering method. Printing and running troubles, causes and remedies.</p> <p>3.4 Working principle and applications of ESA. Safety measures for ESA mechanism. Printing and running troubles, causes and remedies.</p>	<p>Lecture Using Chalk-Board Site/Industry Visit Presentations</p>
4	<p>TLO 4.1 Details ink formulation of gravure ink.</p> <p>TLO 4.2 Select ink drying methods.</p> <p>TLO 4.3 List substrates used in printing and post printing.</p>	<p>Unit - IV Materials in printing</p> <p>4.1 Types of gravure Inks, ingredient, solvents, resin and additives. Function of ingredients and additives. Tests carried out on ink and prints.</p> <p>4.2 Types of ink drying mechanisms, end use requirements of printed products. Remedies for troubles arising out of improper ink drying.</p> <p>4.3 Classification of substrates, surface treatments, printability and runnability properties of substrates. Materials for post printing operations.</p>	<p>Video Demonstrations Site/Industry Visit Lecture Using Chalk-Board</p>

GRAVURE PRINTING PROCESS

Course Code : 324319

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 List advancements in drive mechanism of press units. TLO 5.2 Elaborate web tension control systems. TLO 5.3 State material handling guidelines regarding environment.	Unit - V New trends in gravure printing 5.1 Working principle, construction, advantage of ELS. Servo motors used in printing unit winder and unwinder. 5.2 Auto register system, working principle, advantage. Comparison between open and closed loop system. Stroboscope, video scanner, in process color control. 5.3 OSHA (Occupational Safety and Health Association) standard. Waste disposal approaches, sustainability in the gravure printing processes.	Video Demonstrations Site/Industry Visit Lecture Using Chalk-Board

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 gravure printing machine.	1	*Pass the web through the different sections of gravure printing machine	4	CO1
LLO 2.1 Prepare electroplating for gravure cylinder	2	Demonstrate electroplating for gravure cylinder	4	CO1
LLO 3.1 Prepare gravure cylinder	3	*Demonstrate gravure cylinder using electro-mechanical engraving	4	CO2
LLO 4.1 Prepare gravure cylinder	4	Demonstrate gravure cylinder making using LASER engraving process	4	CO2
LLO 5.1 Identify types of cell.	5	Identify types of cells, and measure the parameters viz; cell volume, cell depth-and-opening ratio	4	CO2
LLO 6.1 Demonstrate Gravure Proofing machine	6	Demonstrate & evaluate a gravure proofing machine.	4	CO2
LLO 7.1 Perform un-winder section setting	7	*Perform un-winder section setting on gravure printing press	4	CO3
LLO 8.1 Mount gravure cylinder	8	Perform mounting of gravure cylinder on gravure press	4	CO3
LLO 9.1 Doctor blade setting	9	*Perform doctor blade assembly setting on gravure press	4	CO3
LLO 10.1 Impression roller setting	10	Perform impression roller setting on gravure machine	4	CO3
LLO 11.1 Use Electrostatic Assist.	11	*Demonstrate the Electrostatic Assist.	4	CO3
LLO 12.1 Use of drying section	12	*Demonstrate a setting of drying section with respect to change in substrate	4	CO4
LLO 13.1 Use electronic line shaft.	13	Demonstrate an electronic line shaft used on gravure printing machine.	4	CO5
LLO 14.1 Use auto register system	14	*Demonstrate auto register system used on gravure machine.	4	CO5
LLO 15.1 Use gravure printing machine.	15	*Demonstrate multicolour printing on Gravure printing machine	4	CO4

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 /

GRAVURE PRINTING PROCESS**Course Code : 324319****SKILLS DEVELOPMENT (SELF LEARNING)****Micro project**

- Identify the samples printed by gravure printing technology.
- Prepare workflow of gravure cylinder making followed in local press.
- Enlist ink and inking related consumables suppliers in market.
- Collect the specifications of gravure press setup in local area.
- Submit survey report on cylinder making used in nearby gravure industry.
- Collect information about waste disposal standard followed in local presses.

Assignment

- Publish a short video on gravure material handling methods used in local press.
- Visit Press setups in Local area to learn workflow of production.
- Visit Press setups in Local area to learn workflow of Gravure cylinder production.
- Visit Press setups in Local area to learn workflow of Packaging job production.
- Refer books in library and online to prepare report on sustainable techniques used in gravure printing.

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	Gravure printing machine (minimum Two Color)	1,4,5,7,8,9,10,11,12,14,13,15
2	Gravure Cylinder Electronic engraving unit	2
3	Gravure Cylinder Laser engraving unit	3
4	Gravure Proofing machine	6

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	Gravure cylinder preparation	CO1	10	4	4	8	16
2	II	Gravure image carrier making	CO2	9	4	4	6	14
3	III	Printing press units	CO3	10	4	4	6	14
4	IV	Materials in printing	CO4	10	4	4	8	16
5	V	New trends in gravure printing	CO5	6	4	2	4	10
Grand Total				45	20	18	32	70

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

- Two unit tests of 30 marks each and average of two unit tests out of 30 marks
- Each practical will be assessed considering 60% weightage to process and 40% weightage to output.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks through offline examination.
- Actual performance in external practical examination of 25 marks.

