Curriculum of Diploma Programme

in

Garment Technology

Department of Science, Technology and Technical Education (DSTTE), Govt. of Bihar

State Board of Technical Education (SBTE), Bihar

Semester – V

Teaching & Learning Scheme

Course Codes	Category of course	Course Titles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
2452501	**PCC**	**Chemical Processing of Fabric and Garments**	03	-	04	02	09	06
2452502	**PCC**	**Garment Testing & Quality Control**	03	-	04	02	09	06
2452503	**PEC**	**Program Electives*** -Any One	02	01	04	02	09	06
2400504	**OEC**	**Open Electives** / COE** (Basic –Any One)	03	-	04	02	09	06
2452505	**PCC**	**Apparel Costing and EXIM**	03	-	-	02	05	04
2452506	**PSI**	**Minor Project** (Common for all programmes)	-	-	02	02	04	02
Total			**14**	**1**	**18**	**12**	**45**	**30**

Note: Prefix will be added to Course Code if applicable (T for Theory, P for Practical Paper and S for Term Work)

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem-based learning, etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro-projects, industrial visits, any other student activities, etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources, etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

*: Advanced Software in Garment Technology / Smart Textile/ Apparel Merchandising
3D Printing & Design/ Art. Intelligence (AI)/ Drone Technology / Electric Vehicle / Ind. Automation / Robotics/ IOT/Transformer Manufacturing & Repairing/Optical Fiber and 5G Communication

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

Semester - V
Assessment Scheme

Course Codes	Category of course	Course Titles	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2452501	**PCC**	**Chemical Processing of Fabric and Garments**	30	70	20	30	20	30	200
2452502	**PCC**	**Garment Testing & Quality Control**	30	70	20	30	20	30	200
2452503	**PEC**	**Program Electives*** -Any One	30	70	20	30	20	30	200
2400504	**OEC**	**Open Electives** / COE** (Basic –Any One)	30	70	20	30	20	30	200
2452505	**PCC**	**Apparel Costing and EXIM**	30	70	20	30	-	-	150
2452506	**PSI**	**Minor Project** (Common for all programmes)	-	-	10	15	10	15	50
Total			**150**	**350**	**110**	**165**	**90**	**135**	**1000**

Note: Prefix will be added to Course Code if applicable (T for Theory, P for Practical Paper and S for Term Work)

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test, and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro-projects, industrial visits, self-learning, any other student activities etc.

*: Advanced Software in Garment Technology / Smart Textile/ Apparel Merchandising

*: 3D Printing & Design/ Art. Intelligence (AI)/ Drone Technology / Electric Vehicle / Ind. Automation / Robotics/ IOT/Transformer Manufacturing & Repairing/Optical Fiber and 5G Communication

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro projects, seminar, and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.
- **Note- Full semester In-Plant Industrial Training Major Project will be done by the students in industries in different cities. Hence, they will not be available at the campus for Open Elective/COE Advanced courses. Therefore, two options are given below for semester six, as mentioned below. The option which is workable and practical may be selected.**

A) Course Code **: 2452501 (T2452501/P2452501/S2452501)**

B) Course Title **:** Chemical Processing of Fabric and Garments

C) Pre- requisite Course(s) **:** Textile Science

D) Rationale **:**

Chemical Processing has a major role to play in the Textile and Garment Industry. The finishing of the textile goods is the primary function of the Chemical Processing Unit apart from improving the aesthetic and functional properties of Textile goods. Garment Technologists should be acquainted with the principles and procedures used for finishing of textile fabric and garments. The course also aims for the students to have the advance skills in dyeing, printing of finished garments along with its wash and care procedures.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

- **CO-1** Integrate various preparatory and stabilizing processes.
- **CO-2** Recommend various textural finishes for fabrics and garments as per its end use.
- **CO-3** Suggest the machines used in the dyeing process.
- **CO-4** Select between various garment printing methods and styles.
- **CO-5** Analyse the effect and impact of chemical processing of textiles, garment washes and drycleaning, on the environment.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	2	2	-	2	-	1		
CO-2	3	2	2	-	2	-	1		
CO-3	3	2	2	-	2	-	1		
CO-4	3	2	2	-	2	-	1		
CO-5	3	2	2	-	2	-	1		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2452501	Chemical Processing of Fabric and Garments	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

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Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2452501	Chemical Processing of Fabric and Garments	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2452501

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Classify the preparatory processes for textile fabrics. *TSO 1b.* Explain the objectives of the preparatory processes, De-sizing and scouring. *TSO 1c.* Identify and compare various bleaching agents. *TSO 1d.* Explain the chemical behavior of calcium hypochlorite and hydrogen peroxide. *TSO 1e.* Describe the continuous method of bleaching using J- Box. *TSO 1f.* Describe the J Box and its advantages. *TSO 1g.* Define mercerization and explain its importance. *TSO 1h.* Explain the factors that affect mercerization of cotton. *TSO 1i.* Explain cold and hot mercerization, compare and explain its advantages and disadvantages. *TSO 1j.* Illustrate the flow chart of mercerization process. *TSO 1k.* Explain the working of the continuous cloth mercerizing machine. *TSO 1l.* Explain the need and application of stabilizing process. *TSO 1m.* Categorize various stabilizing processes. *TSO 1n.* Define Calendaring and explain its importance. *TSO 1o.* Explain simple and friction calendaring process. *TSO 1p.* Define shrinkage and its causes. *TSO 1q.* Explain compressive, resin and heat setting shrinkage control treatments and compare. *TSO 1r.* List and explain the types of anti-shrinkage treatments to cotton and wool.	**Unit-1.0 Pre-treatments and Stabilizing Processes of Fabric** 1.1 Classification and objectives of preparatory processes 1.2 Objectives of bleaching, De-sizing and scouring process, 1.3 Various bleaching agents and compare. (Reducing and oxidizing) 1.4 Chemical behavior of calcium hypochlorite and hydrogen peroxide. 1.5 Bleaching of cotton using J-Box. 1.6 Mercerization: importance, factors, different methods (cold and hot), flow chart, continuous cloth mercerizing machine. 1.7 Stabilizing process: Purpose and application 1.8 Calendaring: importance, simple and friction calendaring. 1.9 Shrinkage: causes, control treatments compressive, resin treatment and heat setting. 1.10 Anti-shrink treatments to cotton and wool.	**CO1**
TSO 2a. Classify the finishes on fabric and garments. *TSO 2b.* Explain the objectives and process of temporary and permanent softening and stiffening. *TSO 2c.* Differentiate between softening and stiffening finish. *TSO 2d.* Explain the objectives and process of weighting for rayon and silk. *TSO 2e.* Explain the objectives and the process of embossing. *TSO 2f.* Explain the raising finish and the types of raising. *TSO 2g.* Explain felting and non-felting process of wool.	**Unit-2.0 Textural Finishes on Fabric and Garments** 2.1 Finishes according to designer (Aesthetic and functional finishes) 2.2 Temporary and permanent softening and stiffening: Objectives and method 2.3 Weighting/ Trubenizing of silk and Rayon. 2.4 Embossing. 2.5 Raising: Napping, Sanding, Gigging 2.6 Felting, Non-Felting of wool. 2.7 Shearing. 2.8 Resins and the types of finish. 2.9 Fragrance Finish. 2.10 UV Protection Finish.	**CO1, CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 2h. Explain the types of resins. *TSO 2i.* Explain the finishes given to fabrics using resins. *TSO 2j.* Explain UV protection finish and its objectives. *TSO 2k.* Explain cool finish. *TSO 2l.* Explain the importance and types of eco-friendly finishes. *TSO 2m.* Differentiate between the textural finishes.	2.11 Cool Finish. 2.12 Eco friendly finishes.	
TSO 3a. Explain the advantages and disadvantages of garment dyeing. *TSO 3b.* Practice the general precautions for garment dyeing. *TSO 3c.* Illustrate the flow chart of garment dyeing. *TSO 3d.* describe the paddle dyeing machine and drum dyeing machine. *TSO 3e.* Explain the advantages of reactive dyes for garment dyeing. *TSO 3f.* Explain and prepare the recipe of hot brand reactive dyeing. *TSO 3g.* Explain and prepare the recipe of cold brand reactive. *TSO 3h.* Explain and rectify the defects in garment dyeing. *TSO 3i.* Explain the need of drying dyed garments. *TSO 3j.* Explain the working principles of hydroextractor. *TSO 3k.* Explain the working principles of Tumble Dryer. *TSO 3l.* Explain the working principles of Radio frequency dryer. *TSO 3m.* Compare various drying machines.	**Unit-3.0 Garment Dyeing** 3.1 Garment Dyeing: advantages and disadvantages, general precautions, production Flow Chart, 3.2 Dyes: classification of dyes based on the method of application, percentage of Exhaustion, affinity, substantivity. 3.3 Paddle dyeing machine and drum dyeing machine. 3.4 Reactive dyes for garment dyeing. 3.5 Hot brand reactive dyeing. 3.6 Cold brand reactive dyeing. 3.7 Problems and defects in garment dyeing and its rectifications. 3.8 Drying of dyed garments and its need. 3.9 Drying machine: Hydroextractor, working principle and advantages. 3.10 Tumble dryer: working principle and advantages. 3.11 Radio frequency dryer: working principle and advantages.	**CO3**
TSO 4a. Classify garment printing based on methods and styles. *TSO 4b.* Select the suitable printing style and method as per the requirement. *TSO 4c.* Explain and prepare the recipe of foil printing. *TSO 4d.* Explain the process of puff printing. *TSO 4e.* Explain steps of burn out printing. *TSO 4f.* Explain the types of flock printing and compare. *TSO 4g.* Explain and prepare the recipe of khadi printing. *TSO 4h.* Explain and prepare the recipe of glitter printing. *TSO 4i.* Explain printing with photochromatic and thermochromic dyes.	**Unit-4.0 Garment Printing** 4.1 Printing: classification, Methods and Styles. 4.2 Direct to garment printing: procedure, advantages and shortcomings. 4.3 Foil printing: Recipe, sequence, stamping, process. 4.4 Puff printing: puff ink, process. 4.5 Burn out printing: Steps and procedure 4.6 Flock printing: compressed, shaking, electrostatic. 4.7 Khadi print: recipe and process. 4.8 Glitter printing: recipe/ process. 4.9 Printing garments with photochromatic dyes and thermochromic dyes.	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 4j. Compare and identify various printing technique on garments. *TSO 4k.* Explain various garment printing machines. Viz: multi arm printing machine/ digital printing machine/ transfer printing machine.	4.10 Multi arm flatbed printing machine for Garments. 4.11 Digital printing machine for garments. 4.12 Transfer printing machine for garments.	
TSO 5a. Explain the objectives of garment washing. *TSO 5b.* Explain the types of garment washes. *TSO 5c.* Follow the procedure of garment washing. *TSO 5d.* List the chemicals for denim washing. *TSO 5e.* Explain the objectives of stone washing *TSO 5f.* Explain the process of stone wash. *TSO 5g.* List the types of enzyme washes and explain the procedure of enzyme wash. *TSO 5h.* Explain the mud wash process. *TSO 5i.* Explain the acid wash process. *TSO 5j.* Explain the bleach wash. *TSO 5k.* Differentiate between various garment washes. *TSO 5l.* Explain the objectives and principles of dry cleaning. *TSO 5m.* Classify the drycleaning chemicals. *TSO 5n.* Explain the dry-cleaning process. *TSO 5o.* Analyze the effect of chemicals on environment and its preventive measures.	**Unit-5.0 Garment Washes and Dry Cleaning**. 5.1 Garment washing (wet process): objectives, Types wet, chemical garment washes, common procedure 5.2 Chemicals for denim washing and types of denim washes. 5.3 Stone wash: process and flowchart. 5.4 Enzyme wash: process and flowchart. 5.5 Mud wash: process and flowchart. 5.6 Acid wash: process and flowchart 5.7 Bleach wash: process and flowchart. 5.8 Objectives and principles of dry cleaning. 5.9 Dry cleaning chemicals 5.10 Dry cleaning process, dry-cleaning operations. 5.11 Environmental concern about textile value chain and preventive measures.	**CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2452501

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Demonstrate de-sizing of cotton fabric by different methods. *LSO 1.2.* Evaluate and Test the property of the de-sized cotton fabric. 1. Weight loss calculation. 2. Test for starch using iodine. 3. Observe the hand value by feeling test.	1.	De-sizing of cotton fabric: • Rot Steeping • Acid De-sizing • Oxidative De-sizing • Enzyme De-sizing	CO1
LSO 2.1. Demonstrate scouring of cotton using alkaline scouring agents. *LSO 2.2.* Evaluate and Test the property of scoured cotton fabric. 1.Calculate weight loss. 2.Test for effective scouring.	2.	Scouring of cotton fabric.	CO1
LSO 3.1. Prepare a chart on classification of preparatory processes of textiles.	3.	Bleaching of cotton fabric using different bleaches.	CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 3.2. Prepare a list of oxidizing bleaching agents and reducing bleaching agents. *LSO 3.3.* Demonstrate bleaching of cotton using different bleaches. *LSO 3.4.* Evaluate and Test the property of bleached cotton fabric *LSO 3.5.* Compare bleaching effect of different bleaching agents.		• Peroxide bleaching • Hypochlorite bleaching • Chloride bleaching	
LSO 4.1. Exhibit the principle of operation and mechanism of jigger and winch in processing of cotton fabric. *LSO 4.2.* Demonstrate the pretreatment process of cotton fabric using different preparatory finishing machines. *LSO 4.3.* Evaluate the properties of pretreated cotton fabric treated with different preparatory finishing machines and compare the results	4.	Pretreatment using different preparatory finishing machines. • Jigger • Winch	CO1
LSO 5.1. Illustrate the flow chart of mercerization process. *LSO 5.2.* Demonstrate mercerization (hot and cold mercerization) *LSO 5.3.* Demonstrate slack and tension mercerization. *LSO 5.4.* Compare mercerization effects by different methods.	5.	Mercerization of cotton fabric.	CO 1, CO2
LSO 6.1. Demonstrate the working principle of fabric shrinkage measure. *LSO 6.2.* Compare and calculate the percentage of shrinkage in different fabrics.	6.	Measurement of fabric shrinkage: • Cotton woven fabric • Felt fabric • Knit fabric	CO1, CO2
LSO 7.1. List out different stiffening agents *LSO 7.2.* Demonstrate the process of stiffening using starch and PVA. *LSO 7.3.* Compare and evaluate the effects stiffened fabric using PVA/ Starch.	7.	Stiff finishing of given fabric using Starch/PVA. • Temporary stiffening • Permanent Stiffening	CO1, CO2
LSO 8.1. List out different softeners used for fabric, their advantages and disadvantages. *LSO 8.2.* Demonstrate the procedure of softening the fabric using various softeners. *LSO 8.3.* Compare and evaluate the effects of softening using different softeners.	8.	Soft finishing of given fabric using softener (Anionic/Cationic/Nonionic).	CO2
LSO 9.1. List out the types of resins to give special finishes *LSO 9.2.* Demonstrate the finishing process. *LSO 9.3.* Apply the finishes as per the end use of the fabric.	9.	Special functional finishings • Crease Resistant Finish • Cool Finish	CO2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 10.1. Prepare a flow chart of garment dyeing for woven cotton garments and knitted garments. *LSO 10.2.* Prepare the recipe of knit garment dyeing with reactive dyes (hot Brand). *LSO 10.3.* Demonstrate step by step procedure and after treatment of dyeing process on the paddle dyeing machine and hydro extractor.	10.	Knit garment dyeing with Reactive Dyes (Hot Brand) using Paddle dyeing machine and hydroextractor.	CO3
LSO 11.1. Prepare the flow chart of garment dyeing using reactive dyes (cold brand). *LSO 11.2.* Demonstrate step by step procedure of dyeing using reactive dyes (cold brand). *LSO 11.3.* Compare garment dyeing suing hot brand and cold brand reactive dyes.	11.	Woven garment dyeing with Reactive Dyes (Cold Brand) using exhaust method.	CO3
LSO 12.1. Prepare a flow chart of foil printing process. LSO 12.2 Use the right ingredients and equipment needed for Foil Printing. LSO 12.3 Demonstrate the foil printing process step by step.	12.	Foil Printing on T- shirt.	CO4
LSO 13.1 Prepare a flow chart of puff printing process. LSO 13.2 Use the right chemicals and equipment needed for Puff printing. LSO 13.3 Demonstrate the method of puff printing	13.	Puff Printing on Garments.	CO4
LSO 14.1 Prepare a flow chart of Khadi Block printing process. LSO 14.2 Use the right equipment and recipe paste needed for Khadi Block printing. LSO 14.3 Demonstrate the method of khadi block printing.	14.	Khadi Block printing on Garments.	CO4
LSO 15.1 List the advantages of DTGP rinting LSO 15.2 Demonstrate step by step the process of DTG printing process. Viz: Pretreatment, Printing on a DTG printer and Finishing LSO 15.3 Use the DTG Printer	15.	Direct to Garment Printing {DTG}.	CO4
LSO 16.1 Prepare a flow chart of step-by-step process. LSO 16.2 Demonstrate the process of Normal Was using the right Ingredients and Chemicals. LSO 16.3 Use the different Equipment and machines needed for Normal Wash.	16.	Normal wash of Denim (Twill) Jeans.	CO5
LSO 17.1 Prepare a flow chart of step-by-step process of Acid Wash	17.	Acid Wash.	CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 17.2 Demonstrate the process of enzyme wash using the right ingredients and chemicals. LSO 17.3 Use the different equipment and machines needed for Acid Wash			
LSO 18.1 Prepare a flow chart of step-by-step process of Enzyme Wash LSO 18.2 Demonstrate the process of enzyme wash using the right ingredients and chemicals. LSO 18.3 Use the different equipment and machines needed for Enzyme Wash	18.	Enzyme wash.	CO5

Note: Depending upon the availability of the equipment any 15 experiments from above list may be conducted.

L) Suggested Term Work and Self Learning: S2452501

Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/ Exercises to be provided by the course teacher in line with the targeted Cos

1. Need for and importance of various preparatory and stabilising processes for textile goods (in teams).
2. Make a list of different types of dyeing and printing machineries used in garment processing units.
3. Make a detailed list of various dry-cleaning chemicals and explain step by step process of dry-cleaning process with pictures of the same.
4. Study of effluent treatment plants and its working in a textile processing Unit.
5. Prepare a list of major issues in the Garment Processing.

b. Micro Projects:

1. Compare and prepare a detailed report on the shrinkage control treatments for wool and cotton fabrics.
2. Collect swatches of different textural finishes and create a catalogue of textile finishes.
3. Study of garment dyeing using natural dyes.
4. Develop a collection of T shirts using at least 5 types of printing techniques or styles. Study the process / art of printing by visiting a local garment printer.
5. Write a detailed report on the impact of water in textile wet processing industry.

c. Other Activities:

1. Seminar Topics:
   - Eco friendly garment washes.
   - Digital printing on garments.
   - Study on bleaching – discharge chemicals used in wet textile processing industry.
   - Novel finishes on furnishing fabrics.

2. Visits:
   (1) Visit nearby textile chemical finishing industry. Prepare report of visit highlighting the different chemicals used for different finishes and its importance.
   (2) Visit a garment dyeing industry, prepare a report on the machineries used in the dyeing industry.
   (3) Visit to a garment printing industry with 3D printing and digital printing facility and prepare a report on the printing technique used, material used, single component/batch production/mass production and cost of printed component.

(4) Visit to denim washing industry and prepare a detailed report on various washes carries out in the industry.

3. Self-Learning Topics:
   - 3D printing in garment industry.
   - Effluent treatment plants: Need for and importance of the textile chemical processing industry.
   - Eco friendly technologies in the textile chemical processing industry.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	-	-	20%	20%
CO-2	10%	10%	10%	25%	-	10%	20%
CO-3	15%	15%	15%	25%	33%	15%	20%
CO-4	30%	30%	30%	25%	33%	15%	20%
CO-5	30%	30%	30%	25%	34%	40%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Pre-treatments and Stabilizing Processes of Fabric	8	CO1	10	4	3	3
Unit-2.0 Textural Finishes on Fabric and Garments	8	CO1, CO2	7	3	2	2
Unit-3.0 Garment Dyeing	8	CO3	11	5	3	3
Unit-4.0 Garment Printing	12	CO4	21	5	5	11
Unit-5.0 Garment Washes and Dry Cleaning	12	CO3, CO5	21	3	7	11
Total	**48**	**-**	**70**	**20**	**20**	**30**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	De-sizing of cotton fabric: • Rot Steeping • Acid De-sizing • Oxidative De-sizing • Enzyme De-sizing	CO1	45	45	10
2.	Scouring of cotton fabric.	CO1	45	45	10
3.	Bleaching of cotton fabric using different bleaches. • Peroxide bleaching • Hypochlorite bleaching • Chloride bleaching	CO1	30	60	10
4.	Pretreatment using different preparatory finishing machines. • Jigger • Winch	CO1	50	40	10
5.	Mercerization of cotton fabric	CO1/CO2	50	40	10
6.	Measurement of fabric shrinkage: • Cotton woven fabric • Felt fabric • Knit fabric	CO1/CO2	60	30	10
7.	Stiff finishing of given fabric using Starch/PVA. • Temporary stiffening • Permanent Stiffening	CO1/CO2	50	40	10
8.	Soft finishing of given fabric using softener (Anionic/Cationic/Nonionic)	CO2	50	40	10
9.	Special functional finishings • Crease Resistant Finish • Cool Finish	CO2	50	40	10
10.	Knit garment dyeing with Reactive Dyes (Hot Brand) using Paddle dyeing machine and hydroextractor.	CO3	50	40	10
11.	Woven garment dyeing with Reactive Dyes (Cold Brand) using exhaust method.	CO3	50	40	10
12.	Foil Printing on T shirt.	CO4	45	45	10
13.	Puff Printing on Garments.	CO4	45	45	10
14.	Khadi Block printing on Garments.	CO4	45	45	10
15.	Direct to Garment Printing {DTG}.	CO4	45	45	10
16.	Normal wash of Denim (Twill) Jeans.	CO5	45	45	10
17.	Acid Wash.	CO5	45	45	10
18.	Enzyme Wash.	CO5	45	45	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Chemical processing equipment and tools	Pipettes, Beakers, Stoves, Glass rods, Test tubes, Fabric marker pens, Ph meter, conical flasks, thermometer, etc.	All experiments
2.	Dyeing machines and equipment	Dye vessels, Dye bath cover, Lab dyeing machine, paddle garment dyeing machine, lab hydroextractor etc.	10,11,16,17,18
3.	Garment washing Machines	Garment washing machine and dryers for laboratory	16,17,18
4.	Preparatory Finishing machines	Lab sample dyeing machine, Jigger, winch etc.	1,2,3,4,5
5.	DTG garment printing machine	Automatic A3 Size T-Shirt Printing Machine DTG Printer Machine for T-Shirts, Hoodies etc	15
6.	Printing equipment and tools	Ready Screens with designs etched, squeegees, Printing Table, wooden or metallic blocks, Garment printing machine etc.	12,13,14
7.	CHEMICALS AND Printing pastes and dyes	All Chemicals required ingredients needed for printing and dyeing experiments	All experiments

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Basics of Textile Chemical Processing	D. GopalKrishnan	Daya Publishing House ISBN-10 : 9351308782 ISBN-13 : 978-9351308782
2.	Chemical Processing of Textile Materials	R. Veerapathran	Elsevier Science & Technology, 2015 ISBN: 0857098187, 9780857098184
3.	Chemical Finishing of Textiles	W.D. Schindler, P.J. Hauser	Elsevier Science, 2004 ISBN: 1855739054, 9781855739055
4.	Technology Of Textile processing: Volume 1	V. A. Shenai	Sevak Publishers (January 1, 1991) ASIN: B008H4PCHW
5.	Technology Of Printing	V.A. Shenai	Sevak Publishers ASIN: B001KT69OG
6.	Chemical modification by washing of Denim Ready-made Garments (RMG): To Develop Novel Designs	Md. Ibrahim H. Mondal	ISBN-10 : 9783330024601 ISBN-13 : 978-3330024601
7.	THE COMPLETE TECHNOLOGY BOOK ON TEXTILE SPINNING, WEAVING, FINISHING AND PRINTING	NIIR Board	National Institute Of Industrial Board ISBN-10 : 8178330490 ISBN-13: 978-8178330495
8.	Digital Printing of Textiles.	R. Senthilkumar	CreateSpace Independent Pub (22 May 2016) ISBN-10 : 1533400237 ISBN-13 : 978-1533400239

9.	Garment Dyeing	Farben fabriken	Book on Demand Ltd. (1 January 2022), ISBN-10 : 5519721424 ISBN-13 : 5519721424-978

(b) Online Educational Resources:

1. https://www.cbse.gov.in/publications/vocational/Textile%20Design/CBSE%20CIT%20Textile%20Chemical%20Processing-XII%20text.pdf
2. https://www.worldofchemicals.com/448/chemistry-articles/chemistry-of-textile-manufacturing.html
3. https://www.intechopen.com/chapters/68157
4. https://textilelearner.net/sustainable-garment-and-denim-washing/
5. https://www.astm.org/products-services/standards-and-publications/standards.html
6. http://www.apparel-merchandising.com/p/dyeing.html
7. https://www.denimsandjeans.com/
8. https://nptel.ac.in/courses/116102054
9. https://onlinecourses.swayam2.ac.in/cec22_te01/preview

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. https://www.nios.ac.in/media/documents/SecHmscicour/english/Home%20Science%20(Eng)%20Ch-11.pdf
2. https://dgt.gov.in/sites/default/files/Textile%20Wet%20Processing%20Tech_CTS2.0_NSQF-4.pdf
3. https://www.youtube.com/watch?v=Tmsg5Nt5cqA
4. https://study.com/academy/lesson/chemicals-dyes-used-in-the-textile-industry.html
5. https://study.com/academy/lesson/textile-printing-terminology.html
6. https://www.solidaridadnetwork.org/wp-content/uploads/2021/03/Solidaridad-Guidebook-Wet-Processing-151220.pdf
7. Lab Manuals

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A) Course Code **: 2452502 (T2452502/P2452502/S2452502)**

B) Course Title **:** Garment Testing & Quality Control

C) Pre- requisite Course(s) **:**

D) Rationale **:**

Quality has become the crucial factor in the survival, expansion & success of a business. A cheaper product may initially lure customers but will not survive in the long run. To be able to satisfy most of customer requirements & also to last long, a product needs to be of a good quality. Finally consumers will opt for a quality product. Testing the garment at various stages as well as correcting the faults found will eventually create the niche for the business amongst competitors. Therefore, it is an essential skill that needs to be imparted. This course will develop skills essentials for Garment testing & Quality control, to enable technocrats to work towards Total Quality control.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Undertake operations with Quality Consciousness at work.
CO-2 Test raw material, supplies & products for quality.
CO-3 Conduct Quality Inspections.
CO-4 Practice Quality Standards required in Industries.
CO-5 Develop Spec sheets

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	-	-	3	1	-	3		
CO-2	3	2	-	3	1	1	2		
CO-3	3	2	-	3	2	1	1		
CO-4	3	1	-	3	-	-	1		
CO-5	2	1	3	3	-	3	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2452502	Garment Testing & Quality Control	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2452502	Garment Testing & Quality Control	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2452502

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Establish the desired quality standards which are acceptable to the customers. *TSO 1b.* Discover flaws or variations in the raw materials and the manufacturing processes to ensure smooth and uninterrupted production. *TSO 1c.* Evaluate the methods and processes of production *TSO 1d.* Suggest further improvements in the functioning of methods and processes of production *TSO 1e.* Determine the extent of quality deviation in a product during the manufacturing process. *TSO 1f.* Analyze in detail the causes responsible for such deviation. *TSO 1g.* Undertake such steps which are helpful in achieving the desired quality of the product. *TSO 1h.* Recognize customer requirements. *TSO 1i.* Build processes that anticipate and prevent defects. *TSO 1j.* Make a plan to achieve the desired quality level. *TSO 1k.* Set up ways to measure progress *TSO 1l.* Control Quality at each step to avoid bottlenecks *TSO 1m.* Apply statistical tools in the manufacturing process for the purpose of quality control. *TSO 1n.* Seek out systematic causes of variation *TSO 1o.* Use statistical methods in the monitoring and maintaining of the quality of products and services.	**Unit-1.0 Quality Control & Quality Standards** 1.1 Quality Control: definition & objectives, Need, Importance & benefits 1.2 Perceptions in Quality 1.3 Quality control department and its role. 1.4 Quality Assurance: factors considered to ensure quality 1.5 Statistical Quality Control (S.Q.C) 1.6 Total Quality control (TQC) 1.7 5 Aspects of Quality: Producing Quality products, Checking Quality, Controlling Quality, Managing Quality, Quality Assurance 1.8 Quality related symbols in Industry	**CO1**
TSO2.a Check Quality Parameters of Woven fabric like Length, width & thickness TSO2.b Check count & construction of fabric TSO2.c Check Quality Parameters of Knitted Fabrics: TSO2.d Check Strength and extensibility of Knitted Fabrics. TSO2.e Check Grams per square meter (G.S.M) TSO2.f Check Quality Parameters of Non-woven Fabrics TSO2.g Measure Button size TSO2.h Check Button material TSO2.i Check Zipper material TSO2.j Check Zipper for smooth slider movement TSO2.k Check Slider is getting locked properly TSO2.l Check width of Elastic TSO2.m Check material of Elastic TSO2.n Check count, ply, twist & tenacity of Thread TSO2.o Check hooks for rust &size	**Unit-2.0 Quality Control in Garment Manufacturing Process:** 2.1 In Sample making section 2.2 In- Marker making section 2.3 In checking Raw materials & supplies like Fabric, Thread, Button, Zipper, Interlining, Elastics, Labels, Tags, etc. 2.4 In fabric spreading section 2.5 In fabric cutting section 2.6 In fabric sewing section 2.7 In pressing & Finishing section	**CO1, CO2, CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO2.p Check needles for sharpness, rust &size TSO2.q Check Labels for size, material, print quality, etc TSO2.r Check tags for size, material, print quality, etc		
TSO 3a. Check a garment physically for GSM, Shrinkage, etc. *TSO 3b.* Check a garment by Chemical test for colour fastness, PH, etc. *TSO 3c.* Work with garment testing labs.	**Unit-3.0 Quality Testing Methods, Testing Certification by Labs** 3.1 Off-Line Tests 3.1.1. Physical tests 3.1.2. Chemical tests 3.2 Testing labs 3.2.1 BTRA 3.2.2 NTRA 3.2.3 CTRA 3.2.4 SGS	**CO1, CO3,**
TSO 4a. Inspect garnets on the spot. *TSO 4b.* Inspect garments randomly. *TSO 4c.* Inspect garments at every stage *TSO 4d.* Conduct final inspection of garments before shipment *TSO 4e.* Check tolerance in garments. *TSO 4f.* Inspect upper garments & lower garments. *TSO 4g.* Differentiate between minor, major & critical defects *TSO 4h.* Conduct Internal & External inspections.	**Unit-4.0 Inspections** 4.1 Types of inspections 4.1.1 Spot inspection 4.1.2 Stage inspection 4.1.3 Random inspection 4.1.4 Final inspection. 4.2 Tolerance in inspection. 4.3 Important points to check for quality in Upper garments 4.4 Important points to check for quality in Lower garments 4.5 Major, minor defects & critical defects. 4.6 Internal & External inspections.	**CO3**
TSO 5a. Procure various certifications. TSO 5b. Plan production for approval from all agencies & buyer. TSO 5c. Find faults. TSO 5d. Rectify faults. TSO 5e. Prepare Specs sheets. TSO5f. Follow spec sheets	**Unit-5.0 Quality Standards –** 5.1 ISO 9000-2001 Certification 5.2 ISO 2859 certification 5.3 Six Sigma certification 5.4 NaceRap/ Facerap 5.5 Quality Circles 5.6 Verification & Validation 5.7 Spec sheet/ Tech pack. 5.8 How to follow specifications 5.9 Fixing specs for upper garments 5.10Fixing specs for lower garments	**CO4, CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2452502

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Illustrate Symbols used in Spreading *LSO 1.2.* Illustrate Symbols used in Cutting *LSO 1.3.* Illustrate Symbols used in Stitching *LSO 1.4.* Illustrate Symbols used in Finishing & Packing *LSO 1.5.* Illustrate Symbols used in Wash & Care of garment	1.	Chart preparation of Quality related symbols	CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 2.1. Test Shrinkage by washing 1sq metre LSO 2.2. Check GSM by weighing 1 square metre LSO 2.3. Measure Tensile Test of fabric LSO 2.4. Test by tearing LSO 2.5. Check Color Fastness by dipping in water LSO 2.6. Check Color Fastness by rubbing LSO 2.7 Take PH Test LSO 2.8 Compare Shade Matching in different rolls LSO 2.9. Compare Fabric Width uniformity LSO 2.10 Check warp & weft yarns per square metre using a pick glass LSO 2.11 Check Abrasion resistance. LSO 2.12 Check Water resistance. LSO 2.13 Check Air permeability LSO 2.14 Check drapability LSO 2.15 Check crease resistance	2.	Test Woven Fabric	CO1, CO2, CO3
LSO 3.1. Check Strength and extensibility. LSO 3.2. Check Course density LSO 3.3. Check Wales density LSO 3.4. Check loop length. LSO 3.5. Check Elasticity. LSO 3.6. Check Deformation. LSO 3.7 Check yarn count. LSO 3.7. Check GSM	3.	Test Knitted Fabric	CO1, CO2, CO3
LSO 4.1. Check the Strength and extensibility of fabric. LSO 4.2. Check the Weight. LSO 4.3. Check the Thickness. LSO 4.4. Check the Air permeability. LSO 4.5. Check the Crease resistance. LSO 4.6 Check the Stability of washing/ dry cleaning. LSO 4.7. Check the Dimensional stability. LSO 4.8. Check the Dimensional Elasticity.	4.	Test Non-woven Fabric	CO1, CO2, CO3
LSO 5.1. Check GSM. LSO 5.2. Test Shrinkage. LSO 5.3 Check Tensile strength LSO 5.4. Check Abrasion resistance. LSO 5.5. Check Pilling resistance LSO 5.6. Test Button Strength LSO 5.7. Test crease resistance LSO 5.7. Test Dimensional stability LSO 5.7. Test Brushing strength	5	Physical Tests of a garment	CO1, CO3,
LSO 6.1. Test Color Fastness to washing, lighting, heat, chlorinated water, sea water & perspiration	6	Chemical Tests of garment.	CO1, CO3,