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	2	2	1	1			
CO2	3	3	2	2	3	1	2			
CO3	3	2	2	2	2	2	1			
CO4	3	3	2	2	3	2	2			
CO5	2	2	3	2	2	2	1			

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	Gravure Association of America	Gravure: Process and Technology	Gravure Association of America ISBN-13: 978-1880290002
2	NIIR Board of Consultants & Engineers	Handbook on Printing Technology	NIIR Board of Consultants & Engineers ISBN-13: 978-8178331768
3	Prof. Dr.-Ing. habil. Helmut Kipphan	Handbook of Print Media	Springer-Verlag Berlin Heidelberg New York ISBN 3-540-67326-1
4	John Morton and Robert Shimmin	Conventional Label Printing Processes: Letterpress, lithography, flexography, screen, gravure. combination printing	A Labels and Labelling Publication ISBN-13: 978-0954751890

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=A8ONoyiXboc	Gravure Printing Process
2	https://www.youtube.com/watch?v=seHjG2Xmw2g	Doctor Blade
3	https://www.youtube.com/watch?v=kd9seU1k6FE	Aseptic Packaging material
4	https://www.youtube.com/watch?v=PhqZfILShgE	Proofing Machine
5	https://www.youtube.com/watch?v=qrbJtGcY71s	Gravure Ink Mixing roller
6	https://www.youtube.com/watch?v=JPcJzpunk1o	Rotogravure Printing Machine
7	https://www.youtube.com/watch?v=NseQ7AO6iCo	Automatic Register Control
8	https://www.nature.com/articles/s41598-022-15893-1	Sustainable and green manufacturing of gravure printing cylinder-

GRAVURE PRINTING PROCESS**Course Code : 324319**

Sr.No	Link / Portal	Description
Note : <ul style="list-style-type: none">Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students		

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

Programme Name/s : Printing Technology
Programme Code : PN
Semester : Fourth
Course Title : DATA ANALYTICS USING EXCEL
Course Code : 324320

I. RATIONALE

Data Analytics Using Excel helps the students make informed decisions across various industries. The course covers practical Excel skills, making it accessible and affordable for all students. By learning data cleaning, analysis, and visualization, students gain hands-on experience, preparing them for jobs that require data analysis skills.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply data analytics to create reports and dashboards.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Classify data collected in business processes.
- CO2 - Apply statistical tools to process data.
- CO3 - Test hypothesis in business problems.
- CO4 - Analyse data with Excel and spreadsheet tools.
- CO5 - Elaborate applications of data analytics in printing.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH	Theory			Based on LL & TL				Based on SL						
				CL	TL	LL						Practical				SLA						
												FA-TH	SA-TH	Total		FA-PR	SA-PR	Max	Min			
324320	DATA ANALYTICS USING EXCEL	DUE	GE	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175	