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 6.2 Analyze the fibre content LSO 6.3 test pH LSO 6.4 Test water resistance & repellency			
LSO 7.1 Identify minor faults like skipped stitches, pen marks on wrong side, pocket edge not sharp ,etc. LSO 7.2 Identify major faults like holes in fabric, pen marks on right side, etc. LSO 7.3 Identify critical faults like sleeve lengths differing, collar points not matching, collar not centered, button placket not straight, etc.	7	Inspect one upper garment for major, minor & critical defects	CO3
LSO 8.1 Identify minor faults like skipped stitches, pen marks on wrong side, pocket inside having marks, etc. LSO 8.2 Identify major faults like fly stitches not stitched neatly, zipper attachment not straight, holes in fabric, pen marks on right side, etc. LSO 8.3 Identify critical faults like pant leg lengths differing, fly not stitched properly, etc.	8	Inspect one lower garment for major, minor & critical defects	CO3
LSO 9.1 Find fault LSO 9.2 Name fault LSO 9.3 Check Appearance of fault LSO 9.4 Infer Cause of fault LSO 9.5 Inspect the Effect of fault LSO 9.6 Brainstorm on possible Repairs LSO 9.7 Take Action LSO9.8 Take action for Prevention of the fault	9	NACERAP for a garment	CO4, CO5
LSO 10.1 Illustrate a neat sketch of the required garment LSO 10.2 Prepare a measurement chart as per the standard measurements of the target market LSO 10.3 Grade the sizes as required LSO 10.4 Formulate required cutting, stitching, finishing & packing instructions	10	Prepare a Spec sheet for an Upper garment	CO4, CO5
LSO 11.1. Recognizing the trims *LSO 11.2.* Checking quality of trims	11	Collection of Threads, Buttons, Labels, Tags, Elastics, Laces, & other trims	CO4, CO5
LSO 12.1 Illustrate a neat sketch of the required garment LSO 12. Prepare a measurement chart as per the standard measurements of the target market) LSO 12.3 Grade the sizes as required LSO 12.4 Formulate required cutting, stitching, finishing & packing instructions.	12	Prepare a Spec sheet for a lower garment	CO4, CO5
LSO 13.1 Scrutinize the given spec sheet LSO 13.2 See critical instructions LSO 13.3 Cut as required LSO 13.4 Stitch as required LSO 13.5 Finish as required LSO 13.6 Pack as required	13	Follow specs given by buyer	CO4, CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 14.1 collect fabrics with directional print LSO 14.2 Differentiate between 1 way & 2 wat prints	14	Check fabric for directional print	CO1, CO2, CO3
LSO 15.1 Collect of fabrics with directional weave like corduroy, velvet, etc. LSO 15.2 Recognize the direction & cut accordingly	15	Check fabric for directional weave	CO1, CO2, CO3
LSO 16.1 Check quality of trims LSO 16.2 Check sizes of trims LSO 16.3 Check placement of trims	16	Check one garment for trims	CO1, CO2, CO3

Note: Each practical may take more than one class

L) Suggested Term Work and Self Learning: S2452502

a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

1. Compare the application of different Statistical Quality Control (S.Q.C) tests.
2. Study a case of Total Quality control (TQC) implementation is a garment manufacturing industry.
3. Compare Quality Control in different sections of Garment Manufacturing Process.
4. Explain different Quality testing methods with examples.
5. State the application of Spot inspection, Stage inspection, Random inspection and Final inspection

b. Micro Projects:

1. Prepare a spec sheet for a buyer taking into considerations his/her needs
2. Download videos on practical quality problems in garment making & find solutions to the problems.

c. Other Activities:

1. Seminar Topics:
   - Case study of a unit that has come up only based on quality
   - Case study of a company that closed due to quality issues.
2. Visits: Visit nearby Garment industry to observe, understand & learn their quality standards
3. Self-Learning Topics:
   - Visit to a nearby boutique/ retail shop dealing with garments, making a report of their production methods, what quality standards they are following & suggestions

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	30%	30%	15%	10%	50%	20%	20%
CO-2	20%	20%	10%	10%	05%	10%	20%
CO-3	15%	15%	15%	20%	05%	15%	20%
CO-4	20%	20%	30%	20%	20%	15%	20%
CO-5	15%	15%	30%	40%	20%	40%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Quality Control, Objectives of Quality Control & Quality Standards	8	CO1	20	6	6	8
Unit-2.0 Quality Control in Garment Manufacturing Process	8	CO1, CO2, CO3	15	4	4	7
Unit-3.0 Quality Testing Methods, Testing Certification by Labs	8	CO1, CO3,	10	3	3	4
Unit-4.0 Inspections	12	CO3	15	4	4	7
Unit-5.0 Quality Standards	12	CO4, CO5	10	3	3	4
Total	**48**	**-**	**70**	**20**	**20**	**30**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Chart preparation of Quality related symbols	CO1	45	45	10
2.	Test Woven Fabric	CO1, CO2, CO3	40	50	10
3.	Test Knitted Fabric	CO1, CO2, CO3	30	60	10
4.	Test Non-woven Fabric	CO1, CO2, CO3	30	60	10
5.	Physical Tests of a garment	CO1, CO3,	30	60	10
6.	Chemical Tests of garment.	CO1, CO3,	30	60	10
7.	Inspect one upper garment for major, minor & critical defects	CO3	30	60	10
8.	Inspect one lower garment for major, minor & critical defects	CO3	40	50	10
9.	NACERAP for a garment	CO4, CO5	40	50	10
10.	Prepare a Spec sheet for an Upper garment	CO4, CO5	40	50	10
11.	Collection of Threads, Buttons, Labels, Tags, Elastics, Laces, & other trims	CO4, CO5	45	45	10
12.	Prepare a Spec sheet for a lower garment	CO4, CO5	30	60	10
13.	Follow specs given by buyer	CO4, CO5	40	50	10
14.	Check fabric for directional print	CO1, CO2, CO3	40	50	10
15.	Check fabric for directional weave	CO1, CO2, CO3	40	50	10
16.	Check one garment for trims	CO1, CO2, CO3	30	60	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Pick glass	As available	All
2.	Chemicals	As required for each test	06

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Quality Assurance for textiles & apparel	Sara J Kadolph	Bloomsbury Publishing 2nd Edition ISBN 9781563675546
2.	An introduction to Quality Control for Apparel Industry	Pradip V Mehta	Publisher : CRC Press; 1st edition ISBN-10 : **0824786793** ISBN-13 : **978-0824786793**
3.	Managing quality in the Apparel Industry	Satish Bharadwaj & Pradip Mehta	New Age International Private Limited, ISBN 10: 8122411665 ISBN 13: 978-8122411669
4.	Apparel Manufacturing Technology	By T. Karthik, P. Ganesan, D. Gopalakrishnan	Publisher:CRC Press ISBN:9781315350509, 1315350505

(b) Online Educational Resources:

1. https://textilelearner.net/different-types-of-garment-testing/
2. https://atira.in/fabric-garment-testing/
3. https://www.onlineclothingstudy.com/2011/06/basic-textile-testing-parameters.html
4. https://www.eurofins.com/textile-leather/articles/fundamental-textile-testing-mechanical-and-physical-tests/
5. https://www.textileblog.com/quality-parameters-of-woven-fabric/
6. https://www.qima.com/testing/textile-fabric/physical-testing-textiles
7. https://techpacker.com/blog/manufacturing/all-about-quality-assurance-control/
8. https://www.oreilly.com/library/view/garment-manufacturing-technology/9781782422396/XHTML/B9781782422327000163/B9781782422327000163.xhtml

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. https://ordnur.com/wp-content/uploads/2018/05/Complete-Quality-Manual-of-Garments-Factory.pdf
2. https://ordnur.com/garments-2/quality-control-manual-of-garments/
3. https://www.slideshare.net/SAMultimedia/apparel-quality-control-quality-assurance
4. https://www.powershow.com/view0/6c869d-ZDhjZ/Garment_Manufacturing_Process_Quality_Assurance_powerpoint_ppt_presentation
5. https://www.scribd.com/presentation/284106898/Apparel-Quality-Management
6. https://www.researchgate.net/publication/300558517_Quality_control_and_quality_assurance_in_the_apparel_industry

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A) Course Code **: 2452503A (T2452503A/P2452503A/S2452503A)**

B) Course Title **:** Advanced Software in Garment Technology

C) Pre- requisite Course(s) **:** CAD in Garment Technology

D) Rationale **:**

The world is going digital at a very fast pace & students need to keep themselves abreast of new technologies & apply them in their fields if they want to survive. This course enables the student to learn the available advanced software in Garment technology & also prepare for upcoming latest technologies. The course is planned in a way that gives the student a choice to work in production, design, merchandising or business development.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

- **CO-1** Use advanced software for designing in apparel Industry.
- **CO-2** Prepare Spec. sheets using Tech pack.
- **CO-3** Design & Edit pictures using Digital illustrator & Photoshop.
- **CO-4** Prepare Bills/ tags/Labels using BOM.
- **CO-5** Contrive Digital Presentations & Portfolios.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	1	1	3	3	-	1	1		
CO-2	2	2	3	3	-	1	3		
CO-3	1	1	3	3	-	-	2		
CO-4	-	1	3	3	-	-	2		
CO-5	2	-	-	3	-	-	3		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2452503A	Advanced Software in Garment Technology	02	01	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2452503A	Advanced Software in Garment Technology	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2452503A

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Compare different advanced software for design & data in Apparel Industry. *TSO 1b.* Use suitable software *TSO 1c.* Store data using DBMS *TSO 1d.* Retrieve data using DBMS *TSO 1e.* Inquire on the available 3D software *TSO 1f.* Use 3D software for modelling & production *TSO 1g.* Map Fabric prints *TSO 1h.* Prepare charts for Order concentration. *TSO 1i.* Prepare Order forms. *TSO 1j.* Design factory layouts. *TSO 1k.* Design production layouts. *TSO 1l.* Explain reverse engineering steps for 3D Printing.	**Unit-1.0 Use of Advanced Software for Design & Data in Apparel Industry. 3 D Modelling** 1.1 Introduction to Advanced software, configuration, database structure & content 1.2 Database Management systems- DBMS 1.3 3D Modelling software available. Their advantages & disadvantages 1.4 Fabric Mapping 1.5 Order Concentration using suitable advanced software 1.6 Order form using suitable advanced software 1.7 Layout of factory using suitable advanced software 1.8 Layout of Production.	**CO1**
TSO 2a. Identify various types of Spec sheets. *TSO 2b.* Illustrate a Tech sketch *TSO 2c.* Compare same sketch with different colours with Colorways *TSO 2d.* Render with Colorways *TSO 2e.* Solve measurement problems with Graded spec *TSO 2f.* Illustrate using Artwork spec *TSO 2g.* Simulate with Proto Spec. *TSO 2h.* Design artwork creation for spec sheet *TSO 2i.* Tech pack presentations for Men's wear, Women's wear & Children's wear	**Unit-2.0 Tech Pack** 2.1 Importance of all types of Spec sheets included in a Tech pack-Tech spec, Colorways, Graded spec., Artwork spec., Proto Spec. 2.2 Model Slicing and Contour Data organization, Direct and adaptive slicing: Identification of peak features, Adaptive layer thickness determination. Tool path generation. 2.3 Design artwork creation for spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes, 2.4 Tech pack presentation-Compilation of artwork with stitch detailing, color variation & fabric variation on the standard tech pack For Men's wear- Shirt/ Blazer Shorts/Trouser. For Women's wear -Skirt, Top/ Kurta, Dress/ Gown For Childrens wear -T-Shirt/ Hoody, Jeans, Romper/Jumper	**CO1, CO2**
TSO 3a. Operate tools of Fashion Illustrator. *TSO 3b.* Duplicate files *TSO 3c.* Clone files *TSO 3d.* Create poses in Digital Fashion Illustrator *TSO 3e.* Design Logos *TSO 3f.* Trace poses *TSO 3g.* Render fabric in Photoshop *TSO 3h.* Create Croquis in Photoshop *TSO 3i.* Edit pictures *TSO 3j.* Create marketing & advertising artwork	**Unit-3.0 Digital Fashion Illustrator & Photoshop** 3.1 Tools of Digital fashion Illustrator & their uses. Shapes & transformations in Digital fashion Illustrator. 3.1.1 Duplicating & Cloning. 3.1.2. Fillings, outlines & special effects in Digital fashion Illustrator. 3.1.3 Shaping objects & creating custom shapes 3.1.4 Texts, effects, splitting & erasing parts of objects 3.1.5. Tracing & creating Fashion poses Scanning & converting fashion illustrations to Vector files 3.2 Logo designing in Digital fashion Illustrator.	**CO3, CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3k. Create Collages *TSO 3l.* Creating Mood boards *TSO 3m.* Create Theme boards *TSO 3n.* Create Inspiration boards *TSO 3o.* Design color & texture boards in Photoshop	3.3 Creating tags & labels in Digital fashion Illustrator. 3.4 Tools of Photoshop 3.5 Painting with Photoshop 3.6 Rendering fabric with Photoshop. Gradient use in rendering 3.7 Creating fashion croquis in Photoshop. Manipulating fashion model drawings in Photoshop 3.8 Draping of garments on Men, women & children's croquis 3.9 Editing pictures. Enhancing images using Photoshop. Masking with Photoshop. Transforming images in Photoshop. Layers in Photoshop- merging & blending layers 3.10 Text effects in Photoshop 3.11 Creating Artwork for Marketing & Advertising in Photoshop 3.12 3D effects in Photoshop 3.13 Making Collages. 3.14 Applying filters in photoshop 3.15 Creating Mood boards, Theme boards, Inspiration boards, color & texture boards in Photoshop	
TSO 4a. Produce Labels with BOM. *TSO 4b.* Estimate the cost for preparation of labels. *TSO 4c.* Estimate the time for preparation of labels *TSO 4d.* Produce Tags with BOM *TSO 4e.* Estimate time for preparation of tags *TSO 4f.* Estimate the cost for preparation of tags *TSO 4g.* Design variety of labels & tags	**Unit-4.0 BOM** 4.1 Bill of materials for trims 4.2 Labels- Main label, Size Label, Content label, Country of origin Label & Wash care Label 4.3 Hand tags 4.4 Table for details-Type of product & Description, Supplier, Reference Code, Finish, Content, Weight, Construction, Color, Size	**CO3, CO4**
TSO 5a. Prepare a presentation of a Garment Industry *TSO 5b.* Plan a presentation for an event. *TSO 5c.* Design a look book. *TSO 5d.* Prepare a Catalogue *TSO 5e.* Create a Brochure *TSO 5f.* Prepare a Mood board *TSO 5g.* Prepare a theme board *TSO 5h.* Present a pitch deck *TSO 5i.* Present using 3D & multimedia *TSO 5j.* Prepare a Portfolio *TSO 5k.* Design an E visiting card *TSO 5l.* Prepare an E presentation *TSO 5m.* Simulate a fashion show	**Unit-5.0 Presentations Using advanced Software** 5.1 External & Internal presentation of a Garment Industry 5.2 Planning a computer-generated presentation for an event 5.3 Presentation for a look book 5.4 Presentation of a Catalogue 5.5 Creating a Brochure 5.6 Pitch Deck. 5.7 3D & Multimedia presentations. 5.8 Portfolio presentations. 5.9 E Visiting cards 5.10 E invites 5.11 E presentations 5.12 Simulating a fashion show using 3D	**CO4, CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2452503A

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Design for 3D software *LSO 1.2.* Create articles with 3D software *LSO 1.3.* Develop innovative products with 3D.	1.	3D modelling	CO1
LSO 2.1. Map a design & use it on the virtual croquis *LSO 2.2.* Try different colour combinations on the design *LSO 2.3.* Simulate the image to visually imagine the result	2.	Fabric Mapping	CO1
LSO 3.1. Plan orders that have close deliveries as one order. *LSO 3.2.* Save time by producing together. *LSO 3.3.* Save money by ordering in bulk. *LSO 3.4.* Organize production to high efficiency	3.	Order Concentration	CO1
LSO 4.1. Prepare an order form as needed *LSO 4.2.* Include required terms & conditions *LSO 4.3.* Avoid conflicts with suppliers. *LSO 4.4.* Systematize trade for mutual benefit of buyer 7 supplier.	4.	Order form	CO1
LSO 5.1. Plan the layout. *LSO 5.2.* Deign in such a way that Stores, office & warehouse have separate entrances	5.	Layout of factory	CO1
LSO 6.1. Plan smooth flow of production from stores to warehouse. *LSO 6.2.* Design to suit minimum man handling *LSO 6.3.* Design to ensure quick response systems *LSO 6.4.* Reduce work in progress/ process	6.	Layout of production	CO1
LSO 7.1. Design artwork creation for spec sheet *LSO 7.2.* Illustrate an upper male garment with detailing. *LSO 7.3.* Illustrate embellishing	7.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes for Men's wear- Shirt/ Blazer	CO1, CO2
LSO 8.1. Design artwork creation for spec sheet *LSO 8.2.* Illustrate an lower male garment with detailing. *LSO 8.3.* Illustrate embellishing	8.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes for Men's wear- Shorts/ Trouser	CO1, CO2
LSO 9.1. Design artwork creation for spec sheet *LSO 9.2.* Illustrate a female lower garment with detailing. *LSO 9.3.* Illustrate embellishing	9.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes For Women's wear -Skirt	CO1, CO2
LSO 10.1. Design artwork creation for spec sheet *LSO 10.2.* Illustrate a female upper garment with detailing. *LSO 10.3.* Illustrate embellishing	10.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes	CO1, CO2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
		For Women's wear - Top/ Kurta, Dress/ Gown	
LSO 11.1. Design artwork creation for spec sheet *LSO 11.2.* Illustrate a Child's jeans with detailing. *LSO 11.3.* Illustrate embellishing	11.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes For Childrens wear - Jeans	CO1, CO2
LSO 12.1 Design artwork creation for spec sheet LSO 12.2 Illustrate a Child's T shirt/ Hoody with detailing. LSO12.3 Illustrate a Child's Romper/Jumper with detailing.	12.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes For Women's wear -Skirt, Top/ Kurta, Dress/ Gown. For Childrens wear -T-Shirt/ Hoody, Jeans, , Romper/Jumper	CO1, CO2
LSO 13.1 Practice on Tools of Digital fashion Illustrator. LSO13.2 Duplicate images in Digital fashion Illustrator. LSO13.3 Clone images in Digital fashion Illustrator.	13.	Tools of Digital fashion Illustrator. - Duplicating & Cloning.	CO3, CO4
LSO 14.1 Trace Fashion poses- Male, female, child LSO14.2 Re Draw poses LSO 14.3 Create new Fashion poses- Male, female, child	14.	Trace & create Fashion poses- Male	CO3, CO4
LSO 15.1 Plan LOGO with Digital fashion Illustrator LSO 15.2 Create innovative logo designs LSO 15.3 Compare logo in different colors	15	Design Logos in Digital fashion Illustrator.	CO3, CO4
LSO 16.1 Create tags in Digital fashion Illustrator LSO 16.2 Design different shapes of Tag	16.	Create tags in Digital fashion Illustrator.	CO3, CO4
LSO 17. 1 Create labels in Digital fashion Illustrator LSO 17.2 Design innovative shapes & sizes of labels	17.	Create labels in Digital fashion Illustrator.	CO3, CO4
LSO 18.1. Render fabric print LSO 18.2 Use gradient use in rendering LSO 18.3 Develop new fabric designs	18.	Render fabric with Photoshop. Gradient use in rendering	CO3, CO4
LSO 19.1 Create Fashion croquis LSO 19.2 Manipulate a croqui to required size & shape	19.	Create fashion croquis in Photoshop. Manipulate fashion model drawings in Photoshop	CO3, CO4
LSO 20.1 Dress the croquis in different attire LSO 20.2 Apply different color combinations LSO 20.1 Use different textures in garments	20.	Drape garments on Men, women & children's croquis	CO3, CO4
LSO 21.1 Edit pictures to enhance color LSO 21.2 Change background of an image LSO 21.3 Use layers separately LSO 21.4 Merge layers in an image LSO 21.5 Blend layers in an image	21.	Edit pictures. Enhance images using Photoshop. Mask with Photoshop. Transform images in Photoshop. Layers in Photoshop- merge & blend layers	CO3, CO4
LSO 22.1 Plan artwork for advertising/ marketing based on different strategies LSO 22.2 Analyze each artwork LSO 22.3 Comparing effectiveness of each artwork	22.	Create Artwork for Marketing & Advertising in Photoshop	CO3, CO4

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 22.4 Finalize the design LSO 22.5 create final artwork in photoshop			
LSO 23.1 Practice the tools available LSO 23.2 Select images for collage. LSO 23.3 Compare various layouts available. LSO 23.4 create the final collage	23.	Design Collages.	CO3, CO4
LSO 24.1 Apply filters to an image LSO 24.2 Compare effects on different filters LSO 24.3 Select suitable filter	24.	Apply filters in photoshop.	CO3, CO4
LSO 25.1 Plan mood board LSO 25.2 Collect pictures LSO 25.3 Design a mood board with available	25.	Create Mood boards in Photoshop	CO3, CO4
LSO 26.1 Plan a theme after brainstorming for topics LSO 26.2 Collect suitable images LSO 26.3 Illustrate a theme board	26.	Create Theme boards in Photoshop	CO3, CO4
LSO 27.1 Plan Color board based on requirements LSO 27.2 Design a Color board with Color blocking LSO 27.3 Plan Texture board based on requirements LSO 27.4 Design a Texture board with various textures	27.	Create color & texture boards in Photoshop	CO3, CO4
LSO28.1 Design the label LSO 28.2 Try different colors LSO 28.3 Cost the label based on time taken & material used	28.	Prepare Main label & Size Label	CO3, CO4
LSO 29.1 Design the label LSO 29.2 Cost the label based on time taken & material used	29.	Prepare Content label & Country of origin label	CO3, CO4
LSO 30.1 Design the label LSO 30.2 Illustrate the symbols for various wash & care instructions LSO 30.3 Cost the label based on time taken & material used	30.	Prepare Wash care Label	CO3, CO4
LSO 31.1Plan the size & shape of Hand tag LSO 31.2 Plan space for details on Type of product & Description, Supplier, Reference Code, Finish, Content, Weight, Construction, Color, Size LSO 31.3 Produce hand tags LSO 31.4 Cost hand tags	31.	Prepare Hand tags with details on Type of product & Description, Supplier, Reference Code, Finish, Content, Weight, Construction, Color, Size	CO3, CO4
LSO 32.1 Plan the external layout LSO 32.2 Plan the flow of material from design to dispatch LSO 32.3 Lay departments according to flow LSO 32.4 Illustrate the planned departments with entries & exits	32.	External presentation of a Garment Industry	CO4, CO5
LSO 33.1Plan the display of mannequins, clothes, machinery & equipment	33.	Internal presentation of a Garment Industry	CO4, CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 33.2 Illustrate the planned space to ensure there is no cramping			
LSO 34.1 Plan the different aspects of the event LSO 34.2 Plan the participants, volunteers & other human resource requirements LSO 34.3 Plan the logistics LSO 34.4 Plan the finances LSO 34.5 Check feasibility	34.	Plan a computer-generated presentation for an event	CO4, CO5
LSO 35.1Plan the theme for the look book LSO 35.2 Plan the number of garments LSO 35.3 Illustrating the front, back & side view of garment LSO 35.4 Design the layout of each page LSO 35.5 Design the cover page	35.	Presentation for a look book	CO4, CO5
LSO 36.1 Plan the look for the catalogue LSO 36.2 Plan the number of pages LSO 36.3 Plan the matter as per priority LSO 36.4 Design the layout of the catalogue page wise LSO 36.4 Design the front page	36.	Presentation of a Catalogue	CO4, CO5
LSO 37.1 Plan the look for the Brochure LSO 37.2 Illustrating the design & overall look LSO 37.3 Plan the matter & pictures LSO 37.4 Mark the folds wherever required	37.	Create a Brochure	CO4, CO5
LSO 38.1 Present business idea for a Pitch Deck LSO 38.2 identify problems that need solution LSO 38.3 Find Solution LSO 38.4 Identify Target market LSO 38.5 Plan Marketing & sales strategy LSO 38.6 Plan strategies to out beat Competition LSO 38.7 Plan Team LSO 38.8 Explain feasibility	38.	Presentation for a Pitch Deck.	CO4, CO5
LSO 39.1 Plan the different requirements in the presentation LSO 39.2 Probe the possibilities of using 3D, animations, AV & other media in the presentation LSO 39.3 Scrutinise the effectiveness LSO 39.4 Prepare the presentation	39.	3D & Multimedia presentations.	CO4, CO5
LSO 40.1 Plan the matter for portfolio LSO 40.2 Plan the number of pages LSO 40.3 Select the important work that needs to be shown LSO 40.4 Prepare artwork LSO40.5 Design Cover	40.	Portfolio presentations.	CO4, CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 41.1 Select the important matter that needs to be on the card LSO 41.2 Plan the layout for the card LSO 41.3 Prepare the artwork for the card LSO 41.4 Create hyperlinks for the phone number & address for quick contact	41.	E Visiting cards	CO4, CO5
LSO 42.1 Select the important matter that needs to be on the invite LSO 41.2 Plan the layout for the invite LSO 42.3 Plan the number of pages for the invite LSO 421.4 Prepare the artwork for the invite LSO 42.5 Create hyperlinks for the phone number & address for quick contact	42.	E invites	CO4, CO5
LSO 43.1 Select the important matter that needs to be presented LSO 43.2 Plan the presentation with respect to design & overall look LSO 43.3 Prepare the artwork LSO 43.4 Create hyperlinks wherever required	43.	E presentations	CO4, CO5
LSO 44.1 Plan the show with respect to theme & backdrop LSO 44.2 Plan the rounds LSO 44.3 Plan the participant models LSO 44.4 Plan the number of outfits per round LSO 44.5 Decide the clothes as per round & the model LSO 44.6 Prepare artwork LSO 44.7 Add animation to simulate the show	44.	Simulating a fashion show using 3D	CO4, CO5

L) Suggested Term Work and Self Learning: S2452503A

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted CO's.

1. Students will edit one of their pictures & change the outfit worn, background & also enhance their looks.
2. Students will Download two 3D printing free software and try to check their compatibility with the lab printer if available.
3. Students will make an e visiting card for themselves or for their friends.

b. Micro Projects:

1. Survey on the advanced software available for garment making.
2. A project given on DBMS where students create, modify data, store & retrieve data.
3. Tech pack presentation-Compilation of artwork with stitch detailing, color variation & fabric variation on the standard tech pack. Each student given a different garment which are not from the ones already done in lab.

4. Students will edit one of their pictures & change the outfit worn, background & also enhance their looks.
5. Students will Download two 3D printing free software and try to check their compatibility with the lab printer if available.
6. Students will make an e visiting card for themselves or for their friends.

c. Other Activities:

1. Seminar Topics:
   - Commercially available 3D printers and software.
   - Students will present portfolios made for themselves & explain what is unique in their portfolio & key factors that will make people hire them.
   - Students will prepare a pitch deck for a imaginary business proposal & convince to invest in their project

2. Visits: Visit nearby tool room/industry with 3D Printing facilities. Prepare report of visit with special comments of 3D printing technique used, material used, single component/batch production/mass production and cost of printed component.
   - Visit to a garment factory to see what software they are using for various activities

3. Self-Learning Topics:
   - 3D printing of flexible plastic components.
   - Animation in presentations
   - Learn one latest software & check possibility of using it for garment manufacturing
   - Make all label for a garment with price code/Learn coding online
   - Work on Adobe Illustrator

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	40%	40%	15%	30%	20%	10%	15%
CO-2	10%	10%	10%	20%	20%	15%	20%
CO-3	10%	10%	15%	20%	25%	25%	20%
CO-4	10%	10%	30%	-	15%	25%	20%
CO-5	30%	30%	30%	30%	20%	20%	25%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:
*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
#: Mentioned under point-(O)

Note:
- The percentages given are approximate.

- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Use of Advanced Software for Design & Data in Apparel Industry. 3 D Modelling	12	CO1	28	8	8	12
Unit-2.0 Tech Pack	8	CO1, CO2	07	2	3	2
Unit-3.0 Digital Fashion Illustrator & Photoshop	8	CO3, CO4	07	2	3	2
Unit-4.0 BOM	8	CO3, CO4	07	2	3	2
Unit-5.0 Presentations Using Advanced Software	12	CO4, CO5	21	5	8	8
Total	**48**	**-**	**70**	**19**	**25**	**26**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested AssessmentTable for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	3D modelling	CO1	30	60	10
2.	Fabric Mapping	CO1	30	60	10
3.	Order Concentration	CO1	40	50	10
4.	Order form	CO1	40	50	10
5.	Layout of factory	CO1	40	50	10
6.	Layout of production	CO1	40	50	10
7.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes for Men's wear- Shirt/ Blazer	CO1, CO2	30	60	10
8.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes for Men's wear- Shorts/ Trouser	CO1, CO2	30	60	10
9.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes For Women's wear -Skirt	CO1, CO2	30	60	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
10.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes For Women's wear - Top/ Kurta, Dress/ Gown	CO1, CO2	30	60	10
11.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes For Children's wear - Jeans	CO1, CO2	30	60	10
12.	Spec sheet with flat sketch creation with stitch specification, component description, color variation & detailing, zoom in design details & description for all finishes For Women's wear -Skirt, Top/ Kurta, Dress/ Gown For Children's wear -T-Shirt/ Hoody, Jeans, Romper/Jumper	CO1, CO2	30	60	10
13.	Tools of Digital fashion Illustrator. -Duplicating & Cloning.	CO3, CO4	30	60	10
14.	Trace & create Fashion poses- Male	CO3, CO4	30	60	10
15.	Design Logos in Digital fashion Illustrator.	CO3, CO4	30	60	10
16.	Create tags in Digital fashion Illustrator.	CO3, CO4	30	60	10
17.	Create labels in Digital fashion Illustrator.	CO3, CO4	30	60	10
18.	Render fabric with Photoshop. Gradient use in rendering	CO3, CO4	30	60	10
19.	Create fashion croquis in Photoshop. Manipulate fashion model drawings in Photoshop	CO3, CO4	40	50	10
20.	Drape garments on Men, women & children's croquis	CO3, CO4	40	50	10
21.	Edit pictures. Enhance images using Photoshop. Mask with Photoshop. Transform images in Photoshop. Layers in Photoshop-merge & blend layers	CO3, CO4	30	60	10
22.	Create Artwork for Marketing & Advertising in Photoshop	CO3, CO4	30	60	10
23.	Design Collages.	CO3, CO4	30	60	10
24.	Apply filters in photoshop	CO3, CO4	30	50	20
25.	Create Mood boards in Photoshop	CO3, CO4	30	60	10
26.	Create Theme boards in Photoshop	CO3, CO4	30	60	10
27.	Create color & texture boards in Photoshop	CO3, CO4	30	60	10
28.	Prepare Main label & Size Label	CO3, CO4	30	60	10
29.	Prepare Content label & Country of origin label	CO3, CO4	30	60	10
30.	Prepare Wash care Label	CO3, CO4	30	60	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
31.	Prepare Hand tags with details on Type of product & Description, Supplier, Reference Code, Finish, Content, Weight, Construction, Color, Size	CO3, CO4	30	60	10
32.	External presentation of a Garment Industry	CO4, CO5	30	60	10
33.	Internal presentation of a Garment Industry	CO4, CO5	30	60	10
34.	Plan a computer-generated presentation for an event	CO4, CO5	30	60	10
35.	Presentation for a look book	CO4, CO5	30	60	10
36.	Presentation of a Catalogue	CO4, CO5	30	60	10
37.	Create a Brochure	CO4, CO5	30	60	10
38.	Presentation for a Pitch Deck.	CO4, CO5	30	60	10
39.	3D & Multimedia presentations.	CO4, CO5	30	60	10
40.	Portfolio presentations.	CO4, CO5	30	60	10
41.	E Visiting cards	CO4, CO5	30	60	10
42.	E invites	CO4, CO5	30	60	10
43.	E presentations	CO4, CO5	30	60	10
44.	Simulating a fashion show using 3D	CO4, CO5	30	60	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	High end computers	Processor Intel Core i7 with Open GL Graphics Card, RAM 32 GB, DDR3/DDR4, HDD 500 GB, Graphics Card NVIDIA OpenGL 4 GB, OS Windows 10	All
2.	Parametric Computer Aided Design software	CATIA/Solid works/NX/Creo	01
3.	3D printer	Fused Deposition Modelling system with complete accessories; Build Volume-300 x 300 x 300mm or Higher; Layer Thickness-0.1 – 0.4	01
4.	3D Printing Material	ABS/PLA **OR** Available with C o E	01
5.	3D Printing software	Latest version of software like: Cura/Prusa Slicer/idea Maker/Mesh mixer/MeshLab	01
6.	Post processing equipment and tools	Deburring tools (tool handle & deburring blades), Electronic Digital Caliper, Cleaning Needles, Art knife set, Long nose pliers, Flush cutters, Wire brush, Nozzle cleaning kit, Tube cutter, Print removal spatula, Needle file, Cutting mat, Glue stick, Wire stripper etc.	01
7.	3D Scanner and Processing software	Handheld 3D scanner, Accuracy up to 0.1 mm, Resolution up to 0.2 mm, Real time onscreen 3D model projection and processing, Wireless technology with an inbuilt touch screen and battery, Extended field of view for capturing both large and small objects, Processing Software	01
8.	Photoshop	Latest version	02, 07 to 12, 18 to 27
9.	Illustrator	Latest version	13 to 17
10	Reach CAD solutions	Reach fashion Studio, Reach merchandising Manager, Reach Style Manager	03 to 06
11	Tech Pack	Latest version	07 to 12
12	BOM	Latest version	28 to 31
13	Virtual Fashion Basic	Latest version	20,35,44
14	Story Board Creator	Latest version	35 to 44
15	Other latest software		For all

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	CAD/CAM Computer aided design & manufacturing	Mikell P. Groover & E. Zimmers	Pearson Education, Year 2003 ISBN: 9788177584165
2	CAD/CAM/CIM Computer aided design & manufacturing	R. Radhakrishnan, S. Subramanyam, V. Raju	New age International Publishers 3rd Edition ISBN: 13 9788122427110
3	Fashion Design on Computers	M. Kathleen Colussy	Publisher: Pearson, Year 2000 SBN-10: 0130838381 ISBN-13: 978-0130838384
4	CAD in Clothing	Winfred Aldrick	Blackwell Science, 2nd Edition SBN-10: 0632038934 ISBN-13:978-0632038930

5	3D PRINTING DESIGN: ADDITIVE MANUFACTURING AND THE MATERIALS REVOLUTION	Francis Bitonti (Author)	Bloomsbury Visual Arts, Year 2019 SBN-10: 1474220967 ISBN-13: 978-1474220965
6	3D Printing and Rapid Prototyping- Principles and Applications	C.K. Chua, Kah Fai Leong	World Scientific, 2017 ISBN: 9789813146754
7	Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution	Liza Wallach Kloski, Nick Kloski	Make Community, LLC; 2nd edition, 2021 ISBN: 9781680450200
8	The Fashion Design reference & specification Book. Everything fashion designers need to know everyday,	Jay Calderin & Laura Volpintesta	Rockport Publishers Illustrated edition (Year 2013) ISBN-10 : 1592538509 ISBN-13 : 978-1592538508
9	The Spec Manual	Diane DeMers & Michele Wesen Bryant	Bloomsbury Publications 2nd Edition ISBN-10 : 1563673738 ISBN-13 : 978-1563673733
10	3D Printing & Design	Dr. Sabrie Soloman	Khanna Publishing House 1st edition ASIN : B08KPLCG2L

(b) Online Educational Resources:

1. https://g.co/kgs/w74ucW
2. https://onlinecourses.nptel.ac.in/noc21_me115/preview
3. https://www.youtube.com/watch?v=b2Od4YHcLAQ
4. https://www.dymocks.com.au/book/technical-sourcebook-for-apparel-designers-by-lee-jaeil-lee-and-steen-camille-steen-9781501328411
5. https://www.youtube.com/watch?v=EF8CNR-gcXo
6. https://www.academia.edu/41439870/Education_Resources_for_3D_Printing
7. https://www.think3d.in/landing-pages/beginners-guide-to-3d-printing.pdf
8. https://all3dp.com/1/types-of-3d-printers-3d-printing-technology/
9. https://www.sculpteo.com/en/3d-learning-hub/3d-printing-software/best-cad-fashion-design-software/
10. https://www.g2.com/categories/apparel-design

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Implementation Of Garments Production Operating System Software With Interconnection Technology & Smart Computer Devices In A Textile Industry By Industry 4.0 Concept. December 2021
2. 3D Printing Projects DK Children; Illustrated edition, 2017
3. The 3D Printing Handbook: Technologies, design and applications Ben Redwood, Filemon Schöffer, Brian Garret, 3D Hubs; 1st edition, 2017
4. HANDBOOK OF PRODUCTION SCHEDULING, by JEFFREY W. HERRMANN
5. Production Planning Software for Garment Manufacturing - An overview By Prasanta Sarkar- December 07, 2011

******

A) Course Code : **2452503B (T2452503B/P2452503B/S2452503B)**

B) Course Title : Smart Textiles

C) Pre- requisite Course(s) :

D) Rationale :

Textiles have been used in our daily life since antiquity in both economies and social relationships. Nowadays, Smart textiles can be described as textiles that are able to sense stimuli from the environment, to react to them and adapt to them by integration of functionalities in the textile structure. The stimulus as well as the response can have an electrical, thermal, chemical, magnetic or other origin. This course on Smart Textiles tries to develop understanding of the process of making smart textiles in the students. It also covers fabrication methods, various materials used, product applications. The knowledge gained through this course will help the students to take up advanced courses in future.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1 Characterize materials used in smart fabrics and clothing.
CO-2 Select appropriate manufacturing method for different smart textiles.
CO-3 Identify smart and intelligent textiles for high protection and comfort properties in various fields.
CO-4 Analyze requirements of smart clothing in day today activities.
CO-5 Explore new materials and attempt to design garments using smart textiles based on the requirements.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	-	3	3	-	-	3		
CO-2	3	2	-	3	-	-	-		
CO-3	3	3	-	3	3	-	-		
CO-4	3	3	-	3	3	3	3		
CO-5	3	-	3	3	-	3	3		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2452503B	Smart Textiles	02	01	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment(TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2452503B	Smart Textiles	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2452503B

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain Smart Textiles and related terminologies. *TSO 1b.* Describe history and need of smart textiles and need of smart fabrics in present era. *TSO 1c.* Classify Smart Textiles used in general and specific to fashion industry. *TSO 1d.* List typical components of smart textile systems. *TSO 1e.* Explain difference between Smart and Intelligent textiles	**Unit-1.0 Introduction to Smart Textiles** 1.1 History of Smart Textiles. 1.2 Basic Definition of smart fabric textiles 1.2.1Smart Materials 1.2.2 Smart textile materials. 1.2.3. Smart Textiles 1.3 Classification of Smart Fabric Textiles in general and fashion industry 1.3.1. Passive smart fabric Textiles 1.3.2. Active smart fabric textiles. 1.3.3. Advanced smart fabric textiles 1.3.4, Aesthetic Smart Textiles 1.3.5 Performance Smart Textiles 1.4 Components of Smart textile System Fibers, Yarns, fabrics, Chemicals. 1.5 Intelligent textiles. Definition, Comparison between Intelligent and Smart Textiles.	**CO1**
TSO 2a. List the Basic functions of Smart textiles *TSO 2b.* Describe the basic functions of smart textiles in detail *TSO 2c.* Describe working of sensors, Acuators *TSO 2d.* Describe data processing, storage and communicators in detail. *TSO 2e.* Describe functions of Conductive and Shape memory polymer and their application in manufacturing of intelligent fabrics. *TSO 2f.* Explain the functions of photosensitive materials and application methods in smart textiles *TSO 2g.* Describe method of inserting Phase changing materials. *TSO 2h.* Describe induction of Electronic sensors in to the textiles. *TSO 2i.* Review recent developments in fabrication materials used in manufacturing of smart textiles.	**Unit-2.0 Basic Functions, Fabrication Materials used in Manufacturing of Smart Textiles** 2.1 Basic Functions 2.1.1. Sensors 2.1.2 Data Processing 2.1.3. Actuators 2.1.4. Storage 2.1.5. communicators 2.2 Fabrication Materials used in manufacturing of smart textiles. 2.2.1. Conductive Polymers 2.2.2. Shape memory Polymers 2.2.3 Chemical Responsive Polymers 2.2.4. Photosensitive Materials 2,2.5. encapsulated phase changing materials 2.2.6. Electronic sensors. 2.2.7. Micro Nano materials. 2.3 Recent developments in fabrication materials used for manufacture of smart textiles	**CO1, CO2**
TSO 3a. List the fabrication Methods of Smart and Intelligent textiles *TSO 3b.* Explain the fabrication weaving and Knitting Technology *TSO 3c.* Explain the method of Embroidery and Lamination and stitching techniques in smart textiles. *TSO 3d.* Describe the concept and making smart color changing textiles, and temperature controlling fabric Textiles. *TSO 3e.* Describe concept of shape memory fabric, fabrication method.	**Unit-3.0 Fabrication Methods and Types of Smart Textiles** 3.1 Fabrication methods of Yarns, and Fibers 3.1.1 Weaving Technology 3.1.2 Knitting technology. 3.1.3 Embroidery. 3.1.4 Lamination 3.1.5 Stitching 3.2 Types of Smart Textiles and methods of making them. 3.2.1 Smart Colour-Changing Fabric Textile	**CO3, CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3f. Describe concept of waterproof and Breathable textiles construction method of same. *TSO 3g.* Explain the concept of wearable electronic smart textiles and phase changing textiles and performance of these textiles.	3.2.2 Temperature-Controlling Fabric Textiles 3.2.3 Shape Memory Fabric Textiles 3.2.4 Waterproof and Breathable Fabric Textiles 3.2.5 Wearable Electronics Smart Textile 3.2.6 Phase-Changing Textiles.	
TSO 4a. Describe applications of smart textiles in Medical and Health care segment. *TSO 4b.* Describe applications of smart textiles in Sports... *TSO 4c.* Describe applications of smart textiles in Transportation and road, Building Construction *TSO 4d.* Describe applications of smart textiles in Defense *TSO 4e.* Describe applications of smart textiles in Home Automation. *TSO 4f.* Describe applications of smart textiles in Space *TSO 4g.* Describe applications of smart textiles in Agricultural and Geological activities. *TSO 4h.* Describe applications of smart textiles entertainment Field.	**Unit-4.0 Application Smart and Intelligent Textiles** **Applications of Smart Textiles in,** 4.1 Medical and Health care field 4.2 Sports 4.3 Transportation and road 4.4 Defense 4.5 Home Automation 4.6 Space 4.7 Building Construction 4.8 Agriculture 4.9 Entertainment field. 4.10 Geological Field	**CO3, CO4**
TSO 5a. Explain the use of smart textiles in different areas of fashion. TSO 5b. List the companies producing smart clothing. TSO 5c. List out Clothing manufactured by different companies. TSO 5d. Analyze the difference between each garments and techniques used in manufacturing of smart clothing. TSO 5e. Compare the properties of smart garments produced by different companies. TSO 5f. Examine the new components used in manufacturing of smart clothing and textiles.	**Unit-5.0 3D Smart and Intelligent Textiles in Fashion Industry. Companies producing smart clothing** 5.1 Use of Smart textiles in Fashion 5.1.1 Aesthetic use 5.1.2 Performance enhancement 5.1.3 Interaction 5.1.4. Chameleonic textiles 5.2 Companies Producing Smart Clothing 5.2.1 Cute Circuit 5.2.2 AiQ Smart Clothing (Taiwan) 5.2.3 Athos (U.S.) 5.2.4 Carre Technologies (Canada) 5.2.5 Sensoria (U.S.) 5.2.6 Clothing Plus (Filand) 5.2.7 Cityzen Sciences (France) 5.2.8 Vulpes Electronics (Japan) 5.2.9 DuPont (U.S.) 5.2.10 Wearable X (U.S.) 5.2.11 Applycon (Czechia) 5.2.12 Toray Industries (Japan) 5.2.13 Myontec (Finland) 5.2.14 Myzone (U.S.) 5.2.15 Siren (U.S.) 5.2.16 Owlet (U.S.)	**CO4, CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2452503B

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Identify the components required for manufacturing of smart Textiles. LSO 1.2. Use the sensors and components as per its functionality.	1.	Create collage sheets on components of smart Textiles.	CO1
LSO 2.1. Surf web for downloading research article LSO 2.2. Review the article by group discussion and write summary of the same	2.	Research article review on History of Smart Textiles.	CO1, CO2
LSO 3.1. Identify field of interest. LSO 3.2. Design garments with full descriptions. LSO 3.3. Specify construction method and functionality of the Garments.	3.	Design 2 Garments using conductive polymer finished smart fabric for field of your choice.	CO1, CO2, CO3
LSO 4.1. Identify the components required for the experiment. LSO 4.2. Identify Method of testing LSO 4.3. Analyze the results and distinguish the differences.	4.	Test durability of different samples of shape Memory fabrics.	CO2, CO3
LSO 5.1 Identify the theme LSO 5.2 Design garment based on selected theme LSO5.3 Identify the components required for developing e garment. LSO 5.3 Integrate the components in to the Garment for the required application.	5.	Develop a e garment based on theme.	CO1, CO2, CO5
LSO 6.1 Predict the area to work on. LSO 6.2 Identify the components required for the experiment. LSO 6.3 Design the products based on end use. LSO 6.4 construct the design created.	6.	Design household products using smart fabric	C01, CO2, C03, C04, CO5
LSO 8.1. Develop a tool for survey. LSO 8.2. Identify the target group. LSO 8.3. Use survey tool for gathering information. LSO 8.4. Interpret the results.	7.	Survey on use of Smart fabrics in Medical field/Sports/Defence	CO1, C03, C04
LSO 8.1 List out the garments manufactured by different companies. LSO 8.2 Identify the type of smart fabric used in the garments LSO 8.3 Classify garments according to type. LSO 8.4 Compare the characteristics and record.	8.	Compare characteristics of smart garments manufactured by different companies	C03, C04, C05
LSO 9.1Identify the Components required for incorporating in the design	9.	Design 4 garments based on theme using smart fabrics.	CO5, CO3, CO4,

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 9.2 Integrate the components for the required application.			
LSO 10.1 Develop a tool for survey LSO 10.2 Identify the target group LSO 10.3 Use survey tool for gathering information. LSO 10.4 Interpret the results	10.	Survey on use of Smart fabrics in Construction (Road, Building, etc.)/Agriculture and Geological field.	CO5, CO3, CO4
LSO 11.1 Identify the accessories to be created. LSO 11.2 Identify the methods of making color changing Textiles. LSO 11.3 Design the range of products. LSO 11.4 Prepare one of the Accessory from the range created.	11.	Create a range of Fashion Accessories using Color Changing Textiles.	CO5, CO3, CO4

L) Suggested Term Work and Self Learning: S2452503B

Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions//Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Nanotechnology in sportswear industry-a review of current trends and future applications
2. Download 3 videos on functioning of smart textiles, watch them and write a report to detail the steps involved, Method of manufacturing, used, materials used, complexity involved, their performance and durability of the fabric etc.,
3. The Next Generation electronic textiles.

c. Other Activities:

1. Seminar Topics:
    - Commercially available Machineries used in Manufacture of Smart textiles/Garments.
    - Developing Stimuli Sensitive Polymers for breathability applications.
    - Future of Smart Textiles
    - Smart Textiles- New possibilities in textile engineering.

2. Visits: Visit nearby /textile industry with smart fabric/ garment manufacturing facilities. Prepare report of visit with special comments of smart clothing technique used, materials used, single component/batch production/mass production and cost of smart textile/ Garments.

3. Self-Learning Topics:
    - Computing textiles
    - Machinery involved in Manufacturing of smart textiles

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work& Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	-	-	20%	20%
CO-2	10%	10%	10%	25%	-	10%	20%
CO-3	15%	15%	15%	25%	33%	15%	20%
CO-4	30%	30%	30%	25%	33%	15%	20%
CO-5	30%	30%	30%	25%	34%	40%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Smart Textiles	8	CO1	10	3	3	4
Unit-2.0 Basic Functions, fabrication Materials used in Manufacturing of Smart Textiles	12	CO1, CO2	8	3	2	3
Unit-3.0 Fabrication Methods and Types of Smart Textiles	8	CO3, CO4	10	5	2	3
Unit-4.0 Application of smart and Intelligent textiles.	8	CO3, CO4	21	5	7	9
Unit-5.0 Smart and Intelligent Textiles in Fashion Industry. Companies Producing Smart Clothing	12	CO4, CO5	21	4	6	11
Total	**48**	**-**	**70**	**20**	**20**	**30**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested AssessmentTable for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Design collage sheets on components of smart Textiles	CO1	30	60	10
2.	Research article review on History of Smart Textiles.	CO1, CO2	40	50	10
3.	Design 2 Garments using conductive polymer finished smart fabric for field of your choice.	CO1, CO2, CO3	30	60	10
4.	Test durability of different samples of shape Memory fabrics.	CO2, CO3	40	50	10
5.	Develop a" e garment" based on theme.	CO1, CO2, CO5	30	60	10
6.	Design household products using smart fabric	C01, CO2, C03, C04, CO5	30	60	10
7.	Survey on use of Smart fabrics in Medical field/Sports/Defence	CO1, C03, C04	60	30	10
8.	Compare characteristics of smart garments manufactured by different companies.	C03, C04, C05	45	45	10
9.	Design 4 garments based on theme using smart fabrics.	CO5 CO3, CO4,	30	60	10
10.	Survey on use of Smart fabrics in Construction (Road, Building, etc.)/Agriculture and Geological field.	CO1, C03, C04	40	50	10
11.	Create a range of Fashion Accessories using Color Changing Textiles	CO2, CO3, CO5	50	40	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	High end computers	Processor Intel Core i7 with Open GL Graphics Card, RAM 32 GB, DDR3/DDR4, HDD 500 GB, Graphics Card NVIDIA OpenGL 4 GB, OS Windows 10	All
2.	Bursting strength tester	As per requirement of textile testing laboratory	04

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Wearable, Smart Textiles and Smart Apparel	Paret Dominique and Pierre Crego,	ISTEb Press- Elsevier November 27,2018 Hardback ISBN: 9781785482939 ebook ISBN9780081027646
2.	Smart Textiles for protection	R. Chapman	Woodhead Publishing First edition, 2012 Hard book ISBN:9780857090560 eBook ISBN:9780857097620
3.	Smart textile production. Over view of materials, sensors and Production Technologies for Industrial smart Textiles	Inga Gehrke, Vadim Tenner, Volker Lutz, David Schmelzeisen, Thomas Gries	Published April2019, ISBN: 9783o38970(Hard Back) ISBN 9783038974987(PDF)
4.	Smart textiles and their applications	Valdan Koncar	Woodhead publishing Published April2016 ISBN: 9780081005743 ISBN:9780081005835
5	Advances in Smart Medical Textiles	Lieva van Langenhove	Woodhead publishing December 2015 Hardback ISBN:9781782423799 eBook ISBN: 9781782424000
6	Electronic Textiles Smart Fabrics and Wearable Technology	Tilak Dias	Woodhead Publishing April 2015 Hard back ISBN:9780081002018 eBook ISBN:9780081002230
7	Functional and Technical Textiles	Shubhankar Maity, Kunal Singh, Pintu Pandit	Woodhead Publishing, Januvary2023 Paperback ISBN:9780323915939 eBook ISBN:9780323915946
8	Smart Fibers, Fabrics and Clothing	Xiaoming Tao	October2001 Hardback ISBN:9781855735460 eBook ISBN:9781855737600
9	Nano Sensors and Nano devices for Smart Multifunctional Textiles	Andrea Ehrmann, Tuan Anh Nguyen, Phuong Nguyen Tri	Elsevier, September 2020 Paperback ISBN: 9780128207772 eBook ISBN: 9780128209417
10	Textiles for Sports Wear	Roshan Shishoo	Woodhead Publishing **May 2015** **Hardcover:** 978-1-78242-229-7 **eBook :**978-1-78242-236-5
12	Advances in the Dyeing and Finishing of Technical Textiles	M. L. Gulrajani	Woodhead Publishing Published: February 8, 2013 Hardback ISBN: 9780857094339 eBook ISBN: 9780857097613

(b) Online Educational Resources:

1. https://youtu.be/jDqi5cAiuVI
2. https://youtube.com/shorts/qjOMeEvGZDo?feature=share
3. https://youtu.be/PdN6ZA7X8Oc
4. https://youtu.be/b_AjmLX3t3A
5. https://youtu.be/BEB8iR3SOEU
6. https://youtu.be/uFB9cBgcomc
7. https://youtu.be/4dEhjfSGxjc
8. https://youtu.be/NvPl8ytEe3Q
9. https://youtu.be/TNcDXKQNOoM
10. https://youtu.be/LKHt2hRmVZY

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Lab Manuals
2. Technical textile Journals
3. Fashion and clothing Journals

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A) Course Code **: 2452503C (T2452503C/P2452503C/S2452503C)**

B) Course Title **:** Apparel Merchandising

C) Pre- requisite Course(s) **:**

D) Rationale **:**

The Apparel Industry is growing at a fast pace & specialization is required in each job. Buyers expect professionalism & a merchandiser can understand their needs & fulfil them. One needs skills for handling customers & their problems & merchandisers are trained in acquiring those skills. From design to sourcing to costing to manufacturing, finishing, packing & dispatch, a merchandiser is required to complete orders with high efficiency. Production, planning & control is essential in Apparel business. Skills in Apparel merchandising can fetch jobs & place students as merchandisers in Factories or retail outlets or at e-commerce sites.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Adopt the concepts of fashion & merchandising.
CO-2 Adopt new marketing strategies required for fashion merchandiser.
CO-3 Apply merchandising skills for effective production.
CO-4 Practice retail sale strategies to increase sales, achieve targets of profitability.
CO-5 Prepare documents as required for aapparel Merchandising.

F) Suggested Course Articulation Matrix (CAM):

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** Lifelong Learning	**PSO-1**	**PSO-2**
CO-1	3	1		3	-	-	2		
CO-2	3	-	-	3	1	-	3		
CO-3	3	3	3	3	3	2	2		
CO-4	3	2	1	3	2	-	2		
CO-5	3	2	-	3	2	-	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2452503C	Apparel Merchandising	02	01	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2452503C	Apparel Merchandising	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills,

Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2452503C

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Differentiate between fashion & merchandising. TSO 1b. Analyze their dependency on fashion & merchandising. TSO 1c. Distinguish Retail Merchandising from factory Merchandising & from other forms of Merchandising. TSO 1d. Exhibit the products as a Visual merchandiser to attract customers. TSO 1e. Plan on a micro & macro level merchandising. TSO 1f. Recognize the prevailing fashion trends. TSO 1g. Plan production as per the fashion trends. TSO 1h. Interpret short-term & long-term fashion cycles. TSO 1i. Enquire with the consumers to find out their requirements. TSO 1j. Arrange supply as per demand. TSO 1k. Measure the effectiveness of various distribution channels. TSO 1l. Adopt suitable distribution channels. TSO 1m. Choose from the channels of Sales promotion for effective marketing. TSO 1n. Select suitable media of advertising. TSO 1o. Arrange events for publicity & marketing. TSO 1p. Adopt new marketing strategies to attract customers	**Unit 1.0 Introduction** 1.1 Introduction to Fashion and Merchandising, their definitions & their inter-relation. 1.2 Difference between Retail Merchandising, Factory Merchandising, Visual Merchandising & Merchandising for E Commerce/ magazines/ Mail orders. 1.3 Use of a merchandiser for Garment Industry 1.4 Micro Vs Macro Merchandising 1.5 Fashion terms like Classic, Fad, Style, Vogue, Trend, Contemporary, Pret, Houte Couture, Status symbols, etc. 1.6 Fashion cycle. Trickle up & trickle down fashion & trickle across fashion. 1.7 Influences on Fashion Merchandising like Trends, Economic influence, Global influence, technological influence & Consumer Demand 1.8 Marketing Chain/ Distribution channel from Manufacturer to consumer. Includes Wholesaler, retailer, agent, etc 1.9 Sales promotion – channels of sales promotion like Advertising, personal selling, direct marketing & publicity 1.10 New marketing strategies	**CO1, CO2, CO3**
TSO 2a. Plan production with the help of Charts TSO 2b. Foresee bottlenecks. TSO 2c. Adopt preventive measures. TSO 2d. Plan on a Micro & Macro Level TSO 2e. Develop a Tech pack. TSO 2f. Follow given Tech packs. TSO 2g. Source the required raw materials. TSO 2h. Survey the market for raw materials. TSO 2i. Conduct market surveys for suitability of product	**Unit 2.0 Fashion Merchandiser** 2.1 Follow up from design to dispatch with the help of Production planning chart & Block planning charts. 2.2 Control in Production. Foreseeing and avoiding bottlenecks 2.3 Spec sheet/ Tech pack. How to follow specifications 2.4 Sourcing -Importance of Sourcing 2.4.1 Sources of sourcing like books, magazines, travel, fairs, Internet, existing suppliers, Stock lot dealers, etc. 2.4.2 Factors to consider while sourcing like price, demand & supply, distance, time requirement, transportation charges 2.4.3 Types of sourcing- outsourcing, In-sourcing, global, national & zonal sourcing, single, multi & open sourcing, Qualitative, Quantitative & strategic sourcing. 2.5 Survey.	**CO2, CO3, CO5**
TSO 3a. Employ effective communication skills in talking to buyers/ Consumers TSO 3b. Write official letters.	**Unit– 3.0 Merchandising Skills**	**CO3, CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3c. Develop Contacts. TSO 3d. Identify Customer Needs. TSO 3e. Solve production problems TSO 3f. Plan production as well as display TSO 3g. Organize product displays TSO 3h. Incorporate Quality consciousness in employees TSO 3i. Predict the fashion trends TSO 3j. Evaluate Collection. TSO 3k. Develop vision & Mission statements	3.1 Communication including Business Correspondence, Confidence, Persuasion, Business connections/contacts, Co-ordination, Team spirit, Identifying customer needs using SPIN technique, After sales service, Sincerity & Commitment, Positive attitude, Problem solving using techniques such as Seam technique & Role play, Creativity using some techniques, Learning, Planning & Organizing, Quality consciousness, Fashion Forecasting based on market research, trends & evaluation of collections, making Mission & Vision statements, planning Horizons, etc.. 3.2 Understanding & developing these skills.	
TSO 4a. Compare the past & present requirements in Retailing TSO 4b. Predict future trends in Retailing TSO 4c. Discover new markets TSO 4d. Classify different Clothing segments in Retail TSO 4e. Impact of Demand & Supply on pricing as well as sales TSO 4f. Propose ideas to run an outlet profitably TSO 4g. Recommend purchase based on speculation & market changes TSO 4h. Evaluate the various strategies for selling TSO 4i. Adopt the most effective strategies. TSO 4j. Formulate new strategies for sales TSO 4k. Change customer perceptions in Branding. TSO 4l. Examine the role of wholesalers in retail. TSO 4m. Set up a store or rearrange an existing space utilization. TSO 4n. Design a window display	**Unit 4.0 Retail Outlets** 4.1 Introduction to fashion retailing. Changing dimensions- past, present & future trends. Retailing in the past. First few important retail stops. Growth of retail & causes & conditions for expansion & growth. 4.2 Retail Market. Definition of market. Market based on area like local, Regional, National & international/Global market, age like Child, teenager, adult & senior citizen as consumer, income like low income, lower middle class, higher middle class, Rich, etc. 4.3 Clothes for retail. 4.4. Demand & Supply. Their effect on the business 4.5 Starting & running a retail outlet profitably. 4.6 Retail buying & selling. Specification buying. 4.7 Strategies of selling like discount sales, edited retailing, Tele marketing, mail order, Internet, concessionaires/ shops within shops, franchising, MLM & network marketing. 4.8 Retail branding. Building a brand 4.9 Types of retail stores- Departmental stores, Shopping Centers, specialty stores, boutiques, Discount clothing stores, franchise outlets. Multiple chain stores & variety chain stores, supermarkets, malls, hyper malls etc. 4.10 Role of Wholesalers in Retail 4.11 Value edited retailing& service-oriented retailing 4.12 Visual Merchandising- Elements of visual merchandising. Planning of retail stores- space planning, Display area planning. Designing- windows & interiors. Seasonal planning.	**CO2, CO4**
TSO 5a. Create a Company profile TSO 5b. Rewrite an existing profile as per changes in demand. TSO 5c. Detect critical clauses in a tender. TSO 5d. Differentiate between Tender & Quotation. TSO 5e. Scrutinize an order form. TSO 5f. Prepare Invoices	**Unit 5.0 Documentation** 5.1 Making a company profile. Important points 5.2 Quotations & Tenders. 5.3 Order form 5.4 Invoices- Proforma, final & Consular. 5.5. Delivery Challans.	**CO3, CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 5g. Prepare Challans TSO 5h. Investigate the success of a firm with a merchandising audit. TSO 5i. Infer the strength & weaknesses of the company with a SWOT analysis TSO 5j. Prepare a Marketing calendar based on events TSO 5k. Prepare the schedules & routing of consignments with the freight agents TSO 5l. Use Documentation agents for preparation of Documents as required	5.6 Merchandising Audit 5.7 SWOT analysis 5.8 Design development-elements, principles, line selection, merchandising plan for the design 5.9 Product development- appeal to consumers, target market product development plan 5.10 Marketing calendar 5.11 Working with document agents and freight forwarders.	

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2452503C

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Analyze the different channels of distribution LSO 1.2 Estimate the cost factor in adopting each LSO 1.3 Hypothesize the time requirement LSO 1.4 Develop your own plan.	1	Develop a Marketing Chain/ Distribution channel to suit different fashion products	CO3, CO4, CO5
LSO 2.1 Prepare an advertisement for a newspaper keeping in mind the column size & cost. LSO 2.2 illustrate an advertisement for magazine. LSO 2.3 Simulate a Radio / TV/ movie advertisement. LSO 2.4 Prepare an advertisement for Internet LSO 2.5 Prepare an advertisement for a hoarding LSO 2.6 Compare the effectiveness of each media with respect to cost, efforts, consumer response & effective sales.	2	Illustrate/ dramatize/ Simulate an Advertisement for different media like newspaper, magazine, radio, mobile app, T.V, movie, internet, hoarding, etc. (Different students given different topic & then asked to present).	CO3, CO5
LSO 3.1 Brainstorm to find new strategies. LSO 3.2 Plan strategies for personal selling/ direct marketing & publicity LSO 3.3 Make Groups & work in teams LSO 3.4 Organize strategies in order of effectiveness LSO 3.5 Examine each strategy for effectiveness LSO 3.6 Contrive a strategy that will work	3	Brainstorm to find new Planning strategies for personal selling, direct marketing & publicity (Students will work in groups for each & then make presentation).	CO3, CO5
LSO 4.1 Hypothesize the problems that can occur LSO 4.2 Find solutions to probable problems. LSO 4.3 Calculate the number of days required for Cutting, stitching, finishing & packing LSO 4.4 Plan Production LSO 4.5 Schedule the entire production LSO 4.6 Conclude the date of delivery after deliberating on the schedule for production. LSO 4.7 Arrange the orders in the way they can be taken up depending on which raw materials will reach first.	4.	Prepare a Production Planning Chart (for 3 to 5 orders simultaneously working)	CO2, CO3, CO5
LSO 5.1 Scrutinize the orders in hand LSO 5.2 Compare it to the production capacity LSO 5.3 Plan orders on a macro level.	5.	Make a Block Planning Chart (with 3 orders & 2 batches)	CO2, CO3, CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 5.4 Calculate the delivery date as per capacity & schedule LSO 5.5 Decide on dates that can be committed based on this chart LSO 5.6 Determine the time required for each order			
LSO 6.1 Draw a clear diagram of the product that can show the number of buttons or other fastenings, the kind of stitches required. LSO 6.2 Determine the required specifications. LSO 6.3 Calculate the ratios as required. LSO 6.4 Instruct the manufacturer on the types of stitches required. LSO 6.5 Grade sizes as required LSO 6.6 Recommend the packing methods to be followed LSO 6.7 Scrutinize each specification given to see if possible in production. LSO 6.8 Procure raw materials as specified LSO 6.9 Plan production methods suitable to specification. LSO 6.1 0 Check if inventory needed is available or needs to be procured. LSO 6.11 Inquire about the machinery & equipment required. LSO 6.1 Decide whether to rent or purchase	6.	Prepare a spec sheet/ Tech pack & demonstrate on how to follow specs	CO2, CO3, CO5
LSO 7.1 Develop a profile with requirements like history of the company, strengths, location, etc. LSO 7.2 List the machines in house LSO 7.3 Assess the strengths. LSO7.4 List Inventory. LSO 7.5 list out Buyers LSO 7.6 Rate company standards with existing competitors.	7.	Develop a company profile including list of machinery & List of buyers	CO2, CO3, CO 5
LSO 8.1 Correspond using right & impressive words LSO 8.2 Compose a letter using proper punctuations LSO 8.3 Develop acceptable official formats for Letter writing	8.	Write a letter to a Buyer	CO2, CO3, CO 5
LSO 9.1 Question customers to assess their needs LSO 9.2 Dissect the answers to check problems LSO 9.3 Propose possible solutions LSO 9.4 Analyze each solution without criticism LSO 9.5 Conclude with most acceptable solution	9.	Identify customer needs using SPIN technique,	CO2, CO3, CO5
LSO 10.1 State a problem LSO 10.2 Recognize the problem LSO 10.3 Expand the problem LSO 10.4 Scrutinize the origin of the problem LSO 10.5 Alter the statement to see if problem exists somewhere else LSO 10.6 Maximize the problem LSO 10.7 Check repercussions.	10.	Solve Problems using Seam technique	CO2, CO3, CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 10.8 Infer a solution after collecting different aspects of the problem			
LSO 11.1 Examine a problem with the other persons point of view LSO 11.2 Contrast views taken from both sides LSO 11.3 Compare the situation from both angles LSO 11.4 interpret each persons behavior LSO 11.5. Describe possible solutions to problems LSO 11.6 Conclude with most acceptable solution	11.	Dramatize a situation using Role play to solve a problem, (A group of students will be given a situation (but individually told about it) that they will enact & the rest of the class observes & judges the actors. At the end each actor would explain how they felt in that role & audience would critically observe the behaviour of the person in that role)	CO3, CO5
LSO 12.1 Think Creatively LSO 12.2 Alternate solutions to problems LSO 12.3 Alternate methods of construction LSO 12.4 imagine better	12.	Develop Creativity using different techniques,	CO3, CO5
LSO 13.1 Differentiate between studying & learning LSO 13.2 Practice different methods of learning LSO 13.3 Invent new techniques of learning	13.	Contrive learning skill by adopting different methods,	CO3, CO5
LSO 14.1 Predict future colour in fashion LSO 14.2 Relate fashion in colour to new architectural developments, technology & current affairs LSO 14.3 Interpret the effects of these factors in deciding the final colour LSO 14.4 Predict future fashion silhouettes LSO 14.5 Relate fashion silhouettes to health obsessions, new requirements by designers & Industry, technology. LSO 14.6 infer on the new requirements LSO 14.7 Develop designs as per forecast. LSO 14.8 Predict future fashion texture LSO 14.9 Relate fashion textures to the current affairs, new inventions LSO 14.10 Employ these textures in fashion design LSO 14.11 Develop textures as per forecast. LSO 14.12 Predict future fashion designs LSO 14.13 Design a new collection by taking taking inspirations from latest trends, fashion changes, consumer preferences, etc LSO 14.14 Organize a design collection by combining all the above forecasts.	14.	Forecast Fashion based on analysis of last 4 years (Forecast of colour, Forecast of Silhoutte, Forecast of texture, Forecast of Design) (Students will work in different groups to forecast each of the above)	CO3
LSO 15.1 Summarize the aims & values of the organization. LSO 15.2 Organize these aims in order of importance LSO 15.3 Formulate the mission statement taking into consideration these factors	15.	Prepare a Mission statement	CO3, CO5
LSO 16.1 Summarize the short term & long-term goals of the organization. LSO 16.2 Organize these goals in order of achievement target dates LSO 16.3 Formulate the Vision statement	16.	Prepare a Vision statement	CO3, CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 17.1 Design the store within a given space LSO 17.2 Choose the interiors LSO 17.3 Inventory assessment. LSO 17.4 Select the important items to be displayed LSO 17.5 Arrange the display within a given space. LSO 17.6 Inspect the windows & interiors as they exist in terms of attraction, space utilization, etc LSO 17.7 Re-do the windows where required LSO 17.8 Re-Arrange the interiors LSO 17.9 Create new designs in Window Interiors	17,	Plan a retail stores- Plan space & Display area planning. Design- windows & interiors.	CO 3, CO 4
LSO 18.1 Examine the clothing needs of consumers as per season LSO 18.2 list out the requirements LSO 18.3 Group them into categories	18.	Categorize clothing requirements based on Seasons.	CO3, CO 4
LSO 19.1 Discover all the items that can be incorporated in a theme LSO 19.2 Prepare a chart of all these items LSO 19.3 Consider the suitability to the garment or article being made. LSO 19.4 Prepare a theme board incorporating these.	19.	Prepare a theme board (Students are grouped & given different themes to work on like Jungle, Cartoon, Bohemian, Arty, Peppy, Retro, Vintage, Gothic, etc)	CO3, CO 4
LSO 20.1 Prepare a theme board for the given theme LSO 20.2 Design the window display based on the available space in which you can arrange the articles suitable LSO 20.3 Arrange the articles accordingly	20.	Illustrate a Window display for a theme or a Season	CO 3, CO 4
LSO 21.1 Prepare a mood board LSO 21.2 Search online for mood boards for different seasons LSO 21.3 Prepare a mood board for a specific season	21.	Prepare a mood board (Students are grouped & given different seasons to work on like Spring, Summer, Autumn, Winter, Rain & occasional seasons like Christmas, Diwali, Eid, etc)	CO 3, CO 4
LSO 22.1 list the requirements for a Quotation LSO 23.2 Analyze the necessary terms & conditions LSO 23.3 Decide the payment terms LSO 23.4 Prepare of the Quotation based on the above.	22.	Prepare a Quotation	CO3, CO5
LSO 23.1 Generalize the terms & conditions required in a tender form LSO 23.2 Finalize specific terms required by the company for the particular article LSO 23.3 Prepare the Tender form by incorporating the above. LSO 23.4 Probe into the requirements in the given form LSO 23.5 Scrutinize the form to check for any terms & conditions that can be problematic LSO 23.6 Fill the form	23.	Prepare & Fill a Tender form	CO3, CO 5
LSO 24.1 List the requirements for a proforma invoice LSO 24.2 Decide the terms & Conditions LSO 24.3 Decide the payment terms	24.	Prepare a Proforma Invoice	CO3, CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 24.4 Prepare the Proforma incorporating all the important terms & conditions.			
LSO 25.1 Check the Challans for number of pieces delivered LSO 25.2 Prepare a final Invoice based on the Challans & proforma given earlier.	25.	Prepare a final Invoice	CO3, CO 5
LSO 26.1 identify the important things in an order form LSO 26.2 Decide the terms & conditions required. LSO 26.3 Calculate the required values based on size ratios.	26.	Prepare an Order form alongwith the required terms & conditions	CO 3, CO 5
LSO 27.1 Categorize the items delivered LSO 27.2 Prepare a challan based on chronological order of delivery	27.	Prepare a Delivery Challan	CO 5
LSO 28.1 Compare space utilization Vs sale LSO 28.2 Compare staff employed & their salaries Vs sale LSO 28.3 Compare rent paid Vs sale LSO 28.4 Prepare an audit based on all the above factors	28.	Calculate the success rate by a Merchandising Audit	CO3, CO 5
LSO 29.1 List out the strengths of the company that should be retained. LSO 29.2 List out the Weaknesses of the company that we need to be worked upon. LSO 29.3 List out the opportunities that seem possible in the near future. LSO 29.4 List out the threats of the company that should be tackled.	29.	Analyze a company position with SWOT	CO3, CO 5
LSO 30.1 Plan the dates of the season LSO 30.2 Plan the activities LSO 30.3 Plan the events that we would participate in or organize. LSO 30.4 Plan the dates of the events in chronological order LSO 30.5 Plan the activities before each event like Market survey, Designing, Sourcing, Cutting, Stitching, embellishing, accessorizing, Finishing & Packing LSO 30.6 Organize these activities in order of completion for each event	30.	Prepare a Marketing calendar for a season for 2 events	CO3
LSO 31.1 Plan the target market LSO 31.2 Study the types of consumers LSO 31.3 list what appeals to such consumers LSO 31.4 check what is already available LSO 31.5 check requirements of what is in demand but not in supply LSO 31.6 Prepare a product development plan	31.	Prepare a product development plan-	CO3
LSO 32.1 Recognize the need of packaging LSO 32.2 Eliminate chances of pilferage LSO 32.3 Design for attraction LSO 32.4 Make it functional.	32.	Plan Packaging for a ready article along with a price tag	CO3

L) Suggested Term Work and Self Learning: S2452503C

Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects: A suggestive list of micro-projects is given here. Similar micro-projects that match the COs could be added by the concerned course teacher.

1. Design development-elements, principles, line selection, merchandising plan for a design. The USP of the design & strategies for selling
2. Product development- appeal to consumers, target market product development plan
3. New marketing strategies. Students should be given a product to sell & should see which strategies worked

c. Other Activities:

1. Seminar Topics:
   - Online Survey as well as a Physical survey. Survey of one raw material, different raw materials given to different students. They will do a ppresentation of the same.
   - Survey of one market for feasibility of a product. Students could be grouped & can study a market in groups & present the same.
   - Working with document agents and freight forwarders. Finding out different documentation agents freight agents in your city & nearby areas. Visiting their offices or meeting them online to check the jobs they can handle, the terms & conditions & the advantages & disadvantages of working with them

2. Visits:
   - Visit to a mall to study different retail outlets.
   - Case Study: any one case study of a retail outlet that started small & grew big with the right marketing strategies (each student will study one case & present).
   - Case Study: any one case study of a retail outlet that started big but collapsed with the wrong marketing strategies (each student will study one case & present).

3. Self-Learning Topics:
   - Retailing in the past. First few important retail stops. Growth of retail & causes & conditions for expansion & growth.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	10%	-	-	10%	10%
CO-2	15%	15%	10%	25%	10%	10%	10%
CO-3	25%	25%	15%	25%	20%	25%	25%
CO-4	20%	20%	30%	25%	40%	15%	25%
CO-5	30%	30%	35%	25%	30%	40%	30%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction	06	CO1	07	2	2	3
Unit-2.0 Importance & Role of a Fashion Merchandiser	08	CO1, CO2	10	3	3	4
Unit-3.0 Merchandising skills	12	CO3, CO4	18	5	5	8
Unit-4.0 Retail Outlets	10	CO3, CO4	14	4	4	6
Unit-5.0 Documentation	12	CO4, CO5	21	6	6	9
Total	**48**	**-**	**70**	**20**	**20**	**30**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Develop a Marketing Chain/ Distribution channel to suit different fashion products	CO 3, CO 4, CO 5	60	30	10
2.	Illustrate/ dramatize/ Simulate an Advertisement for different media like newspaper, magazine, radio, mobile app, T.V, movie, internet, hoarding, etc. (Different students given different topic & then asked to present).	CO 3, CO 5	60	30	10
3.	Brainstorm to find new Planning strategies for personal selling, direct marketing & publicity (Students will work in groups for each & then make presentation).	CO 3, CO 5	50	40	10
4.	Prepare a Production Planning Chart (for 3 to 5 orders simultaneously working)	CO2, CO3, CO 5	50	40	10
5.	Make a Block Planning Chart (with 3 orders & 2 batches)	CO2, CO 3, CO 5	60	30	10
6.	Prepare a spec sheet/ Tech pack & demonstrate on how to follow specs	CO 2, CO 3, CO 5	60	30	10
7.	Develop a company profile including list of machinery & List of buyers	Co 2, CO 3, CO 5	50	40	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
8.	Write a letter to a Buyer	CO 2, CO 3, CO 5	20	70	10
9.	Identify customer needs using SPIN technique,	CO2, CO3, CO 5	40	50	10
10.	Solve Problems using Seam technique	CO2, CO3, CO 5	60	30	10
11.	Dramatize a situation using Role play to solve a problem, (A group of students will be given a situation (but individually told about it) that they will enact & the rest of the class observes & judges the actors. At the end each actor would explain how they felt in that role & audience would critically observe the behaviour of the person in that role)	CO 3, CO 5	60	30	10
12.	Develop Creativity using different techniques,	CO3, CO5	60	30	10
13.	Contrive learning skill by adopting different methods,	CO3, CO5	40	50	10
14.	Forecast Fashion based on analysis of last 4 years (Forecast of colour, Forecast of Silhoutte, Forecast of texture, Forecast of Design) (Students will work in different groups to forecast each of the above)	CO3	60	30	10
15.	Prepare a Mission statement	CO3, CO5	60	30	10
16.	Prepare a Vision statement	CO3, CO5	60	30	10
17.	Plan a retail stores- Plan space & Display area planning. Design- windows & interiors.	CO 3, CO 4	60	30	10
18.	Categorize clothing requirements based on Seasons.	CO3, CO 4	60	30	10
19.	Prepare a theme board (Students are grouped & given different themes to work on like Jungle, Cartoon, Bohemian, Arty, Peppy, Retro, Vintage, Gothic, etc)	CO3, CO 4	60	30	10
20.	Illustrate a Window display for a theme or a Season	CO 3, CO 4	60	30	10
21.	Prepare a mood board (Students are grouped & given different seasons to work on like Spring, Summer, Autumn, Winter, Rain & occasional seasons like Christmas, Diwali, Eid, etc)	CO 3, CO 4	60	30	10
22.	Prepare a Quotation	CO3, CO5	60	30	10
23.	Prepare & Fill a Tender form	CO3, CO 5	60	30	10
24.	Prepare a Proforma Invoice	CO3, CO5	60	30	10
25.	Prepare a final Invoice	CO3, CO 5	60	30	10
26.	Prepare an Order form alongwith the required terms & conditions	CO 3, CO 5	60	30	10
27.	Prepare a Delivery Challan	CO 5	60	30	10
28.	Calculate the success rate by a Merchandising Audit	CO3, CO 5	60	30	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
29.	Analyze a company position with SWOT	CO3, CO 5	60	30	10
30.	Prepare a Marketing calendar for a season for 2 events	CO3	60	30	10
31.	Prepare a product development plan-	CO3	60	30	10
32.	Plan Packaging for a ready article along with a price tag	CO3	60	30	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	High end computers	Processor Intel Core i7 with Open GL Graphics Card, RAM 32 GB, DDR3/DDR4, HDD 500 GB, Graphics Card NVIDIA OpenGL 4 GB, OS Windows 10	All
2.	Drawing tables/ Cutting long tables	Wood	All
3.	Stools	Wood	All
4.	Window for display	Glass front & wood behind in which mannequins can be kept	20
5.	Mannequinn	Adjustable for male	20
6.	Mannequinn	Adjustable for female	20
7.	Mannequinn	Adjustable for child	20

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Fashion- From Concept to Consumer	Frings Gini Stephens	Pearson Publications, 2001 ISBN-13: 978- 8131701744 ISBN-10: 8131701743

2.	Strategic Marketing	Dr. Ben Kajwang, Dr. Dymphna Bakker- Edoh, Kiprop Eric Kibos	IPRJB Publishers ISBN: 978-9914-728-19-4
3.	Fashion Marketing	Mike Easey	Blackwell Science ASIN: 1405139536
4.	Fashion Retailing	Dimitri Koumbis	Bloomsbury Publishing, 2019 ISBN: 9789388002370

(b) Online Educational Resources:

1. https://researchguides.austincc.edu/fashionmarketing/oer
2. https://libraryguides.mdc.edu/c.php?g=522259&p=7323444
3. https://www.iastatedigitalpress.com/itaa/article/id/15901/
4. https://fitnyc.libguides.com/AltOER/Subject
5. https://www.ohio.edu/education/recreation-sport-pedagogy-consumer-sciences/retail-merchandising

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. New Marketing Strategies, Brent Hale & Natallie Menno, Audi book, narrated by Marcus Mulenga
2. https://www.ohio.edu/education/recreation-sport-pedagogy-consumer-sciences/retail-merchandising
3. https://libguides.sdstate.edu/c.php?g=443826&p=3026838
4. https://www.youtube.com/watch?v=1tJHFaujzpA
5. https://design.umn.edu/academics/programs/about-retail-merchandising

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A) Course Code : **2400504B (T2400504B/P2400504B/S2400504B)**

B) Course Title : Artificial Intelligence (Basic)

C) Pre- requisite Course(s) :

D) Rationale :

Artificial intelligence is the theory and development of computer systems able to perform tasks such as, visual perception, speech recognition, decision-making etc. normally requiring human intelligence. Data analytics gives the basis of developing any artificial intelligence system. The Python programming language is one of the most accessible programming languages, has several modules to write programs to solve Artificial Intelligence, Machine Learning, Data Analysis problems. Moreover, it has simplified syntax and versatile data structures and functionsto speed up the code writing efficiently.

This course provides the basics for Artificial Intelligence problem solving techniques, data analytics and articulates the different dimensions of these areas. This course also provides the students the foundations for data analytics with python. The course explains data science techniques and the various Python programming packages required to prepare data for analysis, perform data analytics and create meaningful data visualization.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensurethe accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1 Elaborate the use of Artificial Intelligence for the problem solving as Technological driver.

CO-2 Write Python Programmes for solving problems.

CO-3 Analyze given data by using NumPy package of Python.

CO-4 Analyze given data by using Pandas package of Python.

CO-5 Visualize given data set using Matplotlib.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	-	2	2	-	-	-	1		
CO-2	-	3	3	3	-	-	2		
CO-3	-	3	3	3	-	-	2		
CO-4	-	2	3	3	-	-	2		
CO-5	-	3	3	3	-	-	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by the respective program coordinator at the institute level. As per the latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400504B	Artificial Intelligence (Basic)	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400504B	Artificial Intelligence (Basic)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400504B

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 1a. Elaborate the use of Artificial Intelligence TSO 1b. Explain various technological Drivers of Modern AI TSO 1c. Describe Knowledge representation TSO 1d. Classify Intelligent agents TSO 1e. List the characteristics of agents TSO 1f. Apply various search strategies for problem solving	**Unit-1.0. Artificial Intelligence** **Artificial Intelligence:** What is AI ?, Types of AI, History of AI, Turing Test, Symbol Systems and the scope of Symbolic AI, Structure of AI, Goals of AI, Importance ofAI, Techniques used in AI, Perception, Understanding and Action**,** Technological drivers of modern AI **Knowledge**: Definition, Knowledge Representation, objectives andrequirements, practical aspects of representation, Components **Intelligent Agents**: Agents and Environments, Properties of environments,characteristics of agents, classification of agents **Problem Solving:** Problem Formulation,Goal Formulation, State Space Search,Search Problem, Basic search algorithm,Search Tree, Search strategies–Uninformed and informed search, Breadth FirstSearch, Depth FirstSearch, Best FirstSearch, Constraint Satisfaction Problem (CSP), Back tracking Search.Problem Definitions: N Queen Problem, 8Puzzle Problem, Tic-tac-Toe.	**CO-1**
TSO 2a. Explain Python tokens and variables TSO 2b. Use the concept of l-value and r -value TSO 2c. Write python program using various data types TSO 2d. Write Program using various operators in Python TSO 2e. Write program using conditional statements TSO 2f. Use various string functions for problem solving in python program TSO 2g. Write programmes using various operations on list TSO 2h. Write programmes by using various operations on Tuples and Dictionary TSO 2i. Create user defined functions TSO 2j. Write python programmes using built- in functions TSO 2k. Describe the procedure to import module in the Python TSO 2l. Describe procedure to Import Library and functions in the Python TSO 2m. Write program using Iterative statements.	**Unit-2.0 Python Programming** Python character set, Python tokens, variables, concept of l-value and r-value,use of comments. Data types: number (integer, floating point, complex), boolean, sequence (string,list, tuple), none, mapping (dictionary), mutable and immutable data types Operators: arithmetic operators, relationaloperators, logical operators, assignmentoperator, augmented assignmentoperators. Expressions, statement, typeconversion & input/output: precedence ofoperators, expression, evaluation ofexpression. **Conditional and Iterative statements:** if, if-else, if-elif-else, for loop, range function, while loop, break and continue statements, nested loops **String, List, Tuples and Dictionary:**	**CO-2**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
	String: indexing, string operations (concatenation, repetition, membership & slicing), traversing a string using loops, built-in functions. Lists: introduction, indexing, list operations (concatenation, repetition, membership & slicing), traversing a list using loops, built- in functions, linear search on list of numbers and counting the frequency of elements in a list Dictionary: accessing items in a dictionary using keys, mutability of dictionary (adding a new item, modifying an existing item), traversing a dictionary, built-in functions **Python Functions:** types of function (built- in functions, functions defined in module, user defined functions), creating user defined function, arguments and parameters, default parameters, positionalparameters, function returning value(s), flow of execution, scope of a variable (global scope, local scope) **Modules and Packages:** Importing module using 'import' Regular Expressions,Exception Handling, PyPI Python PackageIndex, Pip Python package manager, Importing Libraries and Functions	
TSO 3a. Explain Data Analytics and its elements TSO 3b. Differentiate Data Analysis and Data Analytics TSO 3c. Explain the use of open source data TSO 3d. Differentiate Qualitative and Quantitative data analysis TSO 3e. Explain procedure to Install NumPy Library TSO 3f. Use NumPy library to perform various operations and functions on array TSO 3g. Write Programs using NumPy for array manipulations	**Unit-3.0 Data Analytics and Computing with NumPy** **Data Analytics**: Data, Types of Data, Importance of Data, Data Analysis Vs Data Analytics, Types of Data Analytics, Elements of Analytics, Data Analysis Process, Qualitative and Quantitative analyses, Open Source Data. **NumPy Library**: Introduction, Installation, **Ndarray**: creating an array, intrinsic creation of an array, Data types, basic operations, aggregate functions, Indexing, slicing, Iterating, Conditions and Booleanarrays, Array **manipulation:** Joining, splitting, shape changing, sorting, Structured arrays, Reading and Writing array data on a File.	**CO-3**
TSO 4a. Apply Pandas data structure for data analysis TSO 4b. Write Programs using Pandas to perform various operations and functions on series. TSO 4c. Perform various operation in a Data Frame columns and rows TSO 4d. Write Programme to read and write on CSV, XLS and Text data files TSO 4e. Apply various data cleaning operations and prepare data.	**Unit-4.0 Data Analysis with Pandas** **Pandas data structures**: Series, Declaration, selecting elements, assigning values, Filtering values, operations, mathematical functions, evaluating values, handling missing data, creating series from dictionaries, adding two series. **Data Frame:** Defining, selecting elements, assigning values, membership, deleting a column, filtering. Index Objects: Indexing, Re-indexing, Dropping, sorting and ranking, Descriptive Statistics **Data Loading**: Reading and Writing csv, xls, text data files, Data Cleaning and Preparation: Handling missing data, removing duplicates, replacing values,Vectorized String Methods,	**CO-4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
	HierarchicalIndexing, Merging and Combining, Data aggregation and Grouping.	
TSO 5a. Illustrate the use of Matplotlib and PyPlot package for showing plots and images TSO 5b. Customize plots with Colors, Markers, Line Styles, Limits, Tics, Labels, Legends, Grids TSO 5c. Differentiate various charts based on their applications	**Unit-5.0 Data Visualization with Matplotlib** Data Visualization: Introduction to Matplotlib ,PyPlot package, Figures andSubplots, showing plots and images Customizing Plots: Colors, Markers, Line Styles, Limits, Tics, Labels, Legends, Grids ,Annotating with text, Matplotlib Configuration Chart types: Line, Bar, stacked bar, Box plots, pie chart , Histogram and Densityplots, Scatter plot, Saving Plots to a file, Close and clear plots.	**CO-5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504B

Practical/ Lab SessionOutcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 1.1 Use various data types and operators to solve given problem LSO 1.2 Use conditional and iterative statements for solving given problem	1	**Conditional and Iterative statements** 1a. Write a program to generate randomnumbers between 5 and 10. 1b. Write a program to find the square root of a number. 1c. Write a python program to check if a numberis positive, negative or 0. 1d. Write Python program to print all primenumbers between 0-50.	CO-2
LSO 2.1 Use string functions for performing various string operations	2	**String Handling** 2a. Write a Programme that asks the user for astring with only single space between words, and return number of words in thestring. 2b. Write a Program that inputs a line of textand print the count of Vowels in it. 2c. Write a Program that inputs a line of text andprint the biggest word in it. 2d. Write a Program that inputs a line of textand print a new line of text where each word of input line is reversed.	CO-2
LSO 3.1 Use list operations for concatenation, repetition & slicing LSO 3.2 Perform various operation in the Tuples LSO 3.3 Perform various operation in the dictionary	3	**List, Tuples and Dictionary** 3a. Write a python program to convert a stringto a list. 3b. Write a program to print the largest numberin a list. 3c. Given a tuple pairs = ((3,9), (8,4), (3,7), (24,18)), count the number of pairs (a, b)such that both a and b are odd. 3d. Write a program to input a list of numbers and swap elements at the even location withthe elements at the odd location. 3e. Write a program to merge two dictionaries.	CO-2

Practical/ Lab SessionOutcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 4.1 Use built-in functions to solve given problem LSO 4.2 Create user defined functions to solve given problem	4	**Python Functions** 4a. Write a function to reverse a string. 4b. Write a function to calculate the factorial of a number.	CO-2
LSO 5.1 use basic data structure using NumPy LSO 5.2 Convert the list and tuple as NumPy array	5.	**Basic data structures in NumPy** 5a. Create a List, set, tuple and dictionary whichstores the details of a student (roll no, name, dept, branch, percentage of mark) inPython and print the values. 5b. Convert the list and tuple as NumPy array.	CO-3
LSO 6.1 Create Arrays in Numpy using different intrinsic methods LSO 6.2 Perform arithmetic operations and mathematical operations using arrange and ones intrinsic method.	6	**Arrays in NumPy** 6a. Create arrays using different intrinsic methods (ones, zeros, arange, linspace,indice) and print their values. 6b. Check the results of arithmetic operations like add(), subtract(), multiply() and divide()with arrays created using arrange and ones intrinsic method. 6c. Check the results of mathematical operations like exp(), sqrt(), sin(), cos(), log(), dot() on an array created using arrange intrinsic method.	CO-3
LSO 7.1 Apply aggregate functions on data by using Built-in function s in Numpy	7	**Built-in functions in NumPy.** 7a. Load your class Mark list data from a csv (comma separated value) file into an array. Perform the following operations to inspect yourarray. Len(), ndim, size, dtype, shape, info() 7b. Apply the aggregate functions on this data and print the results. (Functions like min(), max(), cumsum(), mean(), median(), corrcoef(), std())	CO-3
LSO 8.1 Handle multiple arrays by applying various operations on arrays	8	**Handling Multiple Arrays** 8a. Create two python NumPy arrays (boys, girls) each with the age of nstudents in the class. 8b. Get the common items between twopython NumPy arrays. 8c. Get the positions where elements of twoarrays match. 8d. Remove from one array those items thatexist in another. 8e. Extract all numbers between a given rangefrom a NumPy array.	CO-3
LSO 9.1 Apply indexing on the given set of data	9	**Indexing in NumPy** 9a. Load your class Mark list data from a csv fileinto an array. 9b. Access the mark of a student in a particularsubject using indexing techniques. 9c. Select a subset of 2D array using fancyindexing (indexing using integer arrays	CO-3
LSO 10.1 Create series using list and dictionary in pandas LSO 10.2 Print different values from series.	10	**Working with a Series using Pandas** 10a. Create a series using list and dictionary. 10b. Create a series using NumPy functions in Pandas. 10c. Print the index and values of series. 10d. Print the first and last few rows from the series.	CO-4
LSO 11.1 Perform various operation in a Data Frame rows	11	**Working with Data Frame Rows** 11a. Slicing Data Frame using loc and iloc. 11b. Filter multiple rows using isin.	CO-4

Practical/ Lab SessionOutcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
		11c. Select first n rows and last n rows 11d. Select rows randomly n rows and fractionsof rows (use df. sample method) 11e. Count the number of rows with eachunique value of variables 11f. Select nlargest and nsmallest values.11g. Order/sort the rows	
LSO 12.1 Apply different techniques to merge and combine data	12	**Merge and combine data** 12a. Perform the append, concat and combinefirst operations on Data Frames. 12b. Apply different types of merge on data. 12c. Use a query method to filter Data Frame with multiple conditions.	CO-4
LSO 13.1 Create Linear Plot to identify various relation in the data using Matplotlib LSO 13.2 Create Scatter Plot to identify various relation in the data using Matplotlib	13	**Consider the Salary dataset, which contains 30 observations consisting of years of working experience and the annual wage. Download thedata set from** https://www.kaggle.com/rohankayan/years-of- experience-and-salary-dataset 13a. Create a linear plot to identify the relationship between years of working experience and the annual wages with suitable title, legend and labels. 13b. Create a scatter plot to identify the relationship between years of working experience and the annual wages with title, legend and labels. 13c. Also distinguish between observations that have more than 5 years of working experience and observations that have lessthan 5 years of working experience by using different colors in one single plot.	CO-5
LSO 14.1 Plot Bar graph by Changing the color of each bar, Change the Edge color, Linewidth and Line style.	14	**Consider the Iris dataset, where observations belong to either one of three iris flower classes. Download the data set from** https://www.kaggle.com/arshid/iris-flower- dataset 14a. Visualize the average value for each feature of the Set osa iris class using a bar chart. 14b. Format the obtained bar graph by Changingthe color of each bar, Change the Edge color, Line width and Line style.	CO-5

L) Suggested Term Work and Self Learning: S2400504B

Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in linewith the targeted COs.

b. Micro Projects:

1. **Handing Two-dimensional array in NumPy**
   Download the data set from
   https://archive.ics.uci.edu/ml/machine-learning-

databases/iris/iris.datahttps://www.kaggle.com/arshid/iris-flower-dataset

a. Import iris dataset with numbers and texts keeping the text intact into python NumPy.
b. Convert the 1D iris to 2D array (iris2d) by omitting the species text field.
c. Find the number and position of missing values in iris2d's sepal_length
d. Insert np.nan values at 20 random positions in iris 2d dataset
e. Filter the rows of iris2d that has petal_length> 1.5 and sepal_length< 5.0

Expected Outcome (Use various operations on two dimensional arrays in NumPy)

2. **Handling missing data and duplicates in Pandas:**
   a. Identify rows with missing data (isnull(), notnull()) and replace NA/Null data with a given value.
   b. Drop rows and columns with any missing data (dropna(), dropna(1))
   c. Find duplicate values and drop duplicates.
   d. Fill the missing values using forward filling and backward filling.
   e. Replace the missing value with new value and write the dataframe to a CSV file in the localdirectory.

   Expected Outcomes (a. Identify missing data, b. Find Duplicates values, c. Write the dataframe to aCSV file in the local directory.)

3. **Working with Data Frame Columns:**
   a. Create and print a Data Frame.
   b. Find the descriptive statistics for each column.
   c. Group the data by the values in a specified column, values in the index.
   d. Set Index and columns in a Data Frame.
   e. Rename columns and drop columns
   f. Select or filter rows based on values in columns.
   g. Select single and multiple columns with specific names

   Expected Outcome (Perform various operation in a Data Frame columns)

4. **Indexing & Sorting in NumPy:**
   a. Load your class Mark list data from a csv file into an array.
   b. Sort the student details based on Total mark.
   c. Print student details whose total marks is greater than 250 using Boolean indexing.

   Expected Outcomes (a. Sort the given set of data, b. Use indexing in an array)

5. **Array Slicing in NumPy:**
   a. Load your class Mark list data into an array called “marks” to store students roll num, subjectmarks and result.
   b. Split all rows and all columns except the last column into an array called “features”.
   c. Split the marks array into 3 equal-sized sub-arrays each for 3 different subject marks.
   d. Split the last column into an array “label”.
   e. Delete the roll num column from the marks array and insert a new column student name in itsplace.

   Expected Outcome (Use array slicing in Numpy for the given set of data)

6. Consider the Iris dataset, where observations belong to either one of three iris flower classes.
Download the data set from
https://www.kaggle.com/arshid/iris-flower-dataset

a. Visualize the Histogram for each feature (Sepal Length, Sepal Width, petal Length & petal Width)separately with suitable bin size and color.
b. Plot the histograms for all features using subplots to visualize all histograms in one single plot. Save the plot as JPEG file.
c. Plot the box plots for all features next to each other in one single plot. Perform 3D printing ofplastic casing of inhaler used by Asthma patients and estimate the cost.