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	<p>TLO 1.1 State the importance and role of data analytics</p> <p>TLO 1.2 Write basic excel functions and formula</p> <p>TLO 1.3 Explain types of Data and Data Formats</p> <p>TLO 1.4 Identify missing data and remove duplicate data</p>	<p>Unit - I Introduction to Data Analytics</p> <p>1.1 Understanding Data Analytics : Definition and importance of data analytics, Role of data analytics in decision-making</p> <p>1.2 Basics of Excel for Data Analytics: Overview of Excel interface, Excel functions and formulas for data manipulation, Data importing and exporting in Excel</p> <p>1.3 Types of Data and Data Formats: Categorical vs. numerical data, Data formats (text, numbers, dates)</p> <p>1.4 Data Cleaning and Preprocessing: Identifying and handling missing data, Removing duplicates, Dealing with outliers</p>	<p>Lecture Using Chalk-Board Presentations Demonstration</p>
2	<p>TLO 2.1 Define and understand Mean, median, mode</p> <p>TLO 2.2 Explain Range, variance, standard deviation, Interquartile range (IQR)</p> <p>TLO 2.3 Create Basic charts and Format them</p> <p>TLO 2.4 Describe PivotTables and PivotCharts</p>	<p>Unit - II Descriptive Statistics</p> <p>2.1 Measures of Central Tendency: Mean, median, mode, Understanding their applications</p> <p>2.2 Measures of Dispersion :Range, variance, standard deviation, Interquartile range (IQR)</p> <p>2.3 Data Visualization in Excel: Creating basic charts (bar charts, pie charts, histograms), Formatting and enhancing charts</p> <p>2.4 PivotTables and PivotCharts: Introduction to PivotTables, Creating PivotTables for data analysis</p>	<p>Presentations Lecture Using Chalk-Board Hands-on</p>
3	<p>TLO 3.1 Explain basic concepts of probability.</p> <p>TLO 3.2 Identify the sampling techniques.</p> <p>TLO 3.3 Describe Hypothesis Testing methods.</p> <p>TLO 3.4 Perform Simple linear regression in Excel.</p>	<p>Unit - III Inferential Statistics</p> <p>3.1 Probability Basics: Probability concepts, Probability distributions.</p> <p>3.2 Sampling Techniques : Simple random sampling, stratified sampling, Understanding the sampling process.</p> <p>3.3 Hypothesis Testing : Null and alternative hypotheses, conducting t-tests and chi-square tests in Excel.</p> <p>3.4 Correlation and Regression Analysis: Understanding correlation, Simple linear regression in Excel.</p>	<p>Lecture Using Chalk-Board Hands-on Presentations</p>
4	<p>TLO 4.1 Use the Analysis ToolPak for statistical analysis</p> <p>TLO 4.2 Gain proficiency in using the Solver Tool in Excel</p>	<p>Unit - IV Data Analysis Tools in Excel</p> <p>4.1 Excel Data Analysis ToolPak: Overview and installation, Using the Analysis ToolPak for statistical analysis</p> <p>4.2 Solver Tool in Excel : Introduction to Solver, Optimization problems using Solver</p>	<p>Lecture Using Chalk-Board Presentations Hands-on</p>
5	<p>TLO 5.1 Describe application of Data Analytics in Business</p> <p>TLO 5.2 Explain Case Studies and Practical Applications of Excel</p> <p>TLO 5.3 Identify Future Trends in Data Analytics.</p>	<p>Unit - V Real-world Applications and Case Studies</p> <p>5.1 Application of Data Analytics in Business: Business intelligence and reporting, Decision-making using data analytics</p> <p>5.2 Case Studies and Practical Applications : Analyzing real-world datasets, Solving practical problems using Excel analytics</p> <p>5.3 Future Trends in Data Analytics: Introduction to advanced analytics techniques (e.g., machine learning, predictive analytics), Role of artificial intelligence in shaping the future of data analytics, Role of Excel in Future Data Analytics Developments, Integrating Excel with other analytics tools and platforms.</p>	<p>Lecture Using Chalk-Board Presentations Hands-on</p>

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 Generate and import datasets into Excel	1	*Create a simple dataset and Importing external data into Excel	2	CO1
LLO 2.1 Identify and manage missing data and duplicates using Excel	2	*Identify and handle missing data and removing duplicates using Excel	2	CO2
LLO 3.1 Cleaning data using Excel functions.	3	*Cleaning data using Excel functions.	2	CO2
LLO 4.1 Create basic charts (bar chart, pie chart) for visual representation	4	*Create basic charts (bar chart, pie chart) for visual representation	2	CO4
LLO 5.1 Create Pivot Tables to summarize data	5	*Create Pivot Tables to summarize data	2	CO4
LLO 6.1 Use Pivot Charts to visualize data trends.	6	Use Pivot Charts to visualize data trends.	2	CO2
LLO 7.1 Create histograms, scatter plots.	7	*Create histograms, scatter plots.	2	CO4
LLO 8.1 Format and enhance charts for better presentation.	8	Format and enhance charts for better presentation.	2	CO4
LLO 9.1 Conduct t-tests and chi-square tests in Excel	9	Conduct t-tests and chi-square tests in Excel	2	CO3
LLO 10.1 Calculate correlation coefficients.	10	Calculate correlation coefficients.	2	CO3
LLO 11.1 Enable and use the Excel Data Analysis ToolPak.	11	*Enabling and using the Excel Data Analysis ToolPak.	2	CO3
LLO 12.1 Create dynamic dashboards in Excel	12	Create dynamic dashboards in Excel	2	CO4
LLO 13.1 Apply various statistical tools for analysis.	13	Apply various statistical tools for analysis.	2	CO2
LLO 14.1 Analyze real-world datasets from various industries.	14	*Analyze real-world datasets from various industries.	2	CO5
LLO 15.1 Import and export data between Excel and other analytics tools	15	Import and export data between Excel and other analytics tools	2	CO4

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**

- Exploring Data Types and Cleaning: Create a simple dataset with both categorical and numerical data in Excel. Import external data with missing values and duplicates. Identify and handle missing data, remove duplicates, and ensure data accuracy. Present the cleaned dataset using basic charts (e.g., bar chart, pie chart).
- Descriptive Statistics in Excel: Create a dataset with numerical values. Calculate and interpret measures of central tendency (mean, median, mode). Determine measures of dispersion (range, variance, standard deviation). Visualize the dataset using Excel charts, emphasizing key statistical measures.
- Real-world Data Analysis: Choose a real-world dataset from various industries (e.g., finance, healthcare). Import and clean the dataset in Excel. Utilize PivotTables and Pivot Charts to summarize and visualize key trends. Draw insights and solve practical problems, presenting findings in a report.

Assignment

- **Decision-Making Report:** Analyze a hypothetical business situation. Utilize Excel analytics tools to make data-driven decisions. Present the decision-making process and outcomes in a structured report.
- **Future Trends in Data Analytics:** Research and summarize advanced analytics techniques, such as machine learning and predictive analytics. Explore the role of artificial intelligence in shaping the future of data analytics. Reflect on the evolving role of Excel in future data analytics developments.
- **Explore the integration of Excel with other tools and platforms:** Export data from Excel to other analytics tools and platforms. Import data into Excel from external sources. Highlight the importance of data interchangeability for comprehensive analytics.

Seminar and Workshop

- Participate in seminars and workshops on topic related to Data Analytics.

Review article

- Read research papers published in national or international conferences on topic related to Data Analytics and publish review article in any technical journal.

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 may be considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Sample Datasets: Provide various sample datasets for exercises and projects, covering different industries and data types.	2,3,4,5,6,7,13,14,15
2	Excel Add-ins such as the Data Analysis ToolPak and Solver	4,5,6,7,11,13
3	Computers: Required for installing and running Microsoft Excel.	All
4	Microsoft Excel: The primary software tool for data analytics in this course. Ensure students have access to the latest version of Microsoft Excel.	All
5	Projector and Screen: For instructors to demonstrate practical sessions and guide students through hands-on exercises.	All
6	Project-Based Tools: Tools for collaborative project work, like cloud storage platforms (Google Drive, Microsoft OneDrive) for sharing datasets and reports among students.	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	Introduction to Data Analytics	CO1	12	4	4	6	14
2	II	Descriptive Statistics	CO4	12	4	6	4	14
3	III	Inferential Statistics	CO3	12	4	4	6	14
4	IV	Data Analysis Tools in Excel	CO2	12	4	4	6	14

DATA ANALYTICS USING EXCEL**Course Code : 324320**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
5	V	Real-world Applications and Case Studies	CO5	12	4	4	6	14
Grand Total				60	20	22	28	70

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

- Two unit tests of 30 marks each.
- Each practical will be assessed considering 60% weightage to process and 40% weightage to output.

Summative Assessment (Assessment of Learning)

- End semester theory examination of 70 marks.
- Actual performance in internal practical examination of 25 marks.

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	2	1	2	1	2	2	1			
CO2	2	3	2	3	2	2	2			
CO3	3	3	2	2	1	2	1			
CO4	3	3	3	2	2	2	1			
CO5	1	2	3	2	2	2	1			

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	Foster Provost and Tom Fawcett	Data Science for Business	O'Reilly Media ISBN-13: 978-1449361327
2	Anil Maheshwari	Data Analytics Made Accessible	Pearson ISBN-13: 978-1292097180
3	Elliot Bendoly	Excel Basics to Blackbelt: An Accelerated Guide to Decision Support Designs	Cambridge University Press ISBN-13: 978-0521898018
4	Peter Bruce and Andrew Bruce	Practical Statistics for Data Scientists: 50 Essential Concepts	O'Reilly Media ISBN-13: 978-1491952962

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
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Sr.No	Link / Portal	Description
1	https://www.kaggle.com/	Kaggle is a platform that offers a variety of datasets and competitions. It's a great place for students to practice data analytics skills using Excel and other tools. The community and forums provide valuable insights and collaboration opportunities.
2	https://learn.microsoft.com/en-us/	Microsoft Learn provides free, interactive learning paths and modules. The "Excel Fundamentals" and "Data Analysis with Excel" modules are helpful for mastering Excel analytics.
3	https://www.analyticsvidhya.com/	Analytics Vidhya is a platform that offers a variety of tutorials, articles, and online courses on data science, machine learning, and analytics. It's a great resource for learning practical applications.
4	https://www.exceltip.com/	Excel Tip is a platform offering a variety of Excel tips, tutorials, and resources. It covers a wide range of topics suitable for beginners to advanced Excel users.
5	https://www.excelsuperstar.org/	Excel Superstar is an Indian platform dedicated to Excel tutorials and resources. It covers a wide range of topics from basic functions to advanced data analysis.

Note :

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

Programme Name/s : Printing Technology
Programme Code : PN
Semester : Fourth
Course Title : IOT IN PRINTING
Course Code : 324321

I. RATIONALE

Teaching Introduction to IoT for Diploma Students is crucial due to its alignment with current industry trends, providing students with hands-on experience in a cross-disciplinary environment. The course fosters problem-solving skills, technological literacy, and creativity, preparing students for diverse careers in sectors increasingly integrating IoT solutions. As IoT operates globally and addresses societal challenges, teaching it instills a global perspective and a commitment to positive social impact. Moreover, IoT's ever-evolving nature cultivates adaptability and a lifelong learning mindset, ensuring students are well-equipped for the dynamic landscape of technological advancements.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Implement IoT and IIoT devices in printing operations to improve quality, save time and cost.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Analyze key components and the architecture of IoT systems.
- CO2 - Evaluate IoT devices used in industry.
- CO3 - Examine the communication protocols used in IoT device communication.
- CO4 - Apply data generated by IoT devices in use.
- CO5 - Document IoT workflow used in printing industry.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH	Theory			Based on LL & TL				Based on SL						
				CL	TL	LL			Total			Practical		SLA								
												FA-TH	SA-TH	FA-PR	SA-PR	Max	Min	Max	Min			
324321	IOT IN PRINTING	IOP	GE	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175	