Expected Outcomes (a. Plot the Histogram for the various features using subplot, b. Plot the boxplots for all features next to each other in one single plot)

c. Other Activities:

1. **Lab Activities:**
   - Install Python IDE and important Python Libraries
   - Install Anaconda and find the features of Jupyter Notebook.
   - Import various module using 'import '
   - Use Pip Python package manager.
   - Import Libraries and Functions in Python

2. **Seminar Topics:**
   - Technological rivers of modern Artificial Intelligence
   - Intelligent Agents and Environments in Artificial Intelligence
   - Various Search Strategies
   - Python for Data Science
   - Python Libraries and Packages used in data Science
   - Data Visualization
   - Various data set available over Internet

3. **Self-Learning Topics:**
   - Use of AI in Engineering and Technology
   - Data Science and Machine Learning
   - Problem and Goal Formulation
   - Search strategies
   - Breadth First Search and Depth First Search
   - Back tracking Search
   - N Queen and 8 Puzzle Problem

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	20%	20%	--	30%	--	--
CO-2	10%	20%	20%	--	20%	20%	25%
CO-3	20%	25%	20%	30%	20%	20%	25%
CO-4	30%	25%	20%	20%	30%	30%	25%
CO-5	20%	10%	20%	50%	--	30%	25%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:
***:** Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.
******: Mentioned under point- (N)
#: Mentioned under point-(O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0. Artificial Intelligence	9	CO-1	14	6	5	3
Unit-2.0. Python Programming	12	CO-2	14	4	4	6
Unit-3.0. Data Analytics and Computing with NumPy	10	CO-3	17	4	5	8
Unit-4.0. Data Analysis with Pandas	10	CO-4	18	4	5	9
Unit-5.0. Data Visualization with Matplotlib	7	CO-5	7	2	2	3
Total Marks	**48**		**70**	**20**	**21**	**29**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Conditional and Iterative statements	CO-2	-	90	10
2.	String handling	CO-2	-	90	10
3.	List, Tuples and Dictionary	CO-2	20	70	10
4.	Python Functions	CO-2	-	90	10
5.	Basic data structures in NumPy	CO-3	-	90	10
6.	Arrays in NumPy	CO-3	-	90	10
7.	Built-in functions in NumPy.	CO-3	20	70	10
8.	Handling Multiple Arrays	CO-3	20	70	10
9.	Indexing in NumPy	CO-3	-	90	10
10.	Working with a Series using Pandas	CO-4	-	90	10
11.	Working with Data Frame Rows	CO-4	20	70	10
12.	Merge and combine data	CO-4	40	50	10
13.	Consider the Salary dataset, which contains 30 observations consisting of years of working experience and the annual wage.	CO-5	80	10	10
14.	Consider the Iris dataset, where observations belong to either one of three iris flower classes.	CO-5	80	10	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Group Discussion, Portfolio Based Learning, Live Demonstrations in Classrooms, Lab, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Computer Systems	Desktop Computers with i3 processor, 16 GB RAM, 512 GBHDD	S. No. 1 to 14
2.	Online Python IDE	https://www.online-python.com/	S. No. 1 to 14
3.	Jupyter Notebook	Download from https://jupyter.org/	S. No. 1 to 14
4.	Pip Python package manager	Download Pip 22.3 From https://pypi.org/project/pip/	S. No. 1 to 14
5.	Various modules, Libraries and Packages	NumPy, Pandas, Matplotlib, PyPlot package	S. No. 1 to 14

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author (s)	Publisher and Edition with ISBN
1.	Artificial Intelligence Basics - A Non-Technical Introduction	TomTaulli	Apress (2019)
2.	Fundamentals of artificial Intelligence	Chowdhary K. R	Springer 2020
3.	Artificial Intelligence A Modern approach	Stuart J. Russell and Peter Norvig	PrenticeHall 2010, 3rdEdition
4.	Introduction to Computing and Problem-Solving using Python	E. Balagurusamy	McGraw Hill Education (India)Pvt. Ltd.1st Edition /2016
5.	Learning Python Programming	Jeffrey Elkner, Allan B.Downey, Chris Meyers	Samurai Media Limited. 2016
6.	Python Programming	Ashok Namdev Kamthane and Amit Ashok Kamthane	McGraw Hill Education (India) Pvt.Ltd.2020, 2nd Edition
7.	Programming in Python	Dr. Pooja Sharma	BPB Publications 2017
8.	Taming Python by Programming	Jeeva ose	Khanna Book Publishing Co(P)Ltd, 2017, Reprinted2019
9.	Python Data Analytics	Fabio Nelli	Apress,2015
10.	Python for Data Analysis: Data Wrangling with Pandas, Numpy, and IPython	Wes McKinney	O'REILLY 2018, Second Edition

(b) Online Educational Resources:

1. NPTEL Web Content- Artificial Intelligence, Prof. P. Mitra, Prof. S. Sarkar, IIT Kharagpur URL: https://nptel.ac.in/courses/106/105/106105078/
2. https://www.learnpython.org
3. www.python.org
4. https://www.tutorialspoint.com/python

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

Data Source:

- https://archive.ics.uci.edu/ml/machine-learning-databases/auto-mpg/
- https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data
- https://www.kaggle.com/arshid/iris-flower-dataset
- https://www.kaggle.com/rohankayan/years-of-experience-and-salary-dataset

******

A) Course Code : **2400504C (T2400504C/P2400504C/S2400504C)**

B) Course Title : Internet of Things (Basic)

C) Pre- requisite Course(s) : Digital Electronics, Electronics Circuits, Fundaments of Computers and Computer networks

D) Rationale :

The Internet of Things (IoT) is the upcoming field that has the capability to connect everything on the earth. This course focuses on the development of IoT concepts such as sensing, actuation with implementation of communication protocols.

The course also focuses on real life aspects of IoT and how to integrate it in real life projects. The course will simplify the concept of IoT by using the Node MCU board for IoT application development. In this course students will learn about the use of Node MCU and its applications as a beginner/intermediate in the field of IoT. Apart from this, students will learn about the APIs, by using which integration of features like send Email, WhatsApp messages and notification based on certain events in projects is possible. Overall, this course covers both hardware and software aspects of IoT with practical exposure.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Describe the functions of each block of the basic IoT system

CO-2 Explain communication protocol used in IoT and its applications

CO-3 Use appropriate sensors for the specific measurement through the IoT platform

CO-4 Explain APIs, client-server connections and its integration in real life applications.

CO-5 Build and test a complete, working IoT system involving prototyping, programming, and data analysis

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	-	-	-	-	-	-		
CO-2	1	2	2	2	2	-	-		
CO-3	1	3	2	2	2	2	2		
CO-4	1	1	2	3	-	2	2		
CO-5	1	1	3	2	2	3	3		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400504C	IoT (Basic)	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400504C	IoT (Basic)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400504C

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1. a. Describe the concept of IoT. TSO.1. b. Explain the functions of each block of the Basic IoT system. TSO.1. c. Compare features of various IoT platforms TSO.1. d. List IoT Real time Applications. TSO.1. e. Describe the functioning of given real-time applications	**Unit-1.0 Introduction to IoT** 1.1 Basics of IoT, concepts of IoT, History of IoT 1.2 Basic IoT System and its building blocks 1.3 Various platforms for IoT (e.g. AWS, AZURE, GCP) 1.4 Introduction to Python programming and IoT software 1.5 Applications of IoT	**CO-1 and CO-5**
TSO.2. a. Explain various communication protocols. TSO.2. b. Explain working and application of blue tooth TSO.2. c. Explain working and application of ZigBee TSO.2. d. Explain working and application of LoRa TSO.2. e. Explain working and application of Wi-fi	**Unit 2.0 IoT Communication Protocols** 2.1 Basics of given communication protocol alongwith its applications 2.2 Explain Communication Protocols MQTT 2.3 Bluetooth Low Energy ZigBee LoRa Wi-fi	**CO-1 and C02**
TSO.3. a. Differentiate between sensor and Actuator. TSO.3. b. Classify IoT sensors on the basis of their application. TSO.3. c. Describe the function of each block of Node MCU. TSO.3. d. Explain the procedure to connect sensors with Node MCU.	**Unit-3.0 Sensors and Hardware for IoT** 3.1 Sensors and Actuators, Transducers, Classifications of sensors, IoT Sensors 3.2 Development Boards, classifications, and basics of wireless networks, WiFi libraries 3.3 Introduction to node MCU, block diagram, functions, interfacing with sensors and publishing data on webserver 3.4 Device integration with node MCU 3.5 Interfacing of sensors with boards	**CO-1, CO-3 and CO-5**
TSO.4. a. Define APIs and its uses TSO.4. b. Explain working and application of REST. TSO.4. c. Explain working and application of SOAP TSO.4. d. Explain working and application of json TSO.4. e. Explain the integration of API in IoT application development.	**Unit.4.0 IoT APIs and its Integration** 4.1 Explain APIs and its use 4.2 Explanation of given IoT APIs along with its applications 4.3 MQTT, Broker, subscriber, publisher 4.4 REST SOAP 4.5 JSON 4.6 Programming API using Python	**CO-1 and CO-4**
TSO.5. a. Differentiate between industrial IoT and IoT. TSO.5. b. Describe the applications of IoT in the medical field. TSO.5. c. Describe the medical applications of IoT in the agriculture field. TSO.5. d. Describe the innovative IoT applications.	**Unit. 5.0 IoT Applications**: - 5.1 Industrial IoT and Internet of everything 5.2 IoT for consumer electronics products 5.3 IoT for Medical applications 5.4 IoT for Agriculture 5.5 IoT for security and Law enforcement	**CO-1 and CO-5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504C

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant CosNumber (s)
LSO 1.1 List various IoT platforms. LSO 1.2 List Down broad features of given platforms. LSO 1.3 List IoT based features in python language.	1.	Prepare a list of platforms used for IoT. Prepare a list of features of above IoT platforms. Prepare a list of features provided by python language for IoT applications.	CO-1
LSO 2.1 Arduino connection with Arduino IDE. Connect Bluetooth with Arduino. verification of data communication withBluetooth.	2.	Establish connectivity between various components of IoT. Establish connection between Arduino and Bluetooth module. Establish connection using WiFi	CO-2
LSO 3.1 Measure the temperature of the givensensor. LSO 3.2 Measure the humidity of the given sensor. LSO 3.3 Measure the pressure of the given sensor.	3.	Publish data on the IoT platform. Measure the temperature of a remotely located temperature sensor Using IOT based temperature data-monitoring system. Measure the humidity of a remotely located humidity sensor Using IOT based humidity data-monitoring system. Measure the pressure of a remotely located pressure sensor Using IOT based pressure data-monitoring system.	CO-3
LSO 4.1 Working with APIs. LSO 4.2 Implementation of APIs using POSTMANApplication.	4	Download and Configure POSTMAN Application Verify REST APIs through POSTMAN. Verify JSON APIs through POSTMAN. Verify SOAP APIs through POSTMAN.	CO-4
LSO 5.1 Identification of components for variousapplications. LSO 5.2 Estimate the cost for components.	5.	Identify components for given project Estimate the cost to make Project working.	CO-5

L) Suggested Term Work and Self Learning: S2400504C

Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in linewith the targeted COs.

b. Micro Projects:

1. Prepare a report on IoT Systems using Internet data.
2. Market survey to identify various types of IoT sensors and its pricing.
3. Interface IR sensor with Arduino and send the data to Arduino cloud.
4. Send IoT data using Node MCU to things Speak cloud.
5. Interface Bluetooth module with Arduino and send data using the Bluetooth module.

c. Other Activities:

1. Seminar Topics: - “Future of IoT”
   “Technologies for IoT “, “Smart City and IoT”
2. Visit to industry for latest IoT setup in industrial process.

3. Surveys of market for availability of various types of sensors and its pricing.
4. Product Development: Development of projects for real life problem solution using IoT.
5. Software Development: various open source platform operations.

d. Self-Learning Topics:

1. IoT hardware and their use for various applications
2. IoT sensors technical specifications
3. IoT enabled services

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	20%	--	33%	10%	20%
CO-2	15%	10%	20%	--	33%	15%	20%
CO-3	30%	30%	20%	--	34%	15%	20%
CO-4	20%	30%	20%	50%	--	30%	20%
CO-5	25%	20%	20%	50%	--	30%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

***:** Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

******: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0. Introduction to IoT	5	CO-1	7	3	4	-
Unit-2.0. IoT Communication Protocols	5	CO-2	7	3	2	2
Unit-3.0. Sensors and Hardware for IoT	14	CO-3	21	6	7	8
Unit-4.0 IoT APIs and its Integration	14	CO-4	21	6	5	10
Unit-5.0. IoT Applications	10	CO-5	14	2	4	8
Total Marks	**48**		**70**	**20**	**22**	**28**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Prepare a list of platforms used for IoT.	CO-1	60	30	10
2.	Prepare a list of features of above IoT platforms.	CO-1	60	30	10
3.	Prepare a list of features provided by python language for IoT applications.	CO-1	60	30	10
4.	Establish connectivity between various components of IoT.	CO-2	60	30	10
5.	Establish connection between Arduino and Bluetooth module.	CO-2	60	30	10
6.	Establish connection using WiFi	CO-2	70	20	10
7.	Publish data on the IoT platform.	CO-3	70	20	10
8.	Measure the temperature of a remotely located temperature sensorUsing IOT based temperature data-monitoring system.	CO-3	60	40	10
9.	Measure the humidity of a remotely located temperature sensor Using IOT based temperature data-monitoring system.	CO-3	60	40	10
10.	Measure the pressure of a remotely located temperature sensor UsingIOT based temperature data-monitoring system.	CO-3	60	40	10
11.	Publish the data using Mqtt	CO-4	60	30	10
12.	Download and Configure POSTMAN Applications	CO-4	60	30	10
13.	Verify REST APIs through POSTMAN.	CO-4	60	30	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
14.	Verify JSON APIs through POSTMAN.	CO-4	60	30	10
15.	Verify SOAP APIs through POSTMAN.	CO-4	60	30	10
16.	Identify components for given project	CO-5	50	40	10
17.	Estimate the cost to make Project working.	CO-5	50	40	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriatelyselected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1	Bluetooth Modem-Blue SMiRF Silver	Sparkfun Bluetooth modem	As mentioned above list
2	Postman Software	Open-source downloadable	
3	Node MCU board	Generic	
4	IoT free cloud	Arduino cloud/Thing Speak/Blynk	
5	ATAL Lab Package-1 Package-2 Package-4	As per the list as address below ATAL Equipment list' (http://aim.gov.in/guidelines-for-school.php).	

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Internet of Things Architecture and Design Principles	Raj Kamal	Mc Graw Hills, New Delhi ISBN 13: 978-93-90722-38-4
2	Internet of things (IoT): technologies,applications, challenges and solutions	Edited By BK Tripathy , J Anuradha	CRC Press, ISBN 9780367572921, June 30, 2020

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
3	Internet-of-Things(IoT) Systems: Architectures, Algorithms, Methodologies	by Dimitrios Serpanos & Marilyn Wolf	Springer; 1st ed. 2018 edition (17 January 2018)
4	Custom Raspberry Pi Interfaces: Design and build hardware interfaces for the Raspberry	Pi by Warren Gay	Apress; 1st ed. edition (23 February 2017), ISBN- 10: 9781484224052, ISBN-13: 978-1484224052
5	'Learning Internet of Things',	Peter Waher	Packt Publishing, 2015, ISBN9781783553532, https://lib.hpu.edu.vn/handle/123456789/31693
6	Sensors, Actuatorsand Their Interfaces,	N. Ida	Scitech Publishers, 2014.

(b) Online Educational Resources:

1. nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024.htm
2. en.wikipedia.org/wiki/Shear and moment diagram
3. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
4. www.engineerstudent.co.uk/stress_and_strain.html
5. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf
6. https://www.veritis.com/blog/aws-vs-azure-vs-gcp-the-cloud-platform-of-your-choice/
7. https://wiki.python.org/moin/TimeComplexity
8. www.engineerstudent.co.uk/stress_and_strain.html
9. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf
10. Amini, P. (2014). Sulley: Pure Python fully automated and unattended fuzzing frame- work.
11. https://github.com/OpenRCE/sulley

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

******

A) Course Code : **2400504D (T2400504D/P2400504D/S2400504D)**

B) Course Title : Drone Technology (Basic)

C) Pre- requisite Course(s) :

D) Rationale :

Rapid technological innovation has provided users cutting-edge products at affordable prices. Traditionally, drones had been limited to military use due to high costs and technical sophistication. In recent years, the drone has number of commercial uses and are also proving to be extremely beneficial in places where a mancannot reach or is unable to perform in a timely and efficient manner. Today, drones are used in construction, photography, agriculture, defense, environmental studies and monitoring and other industries to protect the skies, repopulate forests and accomplish much more on a huge scale. This course will acquaint the student with the basic drone technology and applicable drone rules and regulations in India. Considering that the main operational areas of diploma holders, it is essential that he should be exposed to basic drone designing, programming, operating, maintaining and using them safely.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1 Operate a drone safely by applying appropriate drone rules and regulations.

CO-2 Design the structure of drone with drone components and equipment.

CO-3 Interface flight controller board with sensors, ESC and radio communication unit in drone technology.

CO-4 Use drone simulator and identify different types of ports and connectors of drone.

CO-5 Use python programming while drone designing.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	2	-	-	-	3	-	2		
CO-2	3	2	3	3	-	-	-		
CO-3	3	2	3	3	-	-	-		
CO-4	2	-	-	2	-	3	2		
CO-5	-	2	2	3	-	-	-		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	CourseTitle	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400504D	Drone Technology (Basic)	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		Total Marks (TA+TWA+LA)
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400504D	Drone Technology (Basic)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400504D

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe the various historical evolutionary steps of drone technology TSO 1b. Explain Drone motion based on principle of aerodynamics. TSO 1c. Classify different types of drones and make chart of its application, advantages and disadvantages TSO 1d. Develop attitude to follow proper rules and regulations of drones flying in India. TSO 1e. Explore future prospects of drones in India.	**Unit-1.0Introduction to Drone Technology** Introduction to Drones and UAV • Definition • History • Drone in Indian aspect Introduction to Flight Dynamics Various types of Drones and theirrespective Applications • Multirotor drones • Fixed wing structure ne flights using an understanding of FAA • DGCA • Digital sky platform • RPTO Drone regulations-No drone zones	**CO-1**
TSO 2a. Explain the use and function of different types of Drone components. TSO 2b. Select suitable drone frame and propellers for given application. TSO 2c. Explain working principle and function of different sensors used in drone technology. TSO 2d. Write use of Gyro sensor and Accelerometer in drone. TSO 2e. Describe different types and capacity of Battery used in various drone applications. TSO 2f. State the selection criteria of motor for given drone application. TSO 2g. Write advantage of BLDC motors in making of Drones.	**Unit-2.0 Drone and its Components** Drone's components • Drone frame • Propellers Sensors • Gyro sensor and Accelerometer • Speed and Distance Sensor • Temp sensor • Barometer • TOF Sensor Battery • Types and Capacity Motors • Motor types • Motor capabilities • Application of BLDC motors indrones	**CO-2**
TSO 3a. Explain four types of motion used in drone's operation. TSO 3b. Describe the working and applicationsof Electronic speed controller. TSO 3c. Explain the working principle of Flight controller unit used in drone. TSO 3d. Explain Radio communication unit used in drone. TSO 3e. Explain the communication of Flight controller board with motor, ESC and sensors with suitable diagram	**Unit-3.0 Drone controller and motion** Propulsion and Vertical Motion Controller and Flying Instructions Electronic speed Controller (ESC) Flight Controller Board (FCB) Radio Communication Transmitter and Receiver for radio signal	**CO-3**
TSO 4a.Describe utility of different communication port used in drone.	**Unit-4.0Connections and Interfaces of Devicesin Drone and Drone Simulator**	**CO-4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 4b. Identify different types of connectors and write their specifications TSO 4c. Explain the use of drone simulator software and hardware.	Communication Port • PWM • RS232, RS422, RS485 • UART • CAN • I2C Different types of connectors and its specification Drone Simulator software Drone simulator Hardware	
TSO 5a.Write basic code in Python. TSO 5b. Explain structure and components of a Python program. TSO 5c. write syntax of loops and decision statements in Python. TSO 5d. Explain steps to create functions andpass arguments in Python.	**Unit-5.0 Introduction to Python for Drone** Python programing refreshers for IoT, AI andDrone Integration of devices with cloud services Microsoft Azure, AWS	**CO-5**

Note: One major TSO may require more than one theory session/period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504D

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1 Choose suitable materials for makingdrone frame.	1.	Determine the strength of materials used in drone's frame.	CO-2
LSO 2 Select suitable materials for making drone propellers.	2.	Determine the strength of materials used in drones Propellers.	CO-2
LSO 3 Use appropriate battery as per need of flight time for specific drone application.	3.	Test different parameters of batteries used in drones	CO-2
LSO 4 Identify suitable motors as per payload of specific drone application.	4.	Test motors suitable for specific Drone application.	CO-2
LSO 5 Operate Gyro sensor and Accelerometer.	5.	Test and measure Gyro sensor and Accelerometer and their characteristics.	CO-2
LSO 6.1 Identify different sensors based on their characteristics. LSO 6.2 Interface different types of sensors in drone.	6.	Test different sensors and their characteristics with Microcontroller based Flight controller board.	CO-2, CO-3
LSO 7 Demonstrate four type of drone motion.	7.	Determine thrust/torque of motor by changing different drone motion	CO-2, CO-3
LSO 8.1 Configure Flight control board (FCB) LSO 8.2 Demonstrate use of Flight control board (FCB)	8.	Test and troubleshoot Flight control board (FCB).	CO-3
LSO 9.1 Measure various parameters of sensor LSO 9.2 Interface sensor with flight controller board.	9.	Test and perform communication of Flight control board (FCB) with sensor	CO-3, CO-2
LSO 10 Use motor with flight controller board.	10.	Test and perform communication of Flight control board (FCB) with motor.	CO-3, CO-2
LSO 11 Interface ESC with flight controller board.	11.	Test and perform communication of Flight control board with ESC.	CO-3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 12 Configure radio communication device to control drones	12.	Test and perform communication of Flight control board with RF transceiver.	CO-3
LSO 13.1 Identify different types of ports and connectors of drone. LSO 13.2 Assemble drone component.	13.	Test Hardware assembly for drone.	CO-4 CO-3
LSO 14.1 Identify different motions in drone simulator. LSO 14.2 Operate drone in simulator for specific task	14.	Perform different motion in drone simulator.	CO-4
LSO 15.1 Write code of loop and decision statement in python. LSO 15.2 Interpret loop and decision statement LSO 15.3 Debug code of loop and decision statement	15.	Build and run loops and decision statements for specific application in Python.	CO-5
LSO 16.1 Make function in python. LSO 16.2 Interpret given function statement LSO 16.3 Debug code of function in python	16.	Build and Run functions for specific application and pass arguments in Python.	CO-5
LSO 17.1 Identify python programming steps to interface drone components. LSO 17.2 Identify error in python program LSO 17.3 Debug the given python program	17.	Write basic programming in python to interface different component of Drones	CO-5, CO-3

L) Suggested Term Work and Self Learning: S2400504D

Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in linewith the targeted COs.

b. Micro Projects:

1. Design drone for simple application.
2. Test different sensors, their characteristics and make chart which are used in different drones'applications.
3. Download 5 videos on drone design with different components. Watch them and write report on it.
4. Write report on Drone application for precision agriculture.
5. Survey nearby electronics shop and Prepare report of list of drone component and its specification.
6. Visit nearby tool room, small industry, Drone training institute facilities. Prepare report of visit withspecial comments of drone technology used, material used, cost of printed component.

c. Other Activities:

1. Seminar Topics-History of Drone, Drone regulations, Proximity sensor, Bernoulli's principle apply in drone, Radio communication used in drones, Drone Simulator, Python Programming.
2. Visits: Visit nearby tool room, small industry, Drone training institute facilities. Prepare report of visit with special comments of drone technology used, material used, cost of printed component.
3. Surveys: Survey nearby electronics shop and Prepare report of list of drone component and its specification and explore Drone simulator.
4. Product Development
5. Software Development

d. Self-Learning Topics:

1. History of Drones
2. Drone in Indian aspect
3. Drone regulations
4. Principle of aerodynamics for Drones
5. Drone simulator

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	10%	--	10%	--	--
CO-2	30%	30%	30%	33%	30%	30%	30%
CO-3	30%	30%	30%	34%	30%	30%	30%
CO-4	15%	10%	15%	--	15%	20%	20%
CO-5	15%	20%	15%	33%	15%	20%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:
***:** Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.
******: Mentioned under point- (N)
#: Mentioned under point-(O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant Cos Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0. Introduction to Drone Technology	6	**CO-1**	08	03	02	03
Unit-2.0. Drone and its component	12	**CO-2**	20	05	07	08
Unit-3.0. Drone controller and motion	12	**CO-3**	20	05	07	08
Unit-4.0. Connections and Interfaces of Devices in Drone and Drone Simulator	8	**CO-4**	08	03	02	03
Unit-5.0. Introduction to Python for Drone	10	**CO-5**	14	04	04	06

Total Marks	**48**		**70**	**20**	**22**	**28**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Determine the strength of materials used in drone's frame.	CO-2	60	30	10
2.	Determine the strength of materials used in drones Propellers.	CO-2	60	30	10
3.	Test different parameters of batteries used in drones	CO-2	50	40	10
4.	Test motors suitable for specific Drone application.	CO-2	50	40	10
5.	Test and measure Gyro sensor and Accelerometer and their characteristics.	CO-2	50	40	10
6.	Test different sensors and their characteristics with Microcontroller based Flight controller board.	CO-2, CO-3	50	40	10
7.	Determine thrust/torque of motor by changing different dronemotion	CO-2, CO-3	60	30	10
8.	Test and troubleshoot Flight control board (FCB).	CO-3	60	30	10
9.	Test and perform communication of Flight control board (FCB) with sensor	CO-3, CO-2	60	30	10
10.	Test and perform communication of Flight control board (FCB) with motor.	CO-3, CO-2	60	30	10
11.	Test and perform communication of Flight control board with ESC.	CO-3	60	30	10
12.	Test and perform communication of Flight control board with RF transceiver.	CO-3	60	30	10
13.	Test Hardware assembly for drone.	CO-4 CO-3	50	40	10
14.	Perform different motion in drone simulator.	CO-4	50	40	10
15.	Build and run loops and decision statements for specific applicationin Python.	CO-5	50	40	10
16.	Build and Run functions for specific application and pass arguments in Python.	CO-5	50	40	10
17.	Write basic programming in python to interface different componentof Drones.	CO-5, CO-3	50	40	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ ImplementationStrategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion,

Industrial visits, Industrial Training, Field Trips, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Drone Frame	Tricopter/Quadcopter/Hexacopter	1-13
2.	Propellers	10X4.5 CW/Others	1-13
3.	Speed Sensor	3.3 or 5.0Vdc	1-13
4.	Distance Sensor	5Volt operating voltage	1-13
5.	Gyro sensor and Accelerometer	5Volt operating voltage	1-13
6.	Barometer	Altitude tracking, temp range from 25°C to 40°C	1-13
7.	TOF Sensor	Accurate ranging up to 4 m, Fast ranging frequency up to 50	1-13
8.	Battery	Lithium Polymer Battery,2200mAH/others	1-13
9.	Motor	BLDC,1000kv or 1000RPM/volt	1-13
10.	Electronic speed Controller (ESC)	30 Amp,2-4s or cell	1-13
11.	Flight Controller Unit	KK 2.1.5/ ArdupilotAPM 2.8/ Pixhawk/others	1-13
12.	Transmitter and Receiver for radio signal	4 channels/6 Channels, 2.4 GHz & 5.8 GHz	1-13
13.	Drone Simulator Software	RC flight simulator	14
14.	Python Software	Hardware required-More than 4 GB RAM, 64-bitCPU preferable	15,16,17

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author (s)	Publisher and Edition with ISBN
1.	Make: Getting Started with Drones: Build and Customize Your Own Quadcopter	Terry Kilby & Belinda Kilby	Shroff/Maker Media, First edition 2016, ISBN-978-9352133147
2.	Agricultural Drones: A Peaceful Pursuit	K R Krishna	Apple Academic Press,1st edition 2018, ISBN-978-1771885959
3.	DIY Drone and Quadcopter Projects: A Collection of Drone-Based Essays, Tutorials, and Projects	Editors of Make	Shroff/Maker Media; First edition 2016, ISBN-978-9352133994

4.	Building Multicopter Video Drones: Build andfly multicopter drones to gather breathtakingvideo footage	Ty Audronis	Packt Publishing Limited; Illustrated edition,2014, ISBN-978-1782175438
5.	The Complete Guide to Drones	Adam Juniper	Ilex Press, Extended 2nd Edition,2018 ISBN-9781781575383

(b) Online Educational Resources:

1. https://nptel.ac.in/courses/101104073
2. https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle
3. https://www.scienceabc.com/innovation/what-is-drone-technology.html
4. https://www.dronezon.com/learn-about-drones-quadcopters/what-is-drone-technology-or- how-does-drone-technology-work/
5. https://www.youtube.com/watch?v=OWaXIK9sHeE
6. https://books.google.co.in/books?id=2M0hEAAAQBAJ&printsec=copyright&redir_esc=y #v=onep age&q&f=false

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

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A) Course Code **: 2400504E (T2400504E/P2400504E/S2400504E)**

B) Course Title **:** 3D Printing and Design (Basic)

C) Pre- requisite Course(s) **:** Computer Aided Modeling

D) Rationale **:**

Additive manufacturing (AM) or Additive layer manufacturing (ALM) is the industrial production name for 3D Printing. 3D Printing is a process that makes solid objects from a digital model. It involves depositing material either metal, powdered plastic, or liquid in thin layers (2D) to get a 3D object. This basic course on 3D Printing tries to develop understanding of the process of making real object from digital model in the students. It also covers the software/hardware required, various materials used for FDM based 3D Printing and details about printing process parameters. The knowledge gained through this course will help the students to take up advanced course on 3D Printing in next semester.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Develop CAD models for 3D Printing.
CO-2 Import and Export CAD data in .STL file format to generate GCODE file.
CO-3 Select suitable FDM based 3D Printing material for given applications.
CO-4 Select suitable FDM based 3D Printing process parameters for given situations.
CO-5 Produce products using FDM based 3D Printing processes.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	-	3	2	-	-	2		
CO-2	3	2	-	2	-	-	-		
CO-3	3	3	-	2	3	-	-		
CO-4	3	3	-	2	-	-	-		
CO-5	3	-	3	3	-	3	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400504E	3D Printing and Design (Basic)	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400504E	3D Printing and Design (Basic)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400504E

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain CAD-CAM and related terminologies. *TSO 1b.* Convert the given CAD file format into others. *TSO 1c.* Transfer the given CAD data to CAM facilities. *TSO 1d.* Classify 3D Printing processes. *TSO 1e.* List the advantages of additive manufacturing processes over conventional manufacturing processes. *TSO 1f.* List typical steps involved in 3D printing of an object from digital model. *TSO 1g.* Explain reverse engineering steps for 3D Printing.	**Unit-1.0 Additive Manufacturing Introduction and CAD** 1.1 CAD-CAM and its integration. 1.2 CAD- Part and Surface modeling. 1.3 CAD file formats. 1.4 Additive v/s Conventional Manufacturing processes. 1.5 Process chain for 3D Printing. 1.6 Classification of 3D Printing Processes. 1.7 Product design and prototyping. 1.8 Reverse Engineering for 3D Printing.	**CO1**
Explain the given STL interface terminology. Use the given alternative 3D printing interface. Generate STL file for the given CAD file. Repair the given STL file. Apply part orientation and support techniques for the given situation. Perform slicing of the given CAD model using the given slicing software. Generate tool path using simulation software for the given situation.	**Unit-2.0 Data Preparation for 3D Printing** 2.1 STL interface Specification, STL data generation, STL data Manipulation. 2.2 Advantages and limitations of STL file format, Open files, Repair of STL files, 2.3 Alternative 3D Printing interfaces. 2.4 Part orientation and support generation, Factors affecting part orientation, Various models for part orientation determination. 2.5 The function of part supports, Support structure design, Automatic support structure generation. 2.6 Model Slicing and Contour Data organization, Direct and adaptive slicing: Identification of peak features, Adaptive layer thickness determination. 2.7 Tool path generation.	**CO1, CO2**
TSO 3a. Explain the given 3D Printing process. *TSO 3b.* Select FDM 3D Printing materials for the given application. *TSO 3c.* Select FDM based 3D Printing processes parameters for given application with justification.	**Unit-3.0 Additive Manufacturing Techniques** 3.1 Fused Deposition Modeling (FDM), Stereo lithography (SLA), Selective Laser Sintering (SLS), Binder Jetting, Material Jetting, Direct Energy Deposition and Laminate Object Manufacturing. 3.2 FDM based 3D printing process details.	**CO3, CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	3.3 3D Printing materials and selection for FDM. 3.4 FDM Process parameter for various applications.	
TSO 4a. Identify various Aerospace, Electronics, Health care, Automotive, Construction, Food processing, Machine tool components that can be 3D Printed. *TSO 4b.* Estimate the cost and time of FDM based 3D printing of the given component.	**Unit-4.0 Application of 3D Printing** 4.1 Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defense, Automotive, Construction, Food Processing, Machine Tools	**CO3, CO4**
TSO 5a. Select suitable 3D Printer (FDM) and software for the given application with justification. *TSO 5b.* Analyze the effect of given FDM based 3D printing process parameters using 3D printer software simulation. *TSO 5c.* List steps to perform 3D scanning of the given object. *TSO 5d.* Repair 3D scanned digital model. *TSO 5e.* Set different FDM 3D printing process parameters to get a sound plastic component.	**Unit-5.0 3D Printers and Software and Scanners** 5.1 Construction details and working of established FDM based 3D printers for plastics parts. 5.2 Accuracy, Precision and Tolerance in 3D printing. 5.3 3D Printer software- Fusion 360, Solidworks, Onshape, Tinkercad, Ultimaker Cura, MeshLab, Simplyfy 3D, Repetier host, Slic3r, etc. – use and operation of anyone. 5.4 3D Scanners and working. 5.5 Producing a part using FDM based 3D Printer.	**CO4, CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504E

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use CAD software. *LSO 1.2.* Prepare digital models of simple 3D entities.	1.	Develop digital models of following simple components using any CAD software: • Nut • Bolt • Network cable Jack • Coat button • Spoon	CO1
LSO 2.1. Prepare digital models of complex 3D entities and assemblies.	2.	Develop digital models of following assemblies using any CAD software: • Connecting Rod • Piston • Electric switch • Bathroom Tap • Mouse	CO1
LSO 3.1. Surf web for downloading readymade free CAD models. *LSO 3.2.* Convert one CAD file format into another.	3.	Download three digital CAD models freely available on web in different formats and then convert them into .stl/obj format.	CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)	
LSO 4.1. Use the given Slicing software for 3D Printing. *LSO 4.2.* Perform slicing operation on the given digital model.	4.	Perform slicing operation on one digital model available under each Pr. No.1, 2 and 3.	CO2	
LSO 5.1. Use the available 3D printing software. *LSO 5.2.* Selection of 3D printing process and performance parameters.	5.	Analyse the effect of different process parameters, materials on printing time, material required, surface finish, etc. through simulation using 3D printing software on sliced models available from Pr. No. 4	CO3, CO4, CO5	
LSO 6.1. Produce single plastic components using available 3D printer. *LSO 6.2.* Perform post processing operations on printed component.	6.	Print one single component on available FDM based 3D printer with PLA/ABS material	CO3, CO4, CO5	
LSO 7.1. Select appropriate layer thickness, tolerance, fit. *LSO 7.2.* Produce an assembly of plastic components using available 3D printer.	7.	Print one assembly on available FDM based 3D printer with PLA/ABS material	CO3, CO4, CO5	
LSO 8.1. Choose suitable material for printing flexible structure (assembly of same small pieces to give flexible fabric effect). *LSO 8.2.* Choose suitable design/shape to create a flexible type structure. *LSO 8.3.* Produce flexible plastic structure using available 3D printer.	8.	Model and print a flexible fabric structure with PLA/ABS material (assembly of same small pieces to give flexible fabric effect)	CO3, CO4, CO5	
LSO 9.1. Selection of 3D printing process parameters.	9.	Change printing process parameters and repeat experiment number 6.	CO4, CO5	
LSO 10.1. Use of available 3D scanner. *LSO 10.2.* Develop 3D digital model using scanning approach. *LSO 10.3.* Modeling of complex 3D objects using 3D scanning.	10.	Scan the given complex component using available 3D Sanner.	CO5	
LSO 11.1. Produce a complex plastic structure using available 3D printer and scanner. *LSO 11.2.* Apply Reverse Engineering approach to exactly 3D print an existing real object.	11.	Print the 3D scanned digital model of Pr. No. 10 on available FDM based 3D printer with PLA/ABS material	CO5	

L) Suggested Term Work and Self Learning: S2400504E

Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

a. Micro Projects:

1. Perform 3D printing of plastic casing of inhaler used by Asthma patients and estimate the cost.
2. Download 5 videos on 3D printing of different components, watch them and write a report to detail out the steps involved, 3D Printer used, 3D Printing software used, material used, complexity involved, printing time, post processing steps used.
3. Print two pieces of same components using ABS and PLA and compare their strength, surface roughness, weight, cost.
4. Download two 3D printing free software and try to check their compatibility with your lab printer.

c. Other Activities:

1. Seminar Topics:
   - Commercially available 3D printers and software.
   - Strength of 3D printed Plastic components as compared to Die cast Plastic components.
   - Properties of PLA and ABS 3D printing materials.
   - Reverse engineering application of 3D Printing.