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 Explain stages in development of IoT. TLO 1.2 List components used in IIoT and IoT. TLO 1.3 State types of layers in IoT architecture.	Unit - I Basics of IoT 1.1 Features of industry 4.0, concept of IoT and IIoT, difference between IoT and IIoT. 1.2 Classification of communication protocols, IoT Platforms. Components of IoT, applications and advantages of IoT. 1.3 Layers in IoT- device layer, communication layer, cloud layer, application layer. Function of each layer.	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit
2	TLO 2.1 Classify IoT devices. TLO 2.2 State functions of sensors and actuators. TLO 2.3 Identify microcontroller for IoT applications.	Unit - II IoT devices and sensors. 2.1 Overview of IoT devices, smartphones, wearables, and smart home devices. 2.2 Working principle and types of sensors (temperature, humidity, motion, etc.). 2.3 Microcontroller boards (Arduino, Raspberry Pi). Power sources for IoT devices, energy-efficient design considerations.	Lecture Using Chalk-Board Demonstration Site/Industry Visit
3	TLO 3.1 Compare wired and wireless protocols. TLO 3.2 List examples of wireless protocols. TLO 3.3 Describe IoT based security system.	Unit - III Communication protocols 3.1 Comparison between wired and wireless communication, importance of standardization. 3.2 Wireless protocols: Wi-Fi, Bluetooth, Zigbee, and LoRaWAN. Advantages and limitations. 3.3 Challenges in IoT security, encryption and authentication.	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit
4	TLO 4.1 Describe Data sources in IoT Cloud storage and edge computing. TLO 4.2 Explain data analytics for IoT application. TLO 4.3 State tools of data visualization.	Unit - IV Data handling 4.1 Data sources in IoT Cloud storage and edge computing. 4.2 Introduction to data analytics, compare real-time analytics with batch processing method. 4.3 Importance of data visualization, tools for data visualization.	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit
5	TLO 5.1 State different applications of IIoT in offset and gravure printing. TLO 5.2 Identify areas of IoT applications in digital printing environment. TLO 5.3 Explain application of IIoT in transportation of printed products, maintenance and machine operation.	Unit - V Applications in printing. 5.1 Concept of smart factories, sustainable production using IoT application. Centralization of printing facilities operating from different locations. 5.2 Applications of IoT, AI in printing- Variable Data Printing (VDP), Color Correction and Enhancement, Quality Control. 5.3 IoT and AI-Powered packaging design, print automation, augmented reality printing, 3D printing. Challenges and opportunities in AI and IoT enabled printing.	Video Demonstrations Case Study Hands-on Lecture Using Chalk-Board

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 Connect components to form IoT system.	1	*Connect components to form IoT system.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Identify components used in IoT and IIoT systems.	2	*Identify components used in IoT and IIoT systems.	2	CO2
LLO 3.1 Collect sensors for different inputs and calculate power requirement.	3	*Collect sensors for different inputs and calculate power requirement.	2	CO4
LLO 4.1 Operate active and passive RFID.	4	Operate active and passive RFID.	2	CO4
LLO 5.1 Complete a simple gas sensing circuit.	5	*Complete a simple gas sensing and temperature circuit.	2	CO5
LLO 6.1 Practice Arduino and coding.	6	*Make simple Arduino coding.	2	CO1
LLO 7.1 Demonstrate the action of actuators on receiving input in IoT circuit environment.	7	Demonstrate the action of actuators on receiving input in IoT circuit environment.	2	CO2
LLO 8.1 Connect an LED to an Arduino and write a program to make it blink.	8	*Make the connection of LED with Arduino and write a program for blinking it.	2	CO3
LLO 9.1 Experiment with Bluetooth modules to send a signal wirelessly between two Arduinos.	9	*Demonstrate bluetooth modules to send a signal wirelessly between two Arduinos.	2	CO3
LLO 10.1 Set up a basic account on an IoT platform and send a simple data reading from Arduino to the platform.	10	Set up a basic account on an IoT platform and send a simple data reading from Arduino to the platform.	2	CO4
LLO 11.1 Demonstrate application of IoT in offset printing.	11	*Demonstrate application of IoT in offset printing.	2	CO5
LLO 12.1 Demonstrate application of IoT in gravure printing.	12	Demonstrate application of IoT in gravure printing.	2	CO5
LLO 13.1 Demonstrate application of IoT in food packaging.	13	*Demonstrate application of IoT in food packaging.	2	CO5
LLO 14.1 Use of a small wearable using bluetooth to send basic information.	14	Demonstrate use of a small wearable using bluetooth to send basic information.	2	CO3
LLO 15.1 Simulate a basic smart home scenario with LEDs representing lights and motion sensors.	15	Demonstrate a basic smart home scenario with LEDs representing lights and motion sensors.	2	CO4
LLO 16.1 Connect a GPS module to Arduino and display basic location data.	16	Make the Connection of GPS module to Arduino and display basic location data.	2	CO4

Note : Out of above suggestive LLOs -

- '*I' 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

- Survey a local presses to prepare a report on IoT devices used and waste reduction recorded.
- Collect IoT sensors and actuators of different make and tabulate their specifications and uses.
- Integrate sensors to analyze resource usage, including paper and ink consumption, to provide accurate cost estimates for print jobs.
- Visit local industries using IoT and non IoT based production process and tabulate output and speed of production.
- Develop a system to monitor the health of a printing machine using IoT such as temperature, humidity, and ink levels.

Assignment

- Create and publish a short video on social media on various applications of IoT and IIOT in printing industry.
- Visit library and internet resources to document scope of IoT in industry.
- Interview press owner to assess use and benefits of IoT in their presses.

Exhibitions, Workshops and seminars.

- Visit exhibitions, participate in workshops and present papers in seminars arranged on IoT and industry 4.0 topic.

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	Breadboards and Jumper Wires: Used for prototyping circuits before permanent connections.	1,2,3,4,5,7,8,9,14,15,16
2	Electronic Components Kit: Includes LEDs, resistors, temperature sensors, relay modules, Bluetooth modules, keypads, displays, and GPS modules.	1,2,3,4,5,8,9,16
3	Arduino Boards: Arduino Uno or similar microcontroller boards for each student.	2,3,4,5,6,7,8,9,10,11,16
4	LED Displays: Simple LED displays for basic data visualization.	8,15
5	Computer Systems: Required for running the Arduino IDE and programming the Arduino boards.	All
6	USB Cables: To connect Arduino boards to computer systems for programming and power.	All
7	IoT Platform Account: Access to an IoT platform such as ThingSpeak or Blynk for experiments involving data transmission.	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	Basics of IoT	CO1	14	4	4	8	16
2	II	IoT devices and sensors.	CO2	12	4	4	4	12
3	III	Communication protocols	CO3	10	4	4	4	12
4	IV	Data handling	CO4	10	4	4	4	12
5	V	Applications in printing.	CO5	14	4	4	10	18
Grand Total				60	20	20	30	70

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

- Two unit tests of 30 marks each.
- Each practical will be assessed considering 60% weightage to process and 40% weightage to output.

Summative Assessment (Assessment of Learning)

- End semester theory examination of 70 marks.
- Actual performance in internal practical examination of 25 marks.

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	2	2	2	3			
CO2	3	1	2	1	2	2	1			
CO3	2	2	2	1	2	2	3			
CO4	1	3	3	2	3	2	2			
CO5	1	1	2	2	2	2	3			

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	Dr. Anil Kumar Mishra, Mr. Ashis Kumar Mishra, Prof. Yogomaya Mohapatra	Introduction to Internet of Things Introduction to Internet of Things	9789390178230 NITYA PUBLICATION
2	Raj Kamal	Internet of Things (IoT): An Introduction	McGraw Hill Education
3	David Hanes, Gonzalo Salgueiro, Patrick Grossetete	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things"	Cisco Press 978-1587144561
4	Arshdeep Bahga and Vijay Madisetti	Internet of Things (IoT): A Hands-On Guide	978-8173719547, Orient Blackswan Private Limited - New Delhi
5	Peter Waher, Pradeeka Seneviratne, Brian Russell, Drew Van Duren	IoT: Building Arduino-Based Projects	Packt Publishing Limited 978-1787120631

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.arduino.cc/	he official Arduino website provides comprehensive documentation, tutorials, and project ideas for both beginners and advanced users. It covers theoretical concepts, practical guides, and a community forum for discussions.
2	https://www.sparkfun.com/	SparkFun's website offers a wide range of tutorials and guides on electronics, Arduino, and IoT. It includes step-by-step instructions, project ideas, and educational resources suitable for learners at various levels.

Sr.No	Link / Portal	Description
3	https://forum.arduino.cc/t/anyone-from-india/87480	The Arduino Community Forum has a section dedicated to India, where users share local resources, project ideas, and collaborate on Arduino-related discussions.
4	https://www.electronicsforu.com/	EFY is a popular electronics and technology portal that provides articles, tutorials, and projects related to IoT, Arduino, and electronics. It covers a wide range of topics suitable for learners of all levels.
5	https://iotworm.com/	IoT Worm is an Indian platform that focuses on IoT tutorials, projects, and news. It covers a variety of IoT-related topics and provides hands-on learning resources.
6	https://www.geeksforgeeks.org/	GeeksforGeeks is a widely used platform that covers programming, algorithms, and data structures. It has a dedicated section for Arduino programming and projects.
7	https://www.engineersgarage.com/	Engineers Garage is an Indian platform providing project ideas, tutorials, and resources on electronics and IoT. It covers a wide range of topics relevant to learners and enthusiasts.
8	https://www.indiabix.com	IndiaBIX provides a section on Arduino programming with quizzes and explanations. It's a good resource for testing and improving programming skills.
Note : <ul style="list-style-type: none"> Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students 		