2. Visits: Visit nearby tool room/industry with 3D Printing facilities. Prepare report of visit with special comments of 3D printing technique used, material used, single component/batch production/mass production and cost of printed component.

3. Self-Learning Topics:
   - 3D printing of flexible plastic components.
   - 3D printing of micro/mini components.
   - Conversion of CAD file formats into IGES.
   - 3D scanning process.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	-	-	20%	20%
CO-2	10%	10%	10%	25%	-	10%	20%
CO-3	15%	15%	15%	25%	33%	15%	20%
CO-4	30%	30%	30%	25%	33%	15%	20%
CO-5	30%	30%	30%	25%	34%	40%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Additive Manufacturing Introduction and CAD	8	CO1	10	3	3	4
Unit-2.0 Data Preparation for 3D Printing	8	CO1, CO2	10	3	2	5
Unit-3.0 Additive Manufacturing Techniques	8	CO3, CO4	10	5	2	3
Unit-4.0 Application of 3D Printing	12	CO3, CO4	20	5	6	9
Unit-5.0 3D Printers and Software and Scanners	12	CO4, CO5	20	4	6	10
Total	**48**	**-**	**70**	**20**	**19**	**31**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Develop digital models of following simple components using any CAD software: • Nut • Bolt • Network cable Jack • Coat button • Spoon	CO1	30	60	10
2.	Develop digital models of following assemblies using any CAD software: • Connecting Rod • Piston • Electric switch • Bathroom Tap • Mouse	CO1	40	50	10
3.	Download three digital CAD models freely available on web in different formats and then convert them into .stl/obj format.	CO1	30	60	10
4.	Perform slicing operation on one digital model available under each Pr. No.1, 2 and 3.	CO2	30	60	10
5.	Analyse the effect of different process parameters, materials on printing time, material required, surface finish, etc. through simulation using 3D printing software on sliced models available from Pr. No. 4	CO3, CO4, CO5	30	60	10
6.	Print one single component on available 3D based Printer with PLA/ABS material	CO3, CO4, CO5	30	60	10
7.	Print one assembly on available 3D based Printer with PLA/ABS material	CO3, CO4, CO5	30	60	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
8.	Model and print a flexible fabric structure with PLA/ABS material (assembly of same small pieces to give flexible fabric effect)	CO3, CO4, CO5	40	50	10
9.	Change printing process parameters and repeat experiment number 6.	CO4, CO5	40	50	10
10.	Scan the given complex component using available 3D Sanner.	CO5	40	50	10
11.	Print the 3D scanned digital model of Pr. No. 10 on available 3D based Printer with PLA/ABS material	CO5	30	60	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	High end computers	Processor Intel Core i7 with Open GL Graphics Card, RAM 32 GB, DDR3/DDR4, HDD 500 GB, Graphics Card NVIDIA OpenGL 4 GB, OS Windows 10	All
2.	Parametric Computer Aided Design software	CATIA/Solid works/NX/Creo **OR** Available with CoE	1,2
3.	3D printer	Fused Deposition Modelling system with complete accessories; Build Volume-300 x 300 x 300mm or Higher; Layer Thickness-0.1 – 0.4 **OR** Available with CoE	6, 7, 8, 10
4.	3D Printing Material	ABS/PLA **OR** Available with CoE	6, 7, 8, 10
5.	3D Printing software	Latest version of software like: Cura/PrusaSlicer/ideaMaker/Meshmixer/MeshLab **OR** Available with CoE	3,4
6.	Post processing equipments and tools	Deburring tools (tool handle & deburring blades), Electronic Digital Caliper, Cleaning Needles, Art knife set, Long nose pliers, Flush cutters, Wire brush, Nozzle cleaning kit, Tube cutter, Print removal spatula, Needle file, Cutting mat, Glue stick, Wire stripper etc.	6, 7, 8, 10
7.	3D Scanner and Processing software	Handheld 3D scanner, Accuracy up to 0.1 mm, Resolution up to 0.2 mm, Real time onscreen 3D model projection and processing, Wireless technology with an inbuilt touch screen and battery, Extended field of view for capturing both large and small objects, Processing Software **OR** Available with CoE	10

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing	Andreas Gebhardt,	Hanser Publisher, 2011 ISBN: 156990507X, 9781569905074
2.	3D Printing and Design	Sabrie Soloman	Khanna Publishing House, Delhi ISBN: 9789386173768
3.	3D Printing and Rapid Prototyping- Principles and Applications	C.K. Chua, Kah Fai Leong	World Scientific, 2017 ISBN: 9789813146754
4.	Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution	Liza Wallach Kloski, Nick Kloski	Make Community, LLC; 2nd edition, 2021 ISBN: 9781680450200

(b) Online Educational Resources:

1. https://onlinecourses.nptel.ac.in/noc21_me115/preview
2. https://archive.nptel.ac.in/courses/112/104/112104265/
3. https://www.youtube.com/watch?v=b2Od4YHcLAQ
4. https://www.youtube.com/watch?v=EF8CNR-gcXo
5. https://www.academia.edu/41439870/Education_Resources_for_3D_Printing
6. https://www.think3d.in/landing-pages/beginners-guide-to-3d-printing.pdf
7. https://all3dp.com/1/types-of-3d-printers-3d-printing-technology/

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. 3D Printing Projects DK Children; Illustrated edition, 2017
2. The 3D Printing Handbook: Technologies, design and applications Ben Redwood, Filemon Schöffer, Brian Garret, 3D Hubs; 1st edition, 2017
3. 3D Printer Users' Guide
4. 3D Printer Material Handbook
5. Lab Manuals

******

A) Course Code : **2400504F (T2400504F/P2400504F/S2400504F)**

B) Course Title : Industrial Automation (Basic)

C) Pre- requisite Course(s) : Basic Mechanical Engineering, Basic Electrical Engineering, Digital Electronics and Basic programming skills

D) Rationale :

The technological education and research scenario, all over the world, is turning towards a multidisciplinary one. The present scenario is different as compared to the recent past in the sense that the engineering disciplines are now dilating instead of diverging. The primary reason being that the current technological designs are of highly complex and inter-interdisciplinary nature involving synergistic integration of many aspects of engineering knowledge base**.** Industrial automation has become an essential part of every modernindustry. Automation helps industry to increase the productivity, quality, accuracy and precision of industrial processes. Stiff competition, higher quality standards and growing concerns of safety & environmental damage have pushed the Industrial sector to adapt state-of-the-art Automation Techniques for effective utilization of resources and optimized performance of the plants. Today engineer is needed to meet the requirements of designing appropriate automation systems. They should have the knowledge of different fields like PLC and PID based Controller, Instrumentation, Networking, Industrial Drives, SCADA/HMI, High speed data acquisition, etc., to become a successful automation engineer. The discipline Automation is enormous in magnitude. The students passing this course will gain basic understanding about industrial automation and will be prepared to take up the advance course in Industrial automation in next semester**.**

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1 Apply principles and strategies for automation for a given situation.

CO-2 Use sensors and input devices as per given situation.

CO-3 Test the given PLC for its functionality.

CO-4 Use actuators and output devices as per given situation.

CO-5 Test the working of various types of control system and controllers

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	2	-	2	2	-	2		
CO-2	3	2	2	2	-	-	2		
CO-3	3	2	2	2	2	-	2		
CO-4	3	2	2	2	2	-	2		
CO-5	3	2	2	2	-	-	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

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		L	T				
2400504F	Industrial Automation (Basic)	03	-	04	02	09	06

Legend:

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Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

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C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
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2400504F	Industrial Automation (Basic)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

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TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon thecompletion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Society connect, Multidisciplinary aspects, Indian Knowledge System (IKS) and others need to be integrated.

J) Theory Session Outcomes (TSOs) and Units: T2400504F

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1. a Describe Industry 4.0 and its component TSO.1. b Explain different types of automation systems TSO.1.c Identify the type of automation used in a given industry TSO.1.d Analyze the working of industrial processes and products for automation. TSO.1.e Select principles and strategies for automation for a given situation using 4R's and 1U TSO.1. f Select criteria for factory automation and processes automation for a given industry. TSO.1. g Describe briefly different systems used for industrial automation. TSO.1.h Describe IOT, IIOT and role of robots with respect to automation.	**Unit-1.0 Overview of Industrial Automation** Introduction to Industry 4.0 and its components, Issues and challenges in automation Need of automation in industries, Principles and strategies of automation, factory automation, process automation Basic elements of an automated system, Structure of Industrial Automation Advanced automation functions, Levels of automations Industrial control Systems- Process and Discrete system Types of automation system: Fixed, Programmable, Flexible Integrated Automation and its application Different systems used for Industrial automation: PLC, HMI, SCADA, DCS, Drives. Introduction to Internet of Things (IoT) and Industrial Internet of Things (IIOT) and its application in Automation. Role of robots in automation and its components.	**CO1**
TSO.2. a Explain PLC and list its advantages over relay systems. TSO.2.b Distinguish between PLC and a PC, PLC and dedicated controllers. TSO.2.c List the types of PLCs and brands available in the market. TSO.2.d Describe the function of each block of a PLC with the help of a block diagram. TSO.2.e Describe the basic sequence of operation of a PLC with a simple example. TSO.2.f Explain different PLC programming languages withsimple examples. TSO.2.g Describe a simple PLC programming using ladder logic specifying I/O addressing TSO.2.h List the applications of PLC	**Unit-2.0 Fundamentals of PLC** Introduction to PLC, evolution of PLC • Comparison of PLC and Personal Computer(PC) • Comparison of PLC and dedicated controllers like PAC and CNC • Types of PLC – Fixed, Modular and their types • Different brands of PLCs available in the market Building blocks of PLC -CPU, Memory organization, Input-Output modules (Discreteand Analog) Specialty I/O Modules, Power supply PLC programming languages with simpleexamples: • Functional Block Diagram (FBD), • Instruction List. • Structured text, • Sequential Function Chart (SFC), • Ladder Programming PLC I/O addressing in ladder logic Simple programming example using ladderlogic Applications of PLC: Traffic light control, Elevator control, Motor sequencing control, Tank level control, temperature control, Conveyor system control	**CO2**
TSO.3.a Identify the commonly used input field devices in PLC installations along with their symbols. TSO.3.b Draw symbol of various switches used in PLC installations describing the function of each switch. TSO.3.c Identify the various digital input devices used in a PLC installation. TSO.3.d Identify the commonly usedsensors as input field devices found in PLC installations. TSO.3.e Describe the working of different types of	**Unit 3.0 – Sensors and Input field Devices** Analog input devices-Electromagnetic relays, Contactors, Motor starters, Manually operated Switches Toggle switch, pushbutton switch, knife switch and selector switches Mechanically operated switches, Limit switch, Temperature switch (Thermostat), Pressure switch, Level switch and their symbols Discrete/Digital Input device, Constructionand working of Sensors	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
discrete sensors giving their applications. TSO.3.f Describe the working of different types of advanced sensors giving their applications. TSO.3.g Select Sensors as per the given requirement for ecofriendly automation	• Proximity sensors- Inductive, Capacitive, Optical and ultrasonic Advanced sensors- Construction and workingof • Temperature sensors- Thermistor, Thermocouple and Resistance temperature Detector (RTD) • Liquid level sensor -Capacitive and Ultrasonic • Force -Strain/Weight sensors • Flow sensors – turbine flow sensor • Pressure sensors- Linear Variable Differential Transformer (LVDT) • Inclination sensor -Inclinometer • Acceleration sensor- Accelerometer Angular and linear position sensor	
TSO.4.a Classify the actuators. TSO.4.b Describe the construction and working of a given actuator. TSO.4.c Explain the basic principle of operation of a given actuator. TSO.4.d Differentiate between hydraulic and pneumatic actuators TSO.4.e Explain the basic principle of operation of a given control valve. TSO.4.f Select actuators and valves as per the given requirement for ecofriendly automation. TSO.4.g Develop different hydraulic and pneumatic circuits for simple application. TSO.4.h Identify the commonly used output field devices in PLC installations TSO.4.i Draw the symbol of various output devices used in PLC installations describing the function of each. TSO.4.j Select output devices for a PLC installation as per the requirement.	**Unit 4.0- Actuators and output Devices** Introduction to actuators, Classification ofactuators Mechanical actuators -Translational and rotation motion, kinematic chains,cams, gears, belt and chain drives, bearings Hydraulic and Pneumatic actuators- linear and rotary actuators, single and doubleacting cylinder, directional, process and pressure control valves Electrical actuators • Electromechanical actuators Construction, working and application of Stepper motors, AC/DC Servo motors,BLDC Motor (Very brief) • Electrohydraulic actuators-Construction, working and application of Electro- hydrostatic actuator (EHA), ON/OFF Electro-hydraulic Rotary Actuator (E2H90, Control Valve Rotary Actuator (E2HR), Solenoid valve Thermal actuators -Construction, working and application of Hot-And-Cold-Arm Actuators, Chevron-Type Actuators Magnetic actuators- Construction, working principle and application of Moving coil actuators, moving magnet actuator, Moving iron actuator Selection criteria of actuators Other Output devices- Indicators, Alarms Pilot Lights, Buzzers, Valves, Motor starters, Horns and alarms, Stack lights Control relays,Pumps and Fans.	**CO4**
TSO.5.a Describe the basic process control system with the help of a block diagram TSO.5.b Explain the types of control available in a process control TSO.5.c Describe the different types of controllers in a closed loop systemwith the help of a block diagram TSO.5.d Describe the construction, working and application of a given control system components.	**Unit 5.0– Control System** Block diagram of a basic control system Open and closed loop system, their transfer function First order and second order system and their output response and parameters Different types of inputs-step and ramp Types of control – On-off, Feed forward, Open loop and closed loop control and Transfer function Controllers in closed loop control • Proportional Controller (P Controller) • Integral Controller (I Controller) • Derivative controller (D- Controller)	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	• P-I Controller • P-D Controller PID Controller	

Note: One major TSO may require more than one theory session/period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504F

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Identify various building blocks and major automation components in a given robotic system LSO 1.2 Identify various building blocks and major automation components in a given electrical drives	1.	Identify major automation components in a given system	CO1
LSO 1.3 Analyze and plan the steps to automate the given system.	2.	Analyze given traditional machine in the laboratory for and identify thesteps and components required to automate it.	
LSO 1.4. Identify the building blocks of a given typical SCADA system LSO 1.5. Identify the symbol library of SCADA software	3.	Use Scada software for simple application	
LSO 2.1 Identify the various parts and front panel status indicators of the given PLC.	4.	Observe various parts and frontpanel indicators of a PLC	CO2
LSO 2.2 Identify different input and output devices that can be connected to a given PLC.	5.	Observe different types of switches and their symbols sensors, lamp, alarm, motor, fan used in a PLC	
LSO 2.3 Test the analog input and output lines of the given PLC.	6.	Identify Analog input and output lines of a PLC	
LSO 2.4 Test the digital input and outlines of the given PLC.	7.	Identify digital input and output lines of a PLC	
LSO 2.5 Use PLC to control the devices like Lamp, Alarm, motor using push button switches	8.	Practice using PLC to control various digital and analog output devices	
LSO 3.1. Test the response of digital inductive proximity sense or used to detect different types of materials	9.	Identify different types of digital inductive proximity sensor and itsuse	CO3
LSO 3.2. Test the response of digital capacitive proximity sensors used to detect o different materials	10.	Identify different types of digital capacitive proximity sensor and itsuse	
LSO 3.3. Test the response of digital optical proximity sensor used to detect different materials	11.	Identify different types of digital optical proximity sensor and its use	
LSO 3.4. Test the response of digital ultrasonic proximity sensors used to detect different materials	12.	Identify different types of digital ultrasonic proximity sensor and itsuse	
LSO 3.5. Use thermistor to measure temperature of a given material	13.	Identify different types ofthermistor and its use	
LSO 3.6. Use Thermocouple to measure the temperature of a given liquid and plot the output voltage versus temperature	14.	Observe the conversion of temperature to electric parameter conversion of a Thermocouple	
LSO 3.7. Use RTD to control the temperature of an oven	15.	Observe different types of RTDs usedin industries for temperature measurement	

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 3.8. Use flow sensors to measure the flow of a given liquid or gas	16.	Observe different types of flow sensors used in industries for flow measurement	
LSO 3.9. Use pressure sensors to measure the pressure of a liquid or gas	17.	Observe different types of pressure sensors used in industries for pressure measurement	
LSO 3.10. Use load cell for measurement of mechanical force/weight.	18.	Observe the different types of loadcell used in industries for force/weight measurement	
LSO 4.1 Design and actuate pneumatic circuit for lift control LSO 4.2 Design a pneumatic system that rivets the pockets on jeans LSO 4.3 Design pneumatic circuit to open and close the security gate and control the speed. LSO 4.4 Design a circuit for speed control of hydraulic motor meter out circuit by using 4/3 DC valve. LSO 4.5 Design a circuit for speed control of double acting cylinder meter in by using 4/2 dc solenoid valve. LSO 4.6 Designing a circuit for speed control of double acting cylinder meter out by using 4/3 solenoid valve	19.	Design and actuate pneumatic/ hydraulic circuit for the given situation	CO4
LSO 4.7 Direct acting of hydraulic motor	20.	Operate hydraulic motor	
LSO 4.8 Operate stepper motor and control the motor by changing number of steps, the direction of rotation and speed.	21.	Operate stepper motor	
LSO 4.9 Identify the components of thermal and magnetic actuators available in the laboratory. LSO 4.10 Use thermal and magnetic actuators	22.	Thermal and magnetic actuators	
LSO 5.1 Test the output response of a open loop closed loop and feed forward path	23.	Analyze the given system to studyopen loop, closed loop and feed forward path.	CO5
LSO 5.2 Build and test the output response of a first order system for a step input using a CRO	24.	Analyze the given first order system and its transfer function and output response	
LSO 5.3 Build and test the response of a second order system for a step input using CRO. Also mark various parameters	25.	Analyze the given second order system and its transfer function andoutput response	
LSO 5.4 Test the Output response of an on-off and Proportional control-based level control system.	26.	Analyze the given water level control system with on-off, Proportional control.	
LSO 5.5 Test the Output response pf a P+I+D based level control system.	27.	Analyze the given water level control system with P+I+D control.	

L) Suggested Term Work and Self Learning: S2400504F

Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

i. State three advantages of using programmed PLC timer over mechanical timing relay.

ii. Prepare a list of opensource PLC software

iii. Prepare a list of opensource SCADA software.
iv. List the practical applications of PLC systems
v. List the practical applications of SCADA systems.
vi. Compare the PLC and PC with regard to:
- Physical hardware differences
- Operating environment
- Method of programming
- Execution of program

vii. Prepare classification chart of different types of actuators.
viii. Differentiate between Nano and micro actuators.

b. Micro Projects:

1. Develop a relay-based motor control automation such that the motor reverses its direction when the limit switches are activated.
2. Develop a simulation to connect analog and digital input to the PLC.
3. Develop a simulation to connect analog and digital output to the PLC.
4. Develop a simple automatic water level controller using magnetic float switch.
5. Develop a simple automatic door system using optical sensor and linear actuator.
6. Troubleshoot the faulty equipment/kit available in automation laboratory
7. Select one industry and analyze the process and propose the automation strategies' that can be used for automation.
8. Develop a working model of a given application using given actuators and valves.

c. Other Activities:

1. Seminar Topics- PLC architecture, Different types of sensors, Industrial Applications of PLC and SCADA
2. Visits – Visit any industry with full or semi automation and prepare a report on type of automation used.
3. Surveys-Carry out a market/internet survey of PLC and prepare the comparative technicalspecifications of any one type of PLC (Micro or Mini) of different manufacturer.
4. Product Development- Develop a prototype automatic railway crossing system
Software Development- Download any opensource software for PLC and install on your laptop/PC and carry out basic PLC programming
5. Surveys – carry out market survey for different types of electrical actuators available and prepare the comparative technical specifications of electrical actuators used in industries.
6. Visit industry and prepare a report on different types of hydraulic and pneumatic circuits used by the industry in the given section, components used, power requirement, output achieved and maintenance activities required.

d. Self-Learning Topics:

1. Use of PLC for different industrial applications
2. Use of sensors in commercial field
3. Use of sensors in home automation
4. Compare Specifications of PLCs of different manufacturers of any one type PLC

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	20%	--	30%	20%	20%
CO-2	20%	25%	20%	--	20%	25%	20%
CO-3	25%	20%	20%	30%	20%	20%	20%
CO-4	25%	20%	20%	20%	30%	20%	20%
CO-5	15%	20%	20%	50%	--	15%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

***:** Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

******: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Overview of Industrial Automation	8	CO1	11	3	4	4
Unit-2.0 Fundamentals of PLC	12	CO2	17	5	5	7
Unit-3.0 Sensors and Input field Devices	9	CO3	14	4	6	4
Unit-4.0 Actuators and Output Devices	10	CO4	14	4	6	4
Unit- 5.0 Control System	9	CO5	14	4	5	5
Total Marks	**48**		**70**	**20**	**26**	**24**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant Cos Number (s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Identify major automation components in a given system	CO1	50	40	10
2.	Analyze given traditional machine in the laboratory for and identify the steps and components required to automate it.	CO1	50	40	10
3.	Use Scada software for simple application	CO1	50	40	10
4.	Observe various parts and front panel indicators ofa PLC	CO2	50	40	10
5.	Observe different types of switches and theirsymbols sensors, lamp, alarm, motor, fan used in a PLC	CO2	50	40	10
6.	Identify Analog input and output lines of a PLC	CO2	50	40	10
7.	Identify digital input and output lines of a PLC	CO2	50	40	10
8.	Practice using PLC to control various digital and analog output devices	CO2	50	40	10
9.	Identify different types of digital inductiveproximity sensor and its use	CO3	50	40	10
10.	Identify different types of digital capacitiveproximity sensor and its use	CO3	50	40	10
11.	Identify different types of digital optical proximity sensor and its use	CO3	50	40	10
12.	Identify different types of digital ultrasonicproximity sensor and its use	CO3	50	40	10
13.	Identify different types of thermistor and its use	CO3	50	40	10
14.	Observe the conversion of temperature toelectric parameter conversion of a Thermocouple.	CO3	50	40	10
15.	Observe different types of RTDs used in industries for temperature measurement	CO3	50	40	10
16.	Observe different types of flow sensors used inindustries for flow measurement	CO3	50	40	10
17.	Observe different types of pressure sensors used in industries for pressure measurement	CO3	50	40	10
18.	Observe the different types of load cell used inindustries for force/weight measurement	CO3	50	40	10
19.	Design and actuate pneumatic/ hydraulic circuitfor the given situation	CO4	50	40	10
20.	Operate hydraulic motor	CO4	50	40	10
21.	Operate stepper motor	CO4	50	40	10
22.	Thermal and magnetic actuators	CO4	50	40	10

S. No.	Laboratory Practical Titles	Relevant Cos Number (s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
23.	Analyze the given system to study open loop,closed loop and feed forward path.	CO5	50	40	10
24.	Analyze the given first order system and its transfer function and output response	CO5	50	40	10
25.	Analyze the given second order system and itstransfer function and output response	CO5	50	40	10
26.	Analyze the given water level control system with on-off, Proportional control.	CO5	50	40	10
27.	Analyze the given water level control system withP+I+D control.	CO5	50	40	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to beprepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ ImplementationStrategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	SCADA software (reputed make like Allen Bradley, Siemensetc.,)	Ready-to-use symbol library, React and respond in real-time, Real-time monitoring, Friendly, manageable, secure, extensible, Easy-to-use, easy to implement, Easy configuration, simplified maintenance, Communication with PLC, easy and flexible alarm definition, data collection and analysis for new and existing systems, easy-to-use for report generation, open access to historical data, different packages available with input/output structure. Open source software SCADA software: like Ellipse/FTVSE/Wonderware/ open SCADA can also be used	3
2.	Universal PLC Training System with HMI (Of reputed make such as Allen bradely, Siemens, etc.,) Compatible with SCADA software	Human Machine Interface (HMI) display, PLC with 16 digital inputs, 16 digital outputs with RS232 communication facility. Open platform to explore wide PLC and HMI applications. Industrial look & feel. Toggle switches, push to ON switch, proximity sensor, visual indicator, audio indicator, and DC motor. Experiments configurable through patch board. Powerful instruction sets. Several sample ladder and HMI programs. PC based ladder and HMI programming. Extremely easy and student friendly software to develop different programs. Easy downloading of programs. Practice troubleshooting skills. Compact tabletop ergonomic design. Robust construction. PLC gateway for cloud connectivity. Open	4,5,6,7,8

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		source software like Ladder logic simulator, Pico soft Simulator, Logixpro simulator, Simple EDA tools can also be used	
3.	Proximity sensors kit	The kit should comprise of the following proximity sensor - Inductive Proximity Sensor, Capacitive Proximity Sensor,Magnetic Sensor, Optical Sensor, Audio and LED indicator for the object detection. Along with learning material	9,10,11,12
4.	Temperature transducer kit	Temperature Transducers Test Bench includes different types of temperature sensors including bimetallic strip, RTD, thermocouple, thermistor, RTD/thermocouple temperature display and thermistor, temperature display, heater, fan, switches and its indicator. Separate heater and fan chamber withstand. On panel digital voltmeter, digital ammeter, RTD/thermocouple temperature display, NTC temperature display, toggle switch for heater and fan with indicator, experiments configurable through patch board, heavy duty Test bench, castor wheel (with locking mechanism) is provided at legs of Test bench so that it can be easily moved, enhanced electrical safety consideration.	12,13,14
5.	Pressure transducer kit	Pressure transducer kit should include different types of pressure sensors including capacitive pressure transducer, load cell, bourdon tube pressure gauge, and pressure vessel. Pressure vessel with pressure gauge, safety valve, non-returning valve bourdon gauge and capacitive transducer and air compressor, on panel digital voltmeter, digital ammeter, 4-20ma display, 0-10V DC display, toggle switch for compressor, load cell with suitable weight, experiments configurable through patch board, self -contained, bench-mounting arrangement, castor wheel (with locking mechanism) is provided at legs of Test bench so that it can be easily moved, enhanced electrical safety consideration. Detailed experiment manual should be supplied with the kit.	16
6.	Flow sensor kit	Turbine flow sensor kit	15
7.	Strain Gauge kit	The kit should provide study of Strain Gauge and their application for measurement of Strain. It should help to study bridge configuration of Strain Gauge and the signal conditioning circuits required to measure strain. It should use cantilever beam arrangement to produce strain on Strain Gauge. The Strain Gauges are firmly cemented to the cantilever at the point where the strain is to be measured. Weights are placed on free end of cantilever. Strain developed changes the resistance of Strain Gauge which is detected by full bridge configuration. It should comprise of Seven-segment LED display showing strain in micro strain units. Different weights should be provided to perform linearity and sensitivity experiments. Detailed experiment manual should be supplied with the kit. Test-points to observe input output of each block, onboard gain and offset null adjustment, built in DC Power Supplies, 3½ digits LED display, onboard Cantilever	17

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		arrangement, high repeatability and reliability The kit should be capable of performing following experiments: • Measuring strain using strain gauges and cantileverassembly. • Determination of linear range of operation of strainmeasurement. Determination sensitivity of the kit	
8.	Cut sections of pumps, actuators, valves and accessories used in hydraulic systems	Suitably cut and mounted on a sturdy base to show the internal details.	18
9.	Working models of pumps, actuators, valves and accessories used in hydraulic systems	Working models mounted on sturdy base to demonstrate theoperation.	18
10.	Working models of pumps, actuators, valves and accessories used in pneumatic systems	Working models mounted on sturdy base to demonstrate theoperation.	18
11. 8	Oil Hydraulic trainer	Mounted on sturdy base fitted with all standard units andaccessories to create various hydraulic circuits. Hydraulic trainer with simulation software Pneumatic trainer with simulation software • Filter Regulator Combination with Lubricator (FRL Unit) withpressure gauge, Junction Box with slide valve, Push Button Valve, 3/2 NC Roller lever valve ,3/2 NC Roller lever valve ,5/2 Double external pilot operated valve, 5/2 External pilot operated valve with spring return, 5/2 Hand lever with spring return, 5/2 Hand lever valve with detent – for maintained pilot operation of a SAC, 5/2 Valve with Lever head, 5/2 Value with Mushroom head, Flow control valve – Metering IN & OUT, Shuttle Valve (OR valve), Quick ExhaustValve with Quick coupler plug • Double Acting Cylinder (DAC) with Quick coupler socket (with accessories: Screw driver – for cushioning adjustment),Single Acting Cylinder (SAC), Swivel fitting assembly with Quick coupler plug, Multi distributor fittings (for cascading circuit designing) • Single Solenoid Valve with Spring Return (with LED), Double Solenoid Valve (with LED), Magnetic Reed Switch, Magnetic Reed Switch, Relay Logic Unit – 2C/0-3 relays, Electrical Push Button Unit, Electrical Selector Switch Unit, Timer	18
12.	Pneumatic Trainer	Mounted on sturdy base fitted with all standard units and accessories to create various Pneumatic circuits. Pneumatic trainer with simulation software • Filter Regulator Combination with Lubricator (FRL Unit) with pressure gauge, Junction Box with slide valve • Push Button Valve, 3/2 NC Roller lever valve, 3/2 NC Roller lever valve, 5/2 Double external pilot operated valve (Memoryvalve) • 5/2 External pilot operated valve with spring return, 5/2 Hand lever with spring return, 5/2 Hand lever valve with detent, 5/2Valve with Lever head ,5/2 Value with Mushroom head,	18

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		Flow control valve, Shuttle Valve (OR valve), AND valve • Quick Exhaust Valve with Quick coupler plug, Double Acting Cylinder (DAC) with Quick coupler socket, Single Acting Cylinder (SAC), Swivel fitting assembly with Quick coupler plug • Aluminum Profile Table Top, Profile Table Top, Miniature Double Acting Cylinder (DAC), Single Solenoid Valve with Spring Return, Double Solenoid Valve (with LED) • Magnetic Reed Switch, Relay Logic Unit – 2C/0-3 relays, Electrical Push Button Unit, Electrical Selector Switch Unit (Black Selector – 1 no, Green Push Button – 1 no), Timer, Simulation software	
13.	Advanced Electro - Hydraulic and Electro - Pneumatic Hardware systems with work stationsand simulation software	• Electro - Hydraulic and Electro - Pneumatic Hardware systemswith PLC and simulation software Profile plate, Frame with Castor Wheels, Filter, Lubricator, Regulator with pressure gauge, Hand Slide Valve, Connectioncomponent set, Plastic Tubing, Power Supply & cables, Pressure Gauge, 3/2 Way double solenoid valve	18
14.	Output devices	Servomotor, DC motor, AC motor, stepper motor, Conveyer Belt control by PLC, water level control etc.	18,19,20
15.	Thermal actuators	Hot-And-Cold-Arm Actuators, Chevron-Type Actuators	21
16.	Magnetic actuators	Moving Coil Controllable Actuators, Moving Iron ControllableActuator	21
17.	Open and closed loop control system kit	Open and closed loop system kit should be able to measure theoutput response using CRO	22
18.	First and second order control system	First and second order system with input and output terminalsprovision	23,24
19.	Process control system with feed forward path kit	Process control system with feed forward path kit with input and output terminals provision	22
20.	PID Controller Test Bench	PID Controller Test Bench is a complete setup to control process through two-point (on/off) and three-point (PID) controllers. Industrial PID controller with RS485 communication facility, Thermocouple temperature sensor, Float switch for detection of water level, Temperature measurement and control, User friendly software, USB Interface, Heavy duty Test bench, Electrical control panel, Leak proof sturdy piping and tanks, SS Sump tank for inlet and outlet of water, Enhanced electricalsafety considerations, Caster wheel (with locking mechanism) at the legs of Testbench for easy movement.	25,26

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author (s)	Publisher and Edition with ISBN
1.	Introduction to Programmable Logic Controllers	Dunning, G.	Thomson /Delmar learning, New Delhi, 2005,ISBN13: 9781401884260
2.	Programmable Logic Controllers	Petruzella, F.D.	McGraw Hill India, New Delhi, 2010, ISBN:9780071067386
3.	Programmable Logic Controllers	Hackworth, John; Hackworth,Federic	PHI Learning, New Delhi, 2003, ISBN:9780130607188
4.	Industrial automation and Process control	Stenerson Jon	PHI Learning, New Delhi, 2003, ISBN: 9780130618900
5.	Programmable Logic Controller	Jadhav, V. R.	Khanna publishers, New Delhi, 2017, ISBN: 9788174092281
6.	Programmable Logic Controllers and IndustrialAutomation - An introduction,	Mitra, Madhuchandra; Sengupta, Samarjit,	Penram International Publication, 2015,ISBN: 9788187972174
7.	Control System	Nagrath & Gopal	New Age International Pvt Ltd, ISBN:9789386070111, 9789386070111
8.	Linear Control Systems with MATLAB Applications,Publisher:	Manke, B. S.	Khanna Publishers, ISBN: 9788174093103,9788174093103
9.	Supervisory Control and Data Acquisition	Boyar, S. A.	ISA Publication, USA, ISBN: 978-1936007097
10.	Practical SCADA for industry,	Bailey David; Wright Edwin	Newnes (an imprint of Elsevier), UK 2003,ISBN:0750658053

(b) Online Educational Resources:

1. Process Automation Control- online Tutorial: www.pacontrol.com
2. PLC product: www.seimens.com
3. www.ab.rockwellautomation.com
4. PLC product: www.abb.co.in
5. Different product of PLC and Peripherals, Smart Tile CPU Board, All in one lighting energy controller, Classic PLC www.triplc.com
6. Simulation software:http://plc-training-rslogix-simulator.soft32.com/free-download/
7. Simulator :www.plcsimulator.net/
8. https://www.youtube.com/watch?v=y2eWdLk0-Ho&list=PLln3BHg93SQ_X5rPjqP8gLLxQnNSMHuj-
9. https://www.youtube.com/watch?v=86CrhxgAKTw

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

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A) Course Code **: 2400504G (T2400504G/P2400504G/S2400504G)**

B) Course Title **:** Electric Vehicle (Basic)

C) Prerequisite Course(s) **:**

D) Rationale **:**

Fossil fuel consumption and its adverse impact on the environment have led most nations in the world to adopt electric vehicles for mobility. Most automobile companies are switching from internal combustion engines to electric, a cleaner, and more sustainable alternative. But, in the present scenario, the automobile industries are facing a shortage of skilled technicians needed for the transition to electric drives as the primary source of motive power. There is a huge skill gap between industry and academia when it comes to the task of taking the entire automobile industry towards electric mobility. Therefore, this basic course on an electric vehicle is included in the curriculum of the diploma programme as an open elective course to fill this gap and gain a basic understanding of the importance and necessity of electric vehicles. This course tends to enable participants with multidisciplinary exposure and give them a brief idea about electric vehicles, and their importance. This course gives some basic technical foundations regarding electric vehicles to help them move on to advanced electric vehicle courses.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of the following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the student will be able to-

CO-1 Classify the EVs based on configurations.