Programme Name/s : Printing Technology
Programme Code : PN
Semester : Fourth
Course Title : PRINTED ELECTRONICS
Course Code : 324322

I. RATIONALE

Printed electronics is a technique using printing technology to manufacture electronic items such as electronic circuits, displays, sensors, and RFID. It is based on organic and semi-conducting materials, as well as printed inorganic materials. The field of printed electronics encompasses a diverse range of materials and printing processes. Printing electronics is regarded as one of the future emerging technologies for food packaging. The curriculum offered is intended to provide a foundation for understanding the development and applications of printed electronics, and to contribute to the sustainable development of the materials and infrastructure.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Print different electronic circuits and devices on innovative substrates.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Select printed electronics on the basis of their applications.
- CO2 - Plan workflow of printed electronics process cycle.
- CO3 - Recommend a printing method suitable for a printed electronics.
- CO4 - Provide solutions for sustainability and mass production related challenges.
- CO5 - Utilise opportunities and advancements in printed electronics.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH	Theory			Based on LL & TL				Based on SL						
				CL	TL	LL			FA-TH			SA-TH	Total	Practical		SLA						
														FA-PR	SA-PR	Max	Min	Max	Min			
324322	PRINTED ELECTRONICS	PRE	GE	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175	

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 concept of printed electronics. TLO 1.2 Specify various printing methods used in printed electronics. TLO 1.3 Explain the potential level of printed electronics in the industry.	Unit - I Basic concept of printed electronics. 1.1 Introduction to printed electronics. Definition. Printed electronics production methods. Introduction to printing methods used in printed electronics. 1.2 Need of printed electronics. Advantages of printed electronics. Comparison between printed electronics and conventional electronics. 1.3 Potential of printed electronics. Application of printed electronics.	Lecture Using Chalk-Board Video Demonstrations Hands-on
2	TLO 2.1 Specify the area of applications of printed electronics. TLO 2.2 Explain the method of application of printed electronics. TLO 2.3 Describe the benefits of printed electronics.	Unit - II Scope of printed electronics. 2.1 Advantages of printed electronics products from other electronic components – roll to roll production, mass production, flexible products, low price, etc. How printed electronic components are produced with printing process. 2.2 Printing consideration for printed electronics - Resolution, registration, thickness, holes, materials. Benefits of roll to roll printing. 2.3 Printing process challenges – related printing of printed electronics. Material challenge – related printing of printed electronics. Manufacturing challenges. Device challenges.	Lecture Using Chalk-Board Video Demonstrations Hands-on
3	TLO 3.1 Specify raw materials for printing electronics. TLO 3.2 List tests and storage conditions for materials. TLO 3.3 Apply sustainable printing principles.	Unit - III Substrates for Printed Electronics. 3.1 Electrical, physical properties of substrates and inks for printed electronics. 3.2 Tests carried out on substrates and inks for printed electronics. Storage conditions and standards governing production of printed electronics. 3.3 Application of sustainable development principles and methods in manufacturing printed electronics. Substitutes for materials and technology.	Lecture Using Chalk-Board Video Demonstrations Hands-on
4	TLO 4.1 Specify the chances of error during printed electronics production. TLO 4.2 Explain the role of gravure printing in printed electronics. TLO 4.3 Explain the role of screen printing in printed electronics. TLO 4.4 Describe digital printing methods used in printed electronics.	Unit - IV Printing processes used for printed electronics. 4.1 Gravure printing for printed electronics. Gravure printing considerations. 4.2 Screen printing for printed electronics. Flat screen and rotary screen. screen printing considerations. 4.3 Flexographic printing for printed electronics. Different configurations of flexographic press. 4.4 Inkjet printing for printed electronics. Advantages and disadvantages of ink jet printing. Application of printed electronics.	Lecture Using Chalk-Board Video Demonstrations Hands-on

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 Explain various advanced technologies used in printed electronics production. TLO 5.2 Specify different materials and their properties in printed electronics. TLO 5.3 Describe about the future market and future products of printed electronics.	Unit - V Future trends in Printed Electronics. 5.1 Aerosol printing process for printed electronics. Direct write extrusion process for printed electronics. Transfer printing process for printed electronics. 5.2 Printing materials for printed electronics. Different properties of materials. Organic and inorganic materials for printed electronics. Substrates for printed electronics. Conductor materials. Insulators materials. Semiconductor materials . 5.3 Future printed electronics market scope. Future predicted products. OLED displays. Flexible displays. Printed electronics sensors. Interactive packaging.	Lecture Using Chalk-Board Video Demonstrations Hands-on