CO-2 Identify relevant Motors for the given EV application.

CO-3 Test the performance of batteries used for EV applications.

CO-4 Distinguish between the EV Charging stations based on their Configurations.

CO-5 Follow regulatory requirements and policies for EV Industry.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	2	-	2	2	-	3		
CO-2	3	2	2	2	2	1	3		
CO-3	2	2	3	3	2	2	3		
CO-4	2	2	1	2	2	1	2		
CO-5	1	1	-	-	3	1	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction(LI)	NotionalHours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400504G	Electric Vehicles (Basic)	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400504G	Electric Vehicles (Basic)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at the course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to the attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020-related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and

others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400504G

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 1a. Identify the types of the vehicle based on the physical features, specification data and information. TSO 1b. State the advantages of EVs over Conventional IC Engine Vehicles. TSO 1c. Identify different components of Electric Vehicle systems TSO 1d. Explain the functions of different components of the EV	**Unit-1.0Introduction to Electric Vehicle** Review of Conventional Vehicle Engine System Electric Vehicle (EV) • The necessity of Electric Vehicle • Types of Electric Vehicles - Plug-in hybrid - Battery electric vehicle - Hybrid electric vehicle - Fuel Cell Electric Vehicle • Advantages of Electric Vehicles Electric Vehicle Components: Motor, Motor Controller, Battery, Battery Management System, and ChargingSystem.	**CO1**
TSO 2a. Explain the general characteristics of motorsused in EV TSO 2b. List different types of motors used in EV TSO 2c. Explain the working principles of motors used in EV applications TSO 2d. Interpret the nameplate ratings of the motorsfor EV applications. TSO 2e. Explain the motor selection criteria forparticular EV applications. TSO 2f. Describe the Mechanical and ElectricalConnections of Motors.	**Unit-2.0 Electric Motors used in EVs** Electric Motors for EV applications • General Characteristics of motors • Types of Motors: DC, Brushless DC, Induction, Permanent Magnet Synchronous Motors, SwitchedReluctance Motors Rating of Motors Selection Criteria Physical Location Connection of Motors: Mechanical Connections and Electrical Connections	**CO2**
TSO 3a. List the batteries used in EVs for energy storageTSO 3b. State various parameters related to batteries used in EV applications. TSO 3c. Explain the charging and discharging process ofthe given batteries. TSO 3d. Explain the salient features of Lithium ion batteries TSO 3e. Explain the Fuel Cell Storage System. TSO 3f. Identify various sensors installed for monitoringBattery condition. TSO 3g. Explain Battery Management System in EV usingBlock Diagram. TSO 3h. **Describe the procedure of battery Disposal andRecycling**	**Unit- 3.0 EV Batteries and Energy Storages** Types of Batteries: Lead Acid, Nickel Based, Lithium Based Battery Parameters Charging (AC) and Discharging (DC) Process Lithium ion Batteries Fuel Cells, Fuel Cell Storage System Battery Condition Monitoring Battery Management System (BMS) • Need of BMS • Block Diagram of BMS **Battery Disposal and Recycling**	**CO3**
TSO 4a. Identify different types of diodes andtransistors. TSO 4b. Describe the testing procedure for the givenDiode and Transistor. TSO 4c. Explain the working principles of the givenpower electronic converter circuit. TSO 4d. Describe the types of Charging Systems TSO 4e. Describe different Components of the	**Unit- 4.0 EV Charging Systems** Power electronics in EV • Power electronics components • Rectifiers • DC to DC Converter • DC to AC Converter Charging System	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
ChargingSystem TSO 4f. Explain the working of the Charging Systemusing a single-line diagram.	• Types of charging Systems • Components of Charging Systems • Single line Diagram of Charging System	
TSO 5a. Understand the Rules and Regulations set by theGovernment for selecting and manufacturing various components of an electric vehicle. TSO 5b. Understand the Policies for E-Vehicles. TSO 5c. Appreciate the importance of the reduction ofgreenhouse gases in the environment.	**Unit- 5.0 Regulatory Requirements andPolicies for EV Industry** Rules and Regulations set by the Indian government for the designer/manufacturer of EVs. Policies in India Global Policies for E- Vehicles. Carbon Footprint Issues	**CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504G

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 1.1 Use the relevant digital meter for the given application. LSO 1.2 Use a measuring instrument for the given application. LSO 1.3 Use safety kits while working in the laboratory.	1.	• Practice using digital meters such as AC, DC Clamp Meters, Digital Multimeters, Lux Meters, etc. Practice using Screw Driver Kit, Vernier Caliper, Micrometer, Ampere Meter,Voltage Meter, and Techno-meter. Practice using safety kits.	CO1
LSO 2.1 Identify the motors used in EV applications LSO 2.2 Identify the given motor terminals	2.	• Identification of motors used in EVs	CO2
LSO 3.1 Identify the batteries available in the laboratory. LSO 3.2 Measure an open circuit voltage of the given battery. LSO 3.3 Determine the Ampere -Hour Capacity of the given battery with a given load. LSO 3.4 Test the performance of the given battery with different charging rates and at different ambient temperatures LSO 3.5 Demonstrate the effect on the state of health of the battery after several charge/ discharge cycles. LSO 3.6 Evaluate the temperature cut-off point for the given BMS.	3.	• Testing of Batteries used in EVs • Battery Management System	CO3
LSO 4.1 Identify the Electrical & Electronics components available in the laboratory using Digital Multimeters. LSO 4.2 Test the given power electronic components using digital meters LSO 4.3 Identify the given Power Electronic Circuits used in EVs LSO 4.4 Identify the components of the Charging System LSO 4.5 Recognize the types of Charging Systems available in the Laboratory	4.	• Power electronic circuits • Identification of Charging systems	CO4

L) Suggested Term Work and Self-Learning: S2400504G

Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Collect the information related to the performance of different types of electric vehicles and prepare acomparative report on economic and environmental analysis.
2. Collect specifications of different EVs available in the market.
3. Build and test a prototype circuit of converters used in an electric vehicle.
4. Visit a nearby Electric vehicle showroom or service centre & collect information on different types of motors usedin electric vehicles and prepare a comparative report on their performance,
5. Visit a nearby charging station and prepare a report describing the layout and components of the charging station.

c. Other Activities:

1. **Seminar Topics**:
   - Communication Systems, Sensors and batteries used in Evs.
   - Technological advances in Evs
   - Comparison of EVs manufactured by different companies.

2. **Surveys** – Survey the market and gather information on the electric vehicle manufacturers and submit the report.

3. **Product Development**- Develop an electric vehicle prototype using locally procured hardware components.

d. Self-Learning Topics:

- Global Manufacturers of EV
- Indian Manufacturers of EV
- Motors used in EV
- Batteries used in EV
- Cost comparison of EVs in market

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use the appropriate assessment strategy and its weightage, in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	15%	20%	--	33%	10%	20%
CO-2	20%	20%	20%	--	33%	15%	20%
CO-3	20%	30%	20%	--	34%	15%	20%
CO-4	20%	25%	20%	50%	--	30%	20%
CO-5	20%	10%	20%	50%	--	30%	20%
Total	**30**	**70**	**20**	**20**	**10**	**20**	**30**

Marks			50		

Legend:

*** :** Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

****** : Mentioned under point- (N)

: Mentioned under point- (O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Electric Vehicle	8	CO1	12	3	5	4
Unit-2.0 Electric Motors used in EVs.	10	CO2	14	4	5	5
Unit- 3.0 EV Batteries and Energy Storages.	14	CO3	20	5	8	7
Unit- 4.0 EV Charging Systems	10	CO4	15	5	6	4
Unit- 5.0 Regulatory Requirements and Policies for EV Industry	6	CO5	9	3	3	3
Total Marks	**48**		**70**	**20**	**27**	**23**

Note: Similar table can also be used to design class/mid-term/ internal question papers for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1	Practice using digital meters such as AC, DC Clamp Meters, DigitalMultimeters, Lux Meters, etc.	CO1	90	-	10
2	Practice using Screw Driver Kit, Vernier Caliper, Micrometer,Ampere Meter, Voltage Meter, and Techno-meter.				
3	Practice using safety kits.				
4	Identification of motors used in EV	CO2	60	30	10
5	Testing of Batteries used in EVs	CO3	60	30	10
6	Battery Management System				
7	Power electronic circuits	CO4	30	60	10
8	Identification of Charging systems				

Legend:

PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to beprepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Labs, and Field, Information and Communications Technology (ICT)Based, Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	AC, DC Clamp Meters	Application: Non-contact AC/DC Voltage and Current measurement **AC Application:** Current: 0-200Amp, Voltage: 0-600Volt **DC Application:** Current: 4-20mA, Voltage: 0-30Volt.	1
2.	Digital Multimeters	Display: 4 ½ digit Indications: overload protection, polarity indication, over range indication. Auto range change and auto polarity change facility, auto display of polarity and decimal point. **DC**: Volt: 200mV-600V, Current: 200mA-2A **AC**: Volt: 200mV-1000V, Current: 200mA-2A Resistance: 200W-20mW, Power supply: 230V, 50Hz Battery operation: 9 Volt battery Electronic components testing facility should be provided in the Multimeter. A provision for an A.C. adaptor(eliminator) must be available along with the multimeter.	1, 3
3.	Lux Meters	Functions: MAX / MIN, Backlight, Auto Power Off Range: 0 ~ 200,000 lux 0 ~ 20,000 fc Accuracy: ± 5% rdg + 10 dgt (< 10.000 lux / fc) ± 10% rdg + 10 dgt (>10.000 lux / fc) Resolution: 0.1 lux or 0.1 fc Accessories: Carrying Case, Installation Manual, 9V Battery (installed).	1
4.	Screw Driver toolbox	All types of screw drive sets.	1
5.	Vernier Caliper	**Range:** Lower scale: 0-200mm, Upper Scale: 0-12inch **Vernier Resolution:** Lower Scale: 0.02mm, Upper Scale: 0.001inch	1
6.	Micrometer	0-25mm (inside/outside)	1
7.	Ampere Meter	Moving iron and Moving Coil	1
8.	Voltmeter	AC(0-250V)/DC(0-24V)	1
9.	Tachometer	For speed measurement (0-3000rpm)	1

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
10.	Resistors	Low-value Resistors of different types	1,4
11.	Capacitors	Low-value electrolyte Capacitors.	1,4
12.	Inductors	Low-value inductors.	1,4
13.	Safety Kit	First Aid Kit, Helmet, Face Mask, Gloves etc.	1
14.	Motors for Electric Vehicleapplication	Brushless DC, Induction, Permanent Magnet Synchronous Motors, Switched Reluctance Motors	2
15.	EV Machine Cut-out section	for demonstration & training	2
16.	EV mock layout	for demonstration & training	2
17.	Lithium Ion Battery	12V, 7Ah	3
18.	Lead-acid battery	12V, 7Ah	3
19.	Nickel-based batteries (metal hydride and cadmium battery).	12V, 7Ah	3
20.	Battery internal resistance meter	For O.C. voltage & internal battery resistance of each cell	3
21.	Cell Capacity tester	Up to 15V batteries and 3A load current, 10mV voltage and 1mA current resolution, Automatic detection of termination voltage, LED display with a 3-button interface.	3
22.	BMS setup	For Demonstration & training	3
23.	DC power supply	0-32V	3
24.	Power diodes	Power diodes of different current values.	1, 4
25.	Transistors	Power Transistors (NPN, PNP) for Low-frequency high-power applications.	1,4
26.	Voltage Sensors	0-12 Volts.	1,3,4
27.	Current Sensors	Volts: + 15v, 0-5v, Current: 4-20mA.	1,3,4
28.	Converter Models	DC to DC and DA to AC converter model	4
29.	Charging Station Simulator	For Demonstration & training purposes.	4
30.	EV Technology layout 3D posterwith frame	Fuel cell, EV- Charging Systems, HEV, FCEV, Motors & Controllers etc.	3,4

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author (s)	Publisher and Edition with ISBN
1.	Handbook on Electric Vehicles Manufacturing (E-Car, Electric Bicycle, E- Scooter, E-Motorcycle, Electric Rickshaw, E- Bus, Electric Truck with Assembly Process, Machinery Equipment's &Layout)	P.K. Tripathi	Niir Project Consultancy Services; 1st edition (1 January 2022) ISBN-13: 978-8195676927
2.	Electric Vehicles: And the End of the ICE age	Anupam Singh	Kindle Edition ASIN: B07R3WFR28
3.	Wireless Power Transfer Technologies for Electric Vehicles (Key Technologies on New Energy Vehicles)	Xi Zhang, Chong Zhu, Haitao Song	Springer Verlag, Singapore; 1st ed. 2022 edition (23 January 2022) ISBN-13: 978-9811683473
4.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	EHSANI	CRC Press; Third edition (1 January 2019) ISBN-13: 978-0367137465
5.	Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles	John G. Hayes, G. Abas Goodarzi	Wiley; 1st edition (26 January 2018) ISBN-13: 978-1119063643
6.	New Perspectives on Electric Vehicles	Marian Găiceanu (Editor)	IntechOpen (30 March 2022) ISBN-13: 978-1839696145

(b) Online Educational Resources:

1. https://www.energy.gov/eere/fuelcells/fuel-cell-systems
2. https://powermin.gov.in/en/content/electric-vehicle
3. https://www.iea.org/reports/electric-vehicles
4. https://www.oercommons.org/search?f.search=Electric+Vehicles

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

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A) Course Code : **2400504H (T2400504H/P2400504H/S2400504H)**

B) Course Title : Robotics (Basic)

C) Pre- requisite Course(s) :

D) Rationale :

Currently, industries demand non-stop and fine quality work in different processes used. It is difficult for the human beings to give same quantity and quality of work with respect to time, environment and complexity of the work in any process industry. To get quality and quantity of work in toughest environment or the environment which is not suitable for the humans to work, industries demand for robots and its operator. Operators who will operate these robots need some basic knowledge of robotics. To fulfill the need of industries and looking to the advancement in technology, this course aims for the diploma engineers to have knowledge and skills in robotics.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

Select robots for given applications employing basic concepts of design and functions of robots.

Interpret co-ordinate systems and degree of freedom for robots.

Use sensors and drives in context of various robotic applications.

Select appropriate robot control techniques,

Use programs to operate robots.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	-	3	-	2	2	2		
CO-2	3	2	1	2	-	-	-		
CO-3	3	2	1	2	2	-	2		
CO-4	3	1	1	2	-	-	-		
CO-5	3	2	3	3	2	3	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400504H	Robotics (Basic)	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self- Learning Assessment (TWA)		Lab Assessment (LA)		
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2400504H	Robotics (Basic)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills,

Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400504H

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 1a. Explain the basic terms used in robotics TSO 1b. Identify components used in robots. TSO 1c. Explain various types of movements. TSO 1d. Distinguish various robots' configurations and their workspace. TSO 1e. Evaluate the degrees of freedom of the given robot. TSO 1f. Specify the methods of conversion of the given linear motion into rotary motion and vice-versa. TSO 1g. List the criteria for selecting robot for the given simple application with justification.	**Unit-1.0 Basics of Robotics Systems** 1.1 Definition, need, brief history of robotics 1.2 Basic Robot terminology, configuration and its working 1.3 Robot components overview - Manipulator, End effecters, Drive system, Controller, Sensors 1.4 Basic structure of a Robot and Classification – Cartesian, Cylindrical, Spherical, Horizontal articulated (SCARA), Parallel; Mechanic alarm, Degree of freedom, Links and joints, Wrist rotation, Mechanical transmission-pulleys, belts, gears, harmonic drive (gear box) 1.5 Linear and Rotary motion and its devices 1.6 Selection criteria for robots	**CO1, CO2**
TSO 2a. Explain the working of various types of End effecters used in robots with diagram. TSO 2b. Explain with sketches the function of the given sensing device used in a robot. TSO 2c. Describe working of the given sensor used in robot. TSO 2d. Explain the given robot configuration. TSO 2e. Select relevant robot sensors for a given application with justification. TSO 2f. Describe robot machine vision concepts along with block diagram of robot vision system. TSO 2g. Select vision equipment for a given robotic application.	**Unit– 2.0 Robot Components** 2.1 End effecters: types, sketches, working and applications 2.2 Sensing and Feedback devices: Optical sensors, Proximity sensors, LVDT, Thermocouple, RTD, Thermistor, Force sensing – strain gauge, Piezoelectric, Acoustic sensing Feedback devices; Potentiometers; Optical encoders; DC tachometers; 2.3 Robot machine vision: Block diagram of robot vision system, Vision equipment-camera, Imaging Components: Point, Line, Planar and Volume Sensors, Image processing, Part recognition and range detection	**CO3**
TSO 3a. Explain with sketches the function of the specified actuator used in a robot. TSO 3b. Differentiate between open loop and closed loop systems. TSO 3c. Explain various robotic controls. TSO 3d. Describe block diagrams of the given control system. TSO 3e. Specify drive system used for robotic control as per requirement. TSO 3f. Differentiate the various robot path controls. TSO 3g. Justify the selection of actuators, drives, control system, AC servo motor and path control for making of a robot.	**Unit– 3.0 Robotic Drive System and Controller** 3.1 Actuators; Hydraulic, Pneumatic and Electrical drives; linear actuator; Rotary drives 3.2 Control systems: Open loop and close loop with applications and its elements, Servo and non-servo control systems – Types, basic principles and block diagram Robot controller; Level of Controller 3.3 AC servo motor; DC servo motors and Stepper motors; 3.4 Robot path control: Point to point, Continuous path control and Sensor based path control	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 3a. Explain various robot programming languages. TSO 3b. Programme robot for a given simple job. TSO 3c. Describe the procedure to simulate the given robot movements using the relevant software.	**Unit– 4.0 Introduction to Robot Programming** 4.1 Need and functions of programming 4.2 Methods of robot programming: Manual Teaching, Teach Pendant, Lead through, Programming languages. Programming with graphics. 4.3 Programming languages: Types, features and applications 4.4 Controller programming 4.5 Simulation for robot movement	**CO5**
TSO 4a. Select a robot for the given application. TSO 4b. Describe various applications of Robotics. TSO 4c. Explain safety norms in robot handling. TSO 4d. Describe maintenance procedure for the given robot. TSO 4e. Describe common problems in robot operations and suggest remedial action.	**Unit– 5.0 Robotics Applications and Maintenance aspects** 5.1 Application robots including special types 5.2 Robot maintenance: Need and types 5.3 Common troubles and remedies in robot operation. 5.4 General safety norms, aspects and precautions in robot handling	**CO1, CO2, CO3, CO4**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504H

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 1.1 Identify parts of Robot on the basis of function. LSO 1.2 Identify joint type & link parameters (link length, link twist, and Link offset), rotational vs. linear motion, used in robot.	1.	Identify components and different configurations of robots.	CO1
LSO 2.1Identify different types of robot end effecters. LSO 2.2 Use Mechanical grippers to hold objects. LSO 2.3 Use Vacuum grippers to hold objects.	2.	Pick/hold different objects (shape/weight/stiffness) using robot end effecters.	CO1, CO2
LSOs 3.1 Assemble the complete robot using the components as per the procedure LSO 3.2 Apply the functionalities available in rotor trainer kit. LSO 3.3 Test for various configurations. LSO 3.4 Test for various degrees of freedom.	3.	Assemble robot to test various configurations and degrees of freedom using robot trainer kit.	CO1, CO2
LSO 4.1 Identify various types of sensors used in robotic application. LSO 4.2 Measure angular motion using Synchros. LSO 4.3 Detect objects using optical sensors.	4.	Use different types of robotic sensors for a specific situation.	CO3
LSO 5.1 Interface stepper motor. LSO 5.2 Control robot with stepper motor interfacing.	5.	Perform robot control with stepper motor interfacing	CO3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 6.1 Draw the labelled sketch of individual parts and robot arm. LSO 6.2 Assemble the arm using the parts as per the procedure. LSO 6.3 Interface the motor drive and operate.	6.	Assemble robot arms using mechanical transmission components and interface motor drive.	CO2, CO3
LSO 7.1 Use open source or available relevant software to develop pick and place programme. LSO 7.2 Perform simulation.	7.	Perform pick and place operation using Simulation Control Software.	CO5
LSO 8.1 Develop programme for using a robot arm with three degrees of freedom. LSO 8.2 Execute the programme.	8.	Perform 2D simulation of a 3 DOF robot arm.	CO2, CO4, CO5
LSO 9.1 Apply stepper motor control with direction control and step control logic simulation. LSO 9.2 Perform basic PLC programming LSO 9.3 Develop ladder logic programs LSO 9.4 Use programming timers	9.	Programme 5-axis Robotic arm to control various motions.	CO3, CO4, CO5
LSO 10.1Develop a program for a simple application. LSO 10.2 Execute the robot programme.	10.	Program to execute a simple robot application (like painting, straight welding) using a given configuration.	CO4, CO5

L) Suggested Term Work and Self Learning: S2400504H

Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects: A suggestive list of micro-projects is given here. Similar micro-projects that match the COs could be added by the concerned course teacher. The student should strive to identify eco-friendly or recycled material prior to selection for robotic applications.

1. Develop stair climb robot using robotic components.
2. Develop RF controller robot using robotic components.
3. Develop robot for metal detection application using robotic components.
4. Develop line follower robot using robotic components.
5. Develop solar floor cleaner robot using robotic components.
6. Develop solar tracker system using robotic components.
7. **Develop a greenhouse managing robot for a horticulture application.**

c. Other Activities:

1. Seminar Topics: Recent developments in the field of robotics
2. Visits: Visit an automation industry and prepare report for various types of robots employed there and details of any one type of special purpose robot used
3. Case Study: Identify a robotic application in automobiles and present a case study
4. Self-Learning Topics:
   - History of industrial robot
   - Sociological consequences of Robots

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	25%	29%	20%	10%	25%	10%	20%
CO-2	20 %	23%	20%	10%	25%	**20%**	20%
CO-3	20%	17%	20%	25%	25%	**20%**	20%
CO-4	20%	14%	20%	15%	25%	**20%**	20%
CO-5	15%	17%	20%	40%	--	30%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

***** **:** Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

****** : Mentioned under point- (N)

: Mentioned under point-(O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Suggested Specification Table for End Semester Theory Assessment:** Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Number and Title	Total Classroom Instruction (CI) Hours	Relevant Cos Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Basics of Robotics Systems	10	CO1, CO2	20	7	8	5
Unit– 2.0 Robot Components	12	CO2, CO3	16	3	9	4
Unit– 3.0 Robotic Drive System and Controller	10	CO3, CO4	12	4	4	4
Unit– 4.0 Introduction to Robot Programming	8	CO5	10	2	5	3
Unit– 5.0 Robotics Applications and Maintenance aspects	8	CO1, CO2, CO3, CO4	12	4	4	4
Total Marks	**48**		**70**	**20**	**30**	**20**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Identify components and different configurations of robots.	CO1	30	60	10
2.	Pick/hold different objects (shape/weight/stiffness) using robot end effecters.	CO1, CO2	60	30	10
3.	Assemble robot to test various configurations and degrees of freedom using robot trainer kit.	CO1, CO2	70	20	10
4.	Use different types of robotic sensors for a specific situation.	CO3	60	30	10
5.	Perform robot control with stepper motor interfacing	CO3	70	20	10
6.	Assemble robot arms using mechanical transmission components and interface motor drive.	CO2, CO3	60	30	10
7.	Perform pick and place operation using Simulation Control Software.	CO5	70	20	10
8.	Perform 2D simulation of a 3 DOF robot arm.	CO2, CO4, CO5	60	30	10
9.	Programme 5-axis Robotic arm to control various motions.	CO3, CO4, CO5	60	30	10
10.	Program to execute a simple robot application (like painting, straight welding) using a given configuration.	CO4, CO5	60	30	10

Legend :

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
1.	Programmable Robot trainer kit	Trainer kit with - Minimum 3 linkages, Minimum 4 degree of freedom, Mechanical end effecter with servo control, interfacing card (RC servo output, sensors input)	1,2,3
2.	Robotic Arm Control Trainer Kit	Robotic Arm with five axis control application through PLC.; PLC; Digital Inputs: 8 Nos with 4mm banana sockets for getting the external inputs; Digital Outputs: 6 Nos with 4mm banana sockets for applying the inputs; Digital Input Controls: On board Toggle switches, Push Buttons & input	8,9

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
		potentiometers; Digital Outputs Controls: 6 nos. on board LED indicators; PC interfacing facility through RS-232.	
3.	Proximity trainer kit	Indicator Type:LED; PCB Type Glass Epoxy SMOBC PCB; Interconnections**:** 2mm banana Patch cords; On board DC motor to see the application of Proximity sensor. Test points to analyse the signal On board variable supply to vary the speed of DC motor. ON/OFF switch and LED for power indication. All interconnections to be made using 2mm banana Patch cords. User manual and patch cords. Built-in power supply. Robust enclosure wooden/plastic box.	4
4.	Robot - Line Tracking Mouse K	Product Dimensions (20.3 x 11.4 x 8.9 cm); programmed IC, 2 unassembled gear motors, printed circuit boards, mouse-shaped plastic body, necessary components and wires, step-down power converter	3, 4,5
5.	Intelligent Robot Actuator Module	Integrity Serial Bus System, CAN to Build Intelligent Device Network, Open Hardware Platform, Arduino, to control Robot sub-Systems of motor-sensor, movable Omni Wheel of Omni-Directional, Actuator operation control by DC Encoder Motor, DC-Motor control and operation by Accelerometer, Gyro, Ultrasonic and PSD sensor, Androx Studio; brushless ILM 70×10 Robo Drive DC motor; sensor-actuator units of ARMAR-4; SD-25-160-2A-GR-BB Harmonic Drive reduction gear unit high gear ratio of 160: 1; structural parts (white) are made out of high-strength aluminium, Hollow shaft with strain gauges for torque sensing, motor's magnetic incremental encoder (AMS5306), digital buses (SPI or 12C); Motor interface PCB includes a 13-Bit temperature-to-digital converter with a temperature range from −40°C to 125°C (Analog Devices ADT7302)	3, 4, 5
6.	6-axis Robotics Trainer	Programmable robotic arm with an interactive front panel. Software to demonstrates functioning of the trainer as well as allows a user to develop their own programs. NV330; 8 bit microcontroller to ARM processors**;** Record and Play capability**;** Optional interfacing with PL**C;** Touch operated ON/OFF switch**;** Auto set to home position**;** Applications can be developed**;** Data acquisition using USB	3, 4, 5
7.	Robotic Drive System	AC servo motor; DC servo motors, Stepper motors; DC tachometers, etc.	1,3,5,6,7,10
8.	Robot simulator for Robotics	Educational networking licensed Robotic system with simulation software	8, 10
9.	Assorted sensors	Optical encoders, Acoustic sensors ,IR, Potentiometer, RTD, Thermistor, strain gauge, piezoelectric, etc	4
10.	Vision equipment	Camera, Imaging Components: Point, Line, Planar and Volume Sensors	1, 4,10

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author (s)	Publisher and Edition with ISBN
1.	Introduction to Robotics Mechanics and Control	John Craig	Pearson Education; 978-9356062191
2.	Industrial Robotics -Technology, Programming and Applications	Nicholas Odrey Mitchell Weiss, Mikell Groover Roger Nagel, Ashish Dutta	McGraw Hill Education; 2nd Edition; 978 -1259006210
3.	Robotic engineering: an integrated approach	Richard D. Klafter, Thomas A. Thomas A. Chmielewski, Michael Negin	Prentice Hall of India, N.Delhi , 978-8120308428
4.	Industrial Robotics Technology, Programming and Applications	Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey	McGraw-Hill Education, Second Edition, 978-1259006210
5.	Robotics	Appuu Kuttan K. K.	Dreamtech Press, First Edition, 2020, 978-9389583281
6.	Introduction to Robotics: Analysis, Control, Applications	Saeed B. Niku	Wiley; Second Edition, 978-8126533121
7.	Essentials of Robotics Process Automation	S. Muhkerjee	Khanna Publication, First edition, 978-9386173751
8.	Robotics	R R Ghorpade, M M Bhoomkar	Nirali Prakashan 978-9388897020

(b) Online Educational Resources:

1. https://archive.nptel.ac.in/courses/112/105/112105249/
2. https://openlearning.mit.edu/mit-faculty/residential-digital-innovations/task-centered-learning-intro-eecs-robotics
3. http://www.mtabindia.com/
4. http://www.robotics.org/
5. https://en.wikipedia.org/wiki/Industrial_robot
6. http://www.servodatabase.com
7. https://www.youtube.com/watch?v=fH4VwTgfyrQ
8. https://www.youtube.com/watch?v=aW_BM_S0z4k
9. https://uk.rs-online.com/web/generalDisplay.html?id=ideas-and-advice/robotic-parts-guide
10. https://www.automate.org/industry-insights/smarter-robot-grasping-with-sensors-software-the-cloud
11. https://www.iqsdirectory.com/articles/machine-vision-system.html

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Learning Packages

1. https://www.edx.org/learn/robotics
2. https://www.coursera.org/courses?query=robotics
3. https://www.udemy.com/topic/robotics/
4. https://library.e.abb.com/public/9a0dacfdec8aa03dc12578ca003bfd2a/Learn%20with%20ABB.%20Robotic%20package%20for%20education.pdf

2. Users' Guide

- https://roboindia.com/store/DIY-do-it-your-self-educational-kits-robotics-embedded-system-electronics
- https://www.robomart.com/diy-robotic-kits
- https://www.scientechworld.com/robotics

3. Lab Manuals

- http://www-cvr.ai.uiuc.edu/Teaching/ece470/docs/ROS_LabManual.pdf
- https://www.jnec.org/labmanuals/mech/be/sem1/Final%20Year%20B.Tech-ROBOTICS%20LAB%20%20MANUAL.pdf

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A) Course Code : **2400504I(T2400504I/P2400504I/S2400504I)**

B) Course Title : Transformer Manufacturing and Repairing (Basics)

C) Pre- requisite Course(s) : Electric Motors and Transformers

D) Rationale :

Transformers are an essential component in Power systems. They help transmit electrical energy at various voltage and current levels to minimize losses and achieve other technical objectives. They are rated from a few kVA to large MVA. Power systems are growing to meet the increased demand. Hence, the manufacturing of new transformers and repair of existing transformers are vital. This course will pave the way to understand the concepts of manufacturing and repair of transformers. The knowledge gained through this course will help the students choose their career in transformer manufacturing.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Explain the fundamental working principles of a transformer.

CO-2 Explain the different types of construction and cooling mechanism.

CO-3 Analyze the different vector groups in practical power transformers and their connections.