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 Operate any three flexible printed electronic devices.	1	*Operate any three flexible printed electronic devices.	2	CO1
LLO 2.1 Take test print on different flexible substrates using scribing.	2	*Take test print on different flexible substrates using scribing.	2	CO3
LLO 3.1 Take print solid patch on flexible substrates using screen printing.	3	*Take print solid patch on two flexible substrates using screen printing to detect pin holes.	2	CO2
LLO 4.1 Print solid patch on flexible substrates using digital printing.	4	*Print solid patch on two flexible substrates using digital printing to detect pin holes.	2	CO2
LLO 5.1 Measure optical density of flexible material before and after screen printing.	5	*Measure optical density of flexible material before and after screen printing to calculate opacity and reflectance.	2	CO4
LLO 6.1 Measure optical density of flexible material before and after digital printing.	6	*Measure optical density of flexible material before and after digital printing to calculate opacity and reflectance.	2	CO4
LLO 7.1 Test electrical parameters of printed electronic product made by screen printing.	7	*Test electrical parameters of printed electronic product made by screen printing.	2	CO3
LLO 8.1 Test electrical parameters of printed electronic product made by digital printing..	8	*Test electrical parameters of printed electronic product made by digital printing.	2	CO3
LLO 9.1 Operate any three flexible printed electronic gas and temperature sensors.	9	Operate any three flexible printed electronic gas and temperature sensors.	2	CO5
LLO 10.1 Demonstrate operation of printed solar cell.	10	Demonstrate operation of printed solar cell.	2	CO5
LLO 11.1 Demonstrate operation of printed RFID.	11	Demonstrate operation of printed RFID.	2	CO5
LLO 12.1 Demonstrate operation of wearable printed textiles.	12	Demonstrate operation of any two wearable printed textiles.	2	CO1

Note : Out of above suggestive LLOs -

- *1 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

- Promote a scope of printing processes in printed electronics field by participating in a seminar or publishing articles in a journal or local newspaper.
- Visit a screen printing press printing on materials in printed electronic and prepare a report on required pressroom conditions.
- Collect samples of smart wearable materials.
- Survey a food package market and tabulate scope of printed electronics.

Assignment

- Collect printed electronic products and printed textiles and list optical properties of printed layer.
- Conduct an interview of a customers using packaging products involving printed electronics and document their experience and suggestions.
- Visit library and internet for latest references on applications of printed electronic and tabulate them.
- Create and publish a short video on applications of printed Electronics in packaging and printing.

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	Inkjet printer Mono	1,2,3
2	Printed textile and electronic devices products.	1,2,5
3	Laser printer Mono	2,3,4
4	Manual screen printing set up	All
5	Conductive ink for screen printing	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	Basic concept of printed electronics.	CO1	12	4	4	6	14
2	II	Scope of printed electronics.	CO2	12	4	4	6	14
3	III	Substrates for Printed Electronics.	CO3	12	2	4	8	14
4	IV	Printing processes used for printed electronics.	CO4	12	2	4	8	14
5	V	Future trends in Printed Electronics.	CO5	12	2	4	8	14
Grand Total				60	14	20	36	70

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

- Two unit tests of 30 marks each.
- Each practical will be assessed considering 60% weightage to process and 40% weightage to output.

Summative Assessment (Assessment of Learning)

- End semester theory examination of 70 marks.
- Actual performance in internal practical examination of 25 marks.

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	2	2	1	1	2	2	1			
CO2	2	3	3	1	3	1	1			
CO3	1	2	3	2	2	2	1			
CO4	2	1	2	1	3	2	1			
CO5	3	2	2	2	3	1	1			

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	Katsuaki Suganuma	Introduction to Printed Electronics	Springer-Verlag New York Inc.; 2014th edition ISBN-10: 1461496241
2	Ilgu Yun	Printed Electronics: Current Trends and Applications	Interchopen ISBN-10 : 9789535123019
3	Zheng Cui	Printed Electronics: Materials, Technologies and Applications	John Wiley and Sons, ISBN13: 9781118920923
4	Zheng Cui	Printed Electronics: Materials, Technologies and Applications	Wiley ISBN:9781118920923
5	Wei Wu	Printed Electronic Technologies	Royal Society of Chemistry ISBN-10 : 1788014154

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	www.printedelectronics.com	Basic information on printed electronics.
2	https://www.youtube.com/watch?v=b_AjmLX3t3A	An introduction to Printed Electronics
3	https://www.youtube.com/watch?v=nTUW8Yw6Hkc	Printed Electronics What is it.
4	https://www.youtube.com/watch?v=VnbAsCIYMWs	Printed and flexible electronics and sensor applications.

Sr.No	Link / Portal	Description
5	https://www.youtube.com/watch?v=Zqyxrg4Rce8	Printable Electronics Products
6	https://www.youtube.com/watch?v=2zNkuMCNkyg	The Future of Flexible Electronics
7	https://www.youtube.com/watch?v=DID9c3kUwPI	Screen Print line for Flexible/Printed Electronics
8	https://www.youtube.com/watch?v=hZqryncwI7g	Soft fabric sensors

Note :

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