CO-4 Illustrate the different types of transformer protection.

CO-5 Analyze the different types of tests required for a transformer.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme SpecificOutcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Developmentof Solutions	**PO-4** EngineeringTools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	3	-	-	-	-	3		
CO-2	3	1	-	-	2	-	3		
CO-3	3	2	2	-	-	-	3		
CO-4	3	3	2	2	1	-	3		
CO-5	3	3	-	2	1	-	3		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+ SL)	Total Credits (C)
		L	T				
2400504I	Transformer Manufacturing and Repairing (Basic)	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment(LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400504I	Transformer Manufacturing and Repairing (Basic)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing:

Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400504I

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the use of transformers in power systems. *TSO 1b.* List the various types of transformers. *TSO 1c.* Explain the exact and approximate equivalent circuits of a transformer. *TSO 1d.* Explain the relations between input and output quantities through phasor diagrams. *TSO 1e.* List the necessity of open and short circuit tests and explain how they should be performed. *TSO 1f.* Explain the concept of voltage regulation and efficiency and list the ways to improve them in transformers.	**Unit-1.0 Transformer Fundamentals** 1.1 Use of Transformers. 1.2 Types of Transformers. 1.3 The equivalent circuit of a transformer. 1.4 Phasor Diagrams 1.5 Open circuit and short circuit tests. 1.6 Voltage regulation and efficiency.	**CO1**
TSO 2a. Explain the different constructional parts of a transformer. *TSO 2b.* List the different types of core and its construction and sections. *TSO 2c.* Explain the different types of windings and the necessity of insulation. *TSO 2d.* Explain the different types of cooling. *TSO 2e.* List the different tank structure. *TSO 2f.* Explain the necessity of transformer oil.	**Unit-2.0 Transformer Construction** 2.1 Constructional Parts. 2.2 Core Construction and Core Sections. 2.3 Windings and Insulation. 2.4 Cooling: Natural Cooling, Forced Oil cooling and Internal Cooling. 2.5 Tanks. 2.6 Transformer oil.	**CO1, CO2**
TSO 3a. Explain the different connections and vector groups. *TSO 3b.* Explain the three phase to two phase and three phase to single phase connection. *TSO 3c.* List the different types of tap changing positions. *TSO 3d.* Explain the open delta configuration.	**Unit-3.0 Transformer Operation** 3.1 Connection for transformers: star/star, star/delta, delta/star. Zig-zag/star. 3.2 Three phase to two phase connections: Scott connection. 3.3 Three phase to one phase connection. 3.4 Tap changing: On-load and off-load tap changing positions. 3.5 Three phase banks of single phase transformers: Open delta configuration.	**CO3, CO4**
TSO 4a. List the classification of transformer protection. *TSO 4b.* Explain the Buchholz relay and its use in transformers. *TSO 4c.* Explain the different types of transformer protection and the use of indicators in transformers.	**Unit-4.0 Transformer Protection** 4.1 Classification of transformer protection. 4.2 Buchholz Relay 4.3 Differential protection 4.4 Over current, Over voltage and surge protection. 4.5 Temperature indicators, oil level indicators, oil preservation systems, silica gel breather, gas sealed conservators.	**CO3, CO4**
TSO 5a. Explain the objectives of testing of transformers. *TSO 5b.* List the different types of tests. *TSO 5c.* Explain different transformer tests including the Sumpner's test. *TSO 5d.* Explain the insulation and impulse tests.	**Unit-5.0 Transformer Testing** 5.1 Objectives of transformer testing. 5.2 Polarity Test, DC Resistance and voltage ratio tests. 5.3 Magnetizing current and core loss tests. 5.4 Temperature rise test, back to back connection. 5.5 Insulation and Impulse Tests.	**CO4, CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504I

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Knowledge of performing these tests on LV and HV sides. *LSO 1.2.* Determine the equivalent circuit parameters of a transformer.	1.	Conduct open circuit and short circuit tests on a transformer	**CO1**
LSO 2.1. Explain the concept of regulation and efficiency at different loads.	2.	Perform load tests on a transformer.	**CO1**
LSO 3.1. Perform Heat run test on a transformer without being subjected to physical load. *LSO 3.2.* Explain the concept of applying rated voltage and rated current through phantom loading.	3.	Perform the Sumpner's test on two identical transformers.	**CO1**
LSO 4.1. Understand various three phase transformer connections and vector groups.	4.	Perform various connections on three phase transformers and understand vector groups.	**CO2**
LSO 5.1. Explain the Scott connection. *LSO 5.2.* Understand the necessity of conversion.	5.	Three phase to Two phase connection	**CO3, CO4, CO5**
LSO 6.1. Understand the necessity of conversion.	6.	Three phase to single phase connection.	**CO3, CO4, CO5**
LSO 7.1. Explain the concept of open delta configuration in case of any single phase transformer failure.	7.	Perform open delta connection from banks of single phase transformers.	**CO3, CO4, CO5**
LSO 8.1. Explain the concept of CT connections in differential protection. *LSO 8.2.* Understand the working principle of Buchholz Relay.	8.	Understand the differential protection with different CT connections and the working of Buchholz relay.	**CO3, CO4, CO5**
LSO 9.1. Explain the concept of dot convention.	9.	Perform a polarity test on a transformer.	**CO4, CO5**
LSO 10.1. Understand the transformer's failures.	10.	Perform the impulse test on a transformer.	**CO5**

L) Suggested Term Work and Self Learning: S2400504I Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

- Discuss the role of insulation in transformer reliability and longevity.
- Outline the steps involved in the construction of power transformers.
- Discuss the testing procedures to ensure quality and performance standards.
- Explore how environmental factors (temperature, humidity, pollution) affect transformer operation.
- Investigate modern monitoring techniques, including online monitoring systems and diagnostic tools.
- Compare different cooling methods (oil-immersed, air-cooled, water-cooled) and their effectiveness.
- Review recent advancements in transformer protection technologies.
- Discuss the importance of testing for ensuring reliability, efficiency, and safety.

b. Micro Projects:

- Simulate and analyze the operation of overcurrent protection relays in a transformer protection system.
- Implement a Buchholz relay for gas detection in oil-filled transformers.
- Design an earth fault protection system for transformers.
- Measure the insulation resistance of transformer windings to ensure insulation integrity.
- Measure the resistance of transformer windings to detect winding issues such as short circuits or open circuits.
- Assess the dielectric strength of transformer oil to ensure effective insulation.
- Build a simple step-up and step-down transformer.
- Investigate the impact of core material and shape on transformer efficiency.

c. Other Activities:

1. Seminar Topics:
    - Advancements in Transformer Core Materials
    - Winding Techniques in Transformer Construction
    - Temperature Management and Cooling Techniques
    - Protection Against Transformer Overheating
    - Transformer Oil Testing and Analysis
2. Visits: Visit to nearby transformer repair station and prepare technical report on transformer repair process, observe diagnostic techniques, repair procedures, and quality assurance practices.
3. Self-learning topics:
    - Phenomenon of inrush current in transformers.
    - Causes, effects, and methods to mitigate inrush currents.
    - Arc flash incidents in transformers.
    - Strategies and equipment used to mitigate arc flash hazards.
    - Impact of harmonics on transformer protection systems.
    - Partial discharge testing

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	**15%**	**15%**	**15%**	-	-	**20%**	20%
CO-2	10%	10%	10%	25%	-	**10%**	20%
CO-3	15%	15%	15%	25%	33%	**15%**	20%
CO-4	30%	30%	30%	25%	33%	**15%**	20%
CO-5	30%	30%	30%	25%	34%	**40%**	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 **Transformer Fundamentals**	12	CO1	10	3	3	4
Unit-2.0 **Transformer Construction**	8	CO1, CO2	10	3	2	5
Unit-3.0 **Transformer Operation**	8	CO3, CO4	10	5	2	3
Unit-4.0 **Transformer Protection**	8	CO3, CO4	20	5	6	9
Unit-5.0 **Transformer Testing**	12	CO4, CO5	20	4	6	10
Total	**48**	**-**	**70**	**20**	**19**	**31**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

SN	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Conduct open circuit and short circuit tests on a transformer	CO1	30	60	10
2.	Perform load tests on a transformer.	CO1	40	50	10
3.	Perform the Sumpner's test on two identical transformers.	CO1	30	60	10
4.	Perform various connections on three phase transformers and understand vector groups.	CO2	30	60	10
5.	Three phase to Two phase connection	CO3, CO4, CO5	30	60	10
6.	Three phase to single phase connection.	CO3, CO4, CO5	30	60	10
7.	Perform open delta connection from banks of single phase transformers.	CO3, CO4, CO5	30	60	10
8.	Understand the differential protection with different CT connections and the working of Buchholz relay.	CO3, CO4, CO5	40	50	10
9.	Perform a polarity test on a transformer.	CO4, CO5	40	50	10
10.	Perform the impulse test on a transformer.	CO5	40	50	10

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc..

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Transformer, Auto Transformer, Ammeter, Voltmeter, Wattmeter, Multi-meter.	Transformer (1 Phase, 1 kVA HV Side-0-230V & LV:0-115V)-1 QTY Auto-Transformer (0-270 V,5 kVA), Multi-Meter, Voltmeter (0-300 V,0-150 V 0-50 V: -3 Qty), Ammeter (0-5 A,0-10 A,0-1 A:3Qty), Wattmeter (0-300 V,5/10A-3 Qty), Wattmeter (0-150 V,1/2 A-3 QTY), Connecting Wire.	Conduct open circuit and short circuit tests on a transformer
2.	Transformer, Auto Transformer, Ammeter, Voltmeter, Wattmeter, Multi-meter, Load Box	Transformer (1 Phase, 1 kVA HV Side-0-230V & LV:0-115V)-1 QTY Auto-Transformer (0-270 V,5 kVA), Multi-Meter, Voltmeter (0-300 V,0-150 V: -2 Qty), Ammeter (0-5 A,0-10 A,: 2 Qty), Wattmeter (0-300 V,5/10A-2 Qty), Connecting Wire.	Perform load tests on a transformer.
3.	Transformer, Auto Transformer, Ammeter, Voltmeter, Wattmeter, Multi-meter.	Transformer (1 Phase, 1 kVA HV Side-0-230V & LV:0-115V)-2 QTY Auto-Transformer (0-270 V,5 kVA:-2 QTY), Multi-Meter, Voltmeter (0-300 V,0-150 V 0-50 V: -3 Qty), Ammeter (0-5 A,0-10 A,0-1 A:3Qty),Wattmeter(0-300 V,5/10A-3 Qty),Wattmeter(0-150 V,1/2 A-3 QTY), Connecting Wire.	Perform the Sumpner's test on two identical transformers.
4.	Transformer, Auto Transformer, Ammeter, Voltmeter, Wattmeter, Multi-meter, Load Box	Transformer (1 Phase, 1 kVA) - 3 Qty, multi-meter, Series Bulb, Connecting Wire, 3 Phase Auto transformer-1 Qty, Connecting Wire.	Perform various connections on three phase transformers and understand vector groups.
5.	Transformer, Auto Transformer, Ammeter, Voltmeter, Wattmeter, Multi-meter, Load Box	3 Phase Auto transformer, Transformer (1 kVA, 1 Phase)-3 Qty, Ammeter (0-20 A)-5 Qty, Voltmeter (0-500)-2 Qty, Wattmeter (0-300 V,5/10A-2 Qty), 1 Phase Electric Load-2 Qty, Connecting Wire.	Three phase to Two phase connection
6.	Transformer, Auto Transformer, Ammeter, Voltmeter, Wattmeter, Multi-meter, Load Box	3 Phase Auto transformer-1 Qty, Transformer (1 kVA, 1 Phase)-3 Qty, Ammeter(0-10A)-2 Qty, Voltmeter (0-300/500)-2 Qty, Wattmeter (0-300 V,5/10A-2 Qty), 1 Phase Load, Connecting Wire.	Three phase to single phase connection.
7.	Transformer, Auto Transformer, Ammeter, Voltmeter, Wattmeter, Multi-meter, Load Box	Transformer (1 kVA, 1 Phase)-3 Qty, 3 Phase Load-1 Qty, 3 Phase Auto Transformer -1 Qty. Ammeter(0-10A)-2 Qty, Voltmeter (0-300/500)-2 Qty, Wattmeter (0-300 V,5/10A-2 Qty),	Perform open delta connection from banks of single phase transformers.
8	Power Transformer, Differential relay, CT, Buchholz Relay	3 Phase Differential relay, Current transformer-3 Qty, Power Transformer with Buchholz relay -1 Qty, Connecting Wire.	Understand the differential protection with different CT connections and the working of Buchholz relay.
9	Transformer, Auto Transformer, Ammeter, Voltmeter, Multi-meter.	1 Ph Transformer (same rating)-2 Qty,1 Ph Autotransformer -1 Qty, Ammeter (0-2 A)-1 Qty, Voltmeter(0-300V), Voltmeter(0-150V)-1 Qty, Connecting Wire.	Perform a polarity test on a transformer.
10	Transformer, Impulse test Kit	3 Phase transformer -1 Qty, High voltage generating kit (rating in kV), Connecting Wire.	Perform the impulse test on a transformer.

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	The Performance and Design of Alternating Current Machines	M. G. Say	CBS Publishers, 2002 ISBN: 81-239-1027-4
2.	Electrical Machines	D. P. Kothari and I. J. Nagrath	Tata McGraw Hill India, 2004 ISBN: 0070583773, 9780070583771

(b) Online Educational Resources:

1. https://nptel.ac.in/courses/108105017
2. https://nptel.ac.in/courses/108106071

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

*****

A) Course Code : 2400504J(T2400504J/P2400504J/S2400504J)

B) Course Title : **Optical Fiber and 5G Communication (Basics)**

C) Pre- requisite Course(s) : Principle of Electronics Communication, Digital Communication

D) Rationale :

An optical fiber and 5G communication course is essential for interpreting modern high-speed data transmission, which is crucial for supporting the growing demand for fast and reliable internet services. It equips students with the knowledge to design and implement fiber optic networks, which are integral to both wired and wireless communication infrastructures. The course also covers the principles and technologies behind 5G, the latest generation of mobile networks, enabling enhanced connectivity, low latency, and greater capacity. By combining these fields, students gain comprehensive insights into how advanced communication systems operate and interact and preparing them for careers in telecommunicationsand networking field.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to performvarious activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Describe EM wave propagation through an optical fiber.

CO-2 Measure different types of losses of a given optical fiber cable.

CO-3 Perform optical fiber power launching and slicing.

CO-4 Test the performance of the Optical fiber source and detector.

CO-5 Compare mobile communication generations (2G, 3G, 4G and 5G).

F) Suggested Course Articulation Matrix (CAM):

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 Managemen	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	-	3	2	-	-	2		
CO-2	3	2	-	2	-	-	-		
CO-3	3	3	-	2	3	-	-		
CO-4	3	3	-	2	-	-	-		
CO-5	3	-	3	3	-	3	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400504 J	Optical Fiber and 5G Communication(Basics)	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Casemethod, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop,field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedbackof teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment(TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment(LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400504 J	Optical Fiberand 5G Communication on (Basics)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offlinemodes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars,micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** aswell as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria ofinternal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment,the internal faculty should prepare checklist & rubrics for these activities.

I) **Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course leveland session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 relatedreforms like green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400504J

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the need for Optical fiber and 5G Technologies. *TSO 1b.* Define numerical aperture. *TSO 1c.* Classify optical fiber modes with proper sketch. *TSO 1d.* Explain with examples modes of wave propagation through an optical fiber. *TSO 1e.* Classify optical fiber	**Unit-1.0 Introduction of Optical Fibers** 1.1 Introduction to general optical fibercommunication (OFC) system 1.2 Basic optical laws and definitions 1.3 Structure of optical cable- core, cladding, cover 1.4 Numerical aperture 1.5 Optical fiber modes and configurations–mode analysis for optical propagation through fibers 1.6 Classification of optical fiber, single mode fiber,graded index fiber	**CO1**
TSO 2a. Explain the reason for attenuation in the optical fiber cable. *TSO 2b.* Describe fiber losses with examples. *TSO 2c.* Explain various aspects of dispersion *TSO 2d.* Describe how to optimize the dispersion *TSO 2e.* Describe how to generate R-I profile *TSO 2f.* calculate cut-off wavelength, and modefield diameter	**Unit-2.0 Transmission Characteristics of OpticalFiber** 2.1 Attenuation in Optical Fiber 2.2 Fiber Losses (Material, Scattering, Splice,Absorption, Radiative) 2.3 Dispersion (Chromatic, Modal, Material, Waveguide, Polarization mode) 2.4 Dispersion optimization of single mode fiber,characteristics of single mode fiber 2.5 R-I Profile 2.6 Cut off wavelength, dispersion calculation, and mode field diameter	**CO2**
TSO 3a. Explain the need for a source and detector in an optical fiber system.	**Unit-3.0 Optical Sources and Detectors** 3.1 Sources- Intrinsic and extrinsic material,direct and indirect band	**CO3**

TSO 3b. Describe about direct and indirect bandgap materials used for make fiber sources. *TSO 3c.* Describe the basic operating principle of optical sources such as LED and Lasers in detail. *TSO 3d.* Describe the detection process and noise inthe optical detectors.	gaps 3.2 LED structures- Surface-emitting and Edgeemitting LED 3.3 Optical Source: Laser diodes, Laser source driver circuit,modes and threshold conditions, Rate equations, external quantum efficiency, resonant frequencies, single-mode laser,external modulation, temperature effort 3.4 Detectors: PIN photodetector, Avalanchephotodiodes, Photodetector noise, noisesources, SNR, detector response time, Avalanche multiplication noise, and temperature effects	
TSO 4a. Describe the basic operations of the given type of optical preamplifier. *TSO 4b.* Analyze the performance of the given optical receiver in detail. *TSO 4c.* Describe the power launching and lensing with respect to the optical fiber system. *TSO 4d.* Describe the fiber splicing process with the help of a suitable sketch. Describe the procedure of optical power measurement.	**Unit-4.0 Optical Receiver, Coupling and Measurements** 4.1 Basic receiver operation, preamplifiers, digital signal transmission, error sources,Front-end amplifiers, probability of error, and receiver sensitivity. 4.2 Power Launching, Lensing Schemes for Coupling Management, coupling losses, 4.3 Fiber Splicing, and Optical power measurement	**CO4**
TSO 5a. Explain the historical development and technological advancements of wireless communication. *TSO 5b.* Compare different wireless communication systems on the basis of technology, data rate, spectrum, QoS, advantages, and services. *TSO 5c.* Describe WLAN principle, standards, and their practical applications. *TSO 5d.* Describe the concept, architecture, and applications of WLL systems, and their role in telecommunications.	**Unit-5.0 Fundamentals of 5G Communication** 5.1 Evolution of mobile radio systems 5.2 Types of Wireless Communication Systems 5.3 Overview of modern mobile communication system (2G, 3G, 4G, 5G) 5.4 Wireless Local Area Network 5.5 Wireless Local Loop 5.6 Service Requirement: Data Rate, Number of users, mobility, energy consumption, spectrum, service quality	**CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504J

Practical/Lab Session Outcomes (LSOs)	Sl. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Identify the fiber cable, optical source, detector and other components of the given optical fiber system.	1.	Identification of various components of Optical fiber communication system	**CO1**
LSO 2.1. Measure the numerical aperture of the given optical fiber cable.	2.	Measurement of Numerical aperture	**CO1**
LSO 3.1. Measure the attenuation and signal loss in optical fiber using optical time-domain reflectometry (OTDR). *LSO 3.2.* Measure the signal loss in optical fibers using optical time-domain reflectometry (OTDR).	3.	Attenuation and Signal Loss Measurement	**CO2**
LSO 4.1 Perform tests on fiber optic cables to identify faults using tools like visual fault locators and OTDR. *LSO 4.2* Troubleshoot faults using tools like visual fault locators and OTDR.	4.	Fiber Optic Cable Testing and Troubleshooting	**CO2, CO3**
LSO 5.1 Test the performance of the given optical source.	5	Performance of optical source (LED, LASER)	**CO3**
LSO 6.1. Test the performance of the given optical detector.	6	Performance of optical doctor (Photo diode, PIN diode)	**CO3**
LSO 7.1. Learn techniques for splicing optical fibers. *LSO 7.2.* Install connectors, crucial for network deployment and maintenance.	7	Optical Fiber Splicing and Monitorization	**CO4**
LSO 8.1. Conduct BER test. *LSO 8.2.* Evaluate the performance of optical communication links. *LSO 8.3.* Evaluate the reliability of optical communication links.	8	Analyze the optical communication system.	**CO4**
LSO 9.1. Noise Modelling and its effect on Wireless Data Transmission	9.	Characterization and Impact of Noise on Wireless Data Transmission: A Comprehensive	**CO5**
LSO 10.1 Effect of fading on wireless data transmission in terms of outage probability	10.	Evaluating Fading Effects on Wireless Data Transmission: Outage Probability Analysis	**CO5**

L) Suggested Term Work and Self Learning: S2400504J Some sample suggested assignments, micro project and otheractivities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line withthe targeted COs.

b. Micro Projects:

Here are five micro projects that can be included in an optical fiber and 5G communication course to give students hands-on experience with practical applications of the concepts learned:

1. Design and Implementation of a Basic Fiber Optic Network:
2. Perform splicing and monetarization on actual fiber optic cables.
3. Test the network for signal loss and attenuation using OTDR.
4. Prepare a report detailing the design, implementation process, and test results.
5. Simulation and Analysis of Wavelength Division Multiplexing (WDM) Systems: Objective: Simulate a WDM system and analyze its performance. Tasks: Use simulation software (e.g., Opti System or MATLAB) to design a WDM system. Simulate the transmission of multiple wavelengths through a single optical fiber. Analyze the system's performance in terms of signal quality, crosstalk, and data capacity.
6. Development of a Simple 5G NR Base Station

Objective: Develop and test a simple 5G NR base station using software-defined radios (SDRs).

c. Other Activities:

1. Seminar Topics: here are 5 seminar topics

   I. "Advancements in Optical Fiber Technology "
   II. "The Future of Wireless Communication: 5G and Beyond"
   III. "Integrating Optical Fiber with 5G Networks: Opportunities and Challenges"
   IV. "Security Strategies for 5G Networks: Ensuring Robust Protection"
   V. "Smart Cities Powered by 5G and Optical Fiber: Innovations and Implementation"

2. Visits: Visit nearby telephone exchanges or wireless communication-related companies

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	-	-	20%	20%
CO-2	10%	10%	10%	25%	-	10%	20%
CO-3	15%	15%	15%	25%	33%	15%	20%
CO-4	30%	30%	30%	25%	33%	15%	20%
CO-5	30%	30%	30%	25%	34%	40%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

: Mentioned under point- (N)#: Mentioned under point-(O) **Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions relatedto achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction(Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				member(R)	lerstanding(U)	Application& above (A)
Unit-1.0 **Introduction of Optical Fibers**	8	CO1	10	2	4	4
Unit-2.0 **Transmission Characteristics of Optical Fiber**	8	CO2	10	4	2	4
Unit-3.0 **Optical Sources and Detectors**	8	CO3	14	4	4	6
Unit-4.0 **Optical Receiver, Coupling and Measurements**	12	CO4	16	4	6	6
Unit-5.0 **Fundamentals of 5G Communication**	12	CO5	20	4	6	10
Total	**48**	**-**	**70**	**18**	**22**	**30**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Identification of various components of Optical fiber communication system	**CO1**	30	60	10
2.	Measurement of Numerical aperture	**CO1**	40	50	10
3.	Attenuation and Signal Loss Measurement	**CO2**	30	60	10
4.	Fiber Optic Cable Testing and Troubleshooting	**CO2, CO3**	30	60	10
5.	Performance of optical source (LED, LASER)	**CO3**	30	60	10
6.	Performance of optical doctor (Photo diode, PIN diode)	**CO3**	30	60	10
7.	Optical Fiber Splicing and Monitorization	**CO4**	30	60	10
8.	Analyze the optical communication system.	**CO4**	30	60	10
9.	Characterization and Impact of Noise on Wireless Data Transmission: A Comprehensive	**CO5**	30	60	10
10.	Evaluating Fading Effects on Wireless Data Transmission: Outage Probability Analysis	**CO5**	30	60	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies maybe appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:
Please insert laboratory equipment in this format

Sl. No.	Name of Equipment,Tools, and Software	Relevant Experiment/Practical Number
1.	Optical Time-Domain Reflectometer (OTDR) Used for measuring the length, loss, and faults in optical fiber cables.	1-3
2.	Fusion Splicer (For splicing optical fibers with minimal loss).	1-3
3.	Optical Power Meter and Light Source (For measuring the power levels in fiber optic links and testing signal loss).	1-3
4.	Visual Fault Locator (VFL): Helps to identify faults, breaks, and bending in optical fibers.	1-3
5.	Optical Spectrum Analyzer (OSA): Used for analyzing the wavelength and spectral characteristics of light in fiber optics.	1-3
6.	Software-Defined Radio (SDR): Allows for the implementation and testing of 5G communication protocols.	4-7
7.	5G NR Testbed: Complete test setups for developing and testing 5G NR systems.	4-7
8.	Vector Signal Analyzer (VSA) and Vector Signal Generator (VSG): For generating and analyzing complex modulated signals used in 5G communication.	4-7
10.	MIMO (Multiple Input Multiple Output) Test System: For testing MIMO technology, which is essential for 5G networks.	7
11.	Optical Fiber Cables and Connectors: Various types of single-mode and multi-mode fibers, along with connectors and adapters.	1-3
12.	Network Simulators: Software tools like Opti System for simulating optical networks and NS-3 for 5G network simulations.	1-3
13	MATLAB/Mathematica	1-7

R) Suggested Learning Resources:

(a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Fiber-Optic Communication Systems	Govind P. Agrawal	John Wiley & Sons, 2012, ISBN 97804705113
2.	Optical Fiber Communications	Gerd Keiser	McGraw-Hill Science, Engineering & Mathematics, 1983. ISBN: 0-07-064810-7
3.	5G NR: The Next Generation Wireless Access Technology	Erik Dahlman, Stefan Parkvall, and Johan Skold	Academic Press, 2020. ISBN-10. 0128143231; ISBN-13. 978-0128143230
4.	Principles of Optical Fiber Measurements	Dietrich Marcuse	Elsevier, 2012. ISBN:012470980X

(b) Online Educational Resources: (Please provide link also if available)

Here are five valuable online references for a course in Optical Fiber and 5G Communication:

1. edX - PurdueX: Fiber Optic Communications: This advanced course covers wave propagation, optical transmitters and receivers, optical communication network architectures, and future optical networks. It's ideal for gaining in-depth knowledge of fiber optic systems and their applications in modern communicationnetworks (edX).
2. Johns Hopkins Engineering - Fiber-Optic Communication Systems: This online course explores the fundamentals of fiber-optic communication systems, including the properties of optoelectronic componentsand system design issues for both terrestrial and submerged point-to-point optical links (Johns Hopkins Engineering Online).
3. Purdue University - Fiber Optics Communications Course: This course provides a comprehensive overview ofthe key components and system-level interactions in fiber optic communication systems, with a focus on current technologies and future advancements in the field (Purdue Eng.).
4. Coursera - Post Graduate Certificate in 5G Technology and IoT: This program covers the essentials of 4G and5G systems, including key technical advancements and challenges. It also delves into topics such as massiveMIMO, OFDM, and mm Wave communication, providing a solid foundation in modern wireless communication (Coursera).
5. Coursera - 5G and Beyond Wireless Technologies: This course provides an in-depth understanding of 5G NewRadio standards, beam management, cell-free massive MIMO, and intelligent reflecting surfaces, making it an excellent resource for those looking to explore the cutting-edge aspects of 5G technology (Coursera).

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, onlineeducational recourses before use by the students.

(c) Others: In this section provide the software name (if any) data sheet according to this course.

a. Operating / Manufacturers' Manuals
b. b. Lab Manuals

*****

A) Course Code **: 2452505 (T2452505/S2452505)**

B) Course Title **:** Apparel Costing & EXIM

C) Pre- requisite Course(s) **:**

D) Rationale **:**

With technological innovations like the internet & quick communication systems, the world has now shrunk as a global village. In the present scenario, one cannot ignore the importance of exporting & importing & need to learn the documentation. Success or failure of an organization lies in the costing & most businesses have failed or succeeded due to this one factor. Learning to cost based on target market & consumer preferences will enable the student to succeed in any organization. Both these skills of costing & documentation for export will go a long way in establishing an organization & students possessing these skills will get gainful employment.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

- **CO-1** Estimate the cost of a garment efficiently.
- **CO-2** Comply with Export & import terms & formalities.
- **CO-3** Conduct market research of export from India and import from different parts of the world.
- **CO-4** Implement Government policies & procedures.
- **CO-5** Make required Documents for Exports & imports.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	-	3	-	-	-	2		
CO-2	3	2	-	-	-	-	-		
CO-3	3	3	-	-	3	-	-		
CO-4	3	3	-	-	-	-	-		
CO-5	3	-	3	-	-	3	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2452505	Apparel Costing & EXIM	03	-	-	02	05	04

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2452505	Apparel Costing & EXIM	30	70	20	30	-	-	150

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2452505

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Differentiate between the External & Internal factors influencing price decisions. *TSO 1b.* Plan costing strategies to match competition. *TSO 1c.* Cost according to target market. *TSO 1d.* Deduce formulas suitable to the market environment. *TSO 1e.* Estimate CMT/Labor cost with formula (Salary/#of working days=salary per day/# of working hrs =Salary per hour multiplied or divided by time taken). *TSO 1f.* Cost a garment with market-based method where SP-C=P *TSO 1g.* Cost a garment with cost plus method where C=P=SP *TSO 1h.* Calculate Cost=R.M+L+O.H+D	**Unit-1.0 Apparel Costing** 1.1 Importance of costing, External & Internal factors influencing price decisions. 1.2 Cost strategies to match competition. 1.3 Cost plus Pricing, Situations suitable for Cost plus pricing, Advantages & disadvantages. 1.4 Market based Pricing Situations suitable for Cost plus pricing, Advantages & disadvantages. 1.5 Formulas for CMT, Cost plus pricing & Market based pricing 1.6 Methods of pricing: shortest method, average method, detailed method 1.7 4.6 Costing for manufacturer, retailer, boutique/ fashion store, export house. 1.8 4.7 Ceiling floor prices and Quotas.	**CO1**
TSO 2a. Differentiate between export & import. *TSO 2b.* Select appropriate personnel for related EXIM work. *TSO 2c.* Examine the various available modes of transport for suitability. *TSO 2d.* Select the mode of transport. *TSO 2e.* Plan the facilities available for exporters & Importers.	**Unit-2.0 EXIM** 2.1 Introduction to Export & Import, History and future trends. 2.2 Types of organizations under EXIM Merchant export units: Manufacturing Export units, Joint Ventures, Buying Agents, Franchisers and E.O.U's. 2.3 Mode of transport for Exports: Road, sea and air consignments. Advantages & disadvantages of each 2.4 Abbreviations and Terms used: Ex- Factory, F.O.B, C&F, CIF, Ex- ship/Quay, DDP, MODVAT, ICD, IGM/EGM, COFEPOSA, ADB, WB, GATT, ASEAN, CESS, DTA & MFA.B/E, CONTAINERISATION, WARE HOUSING, MANUFACTURING, IN BOND, PROJECT IMPORTS, TRANSSHIPMENT CARGO, FULL EXPORT VALUE, SHOW CAUSE NOTICE, CONSULAR INVOICE, DISTRIBUTION CHANNELS, CANALISATION, END USE BOND, DETENTION CERTIFICATE.	**CO2** **CO4**
TSO 3a. Scrutinize import requirements. *TSO 3b.* Analyze if imports can be avoided to save countries economy. *TSO 3c.* Prepare a chart of exportable garments from each state. *TSO 3d.* Plan marketing strategies based on the preferences of each country.	**Unit-3.0 Market Research** 3.1 Exploring India and the world (important countries) for what can be exported and what needs to be imported. 3.1.1 A study: Availability of export items in different states of India. 3.1.2 Countries around the world: a study on the type of people-average height, weight, colour,	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	preference of clothing, currency used, existing industry and market potential.	
TSO 4a. Explain the procedure of procuring orders. *TSO 4b.* Accept or reject payment terms as per suitability of the case. *TSO 4c.* Test raw materials for strength & durability *TSO 4d.* Scrutinize orders for suitability. *TSO 4e.* Plan transfer of funds for the order. *TSO 4f.* Implement Government policies for the project. *TSO 4g.* Select Government schemes for an order. *TSO 4h.* Determine the procedure for obtaining Incentives. *TSO 4i.* Categorise garments as per standard protocol. *TSO 4j.* Apply for procuring licenses. *TSO 4k.* Coordinate with government offices. *TSO 4l.* Contact private organization for specific jobs	**Unit-4.0 Policies & Procedures** 4.1 Procuring orders 4.2 Payment terms: Advance payment, open a/c system, consignment sale and Documentary Collection: D.A., D.P. and L/C. Revocable & Irrevocable L/C 4.3 Import/Export by post. Methods of transferring funds- cash, D.D., T.T., Money exchangers and SWIFT transfers. Government rules and restrictions in using these. 4.4 Government Policies: Trade barriers- Tariff and non-tariff barriers. Protective & Revenue tariff. Reasons for barriers on export and import. 4.5 Government Schemes: Duty Exemption, EPCG, EPZ, Deemed exports, special category scheme, DEPB scheme, Rupee convertibility and Duty drawback scheme 4.6 Incentives: Loans, subsidy, Duty drawback and awards 4.7 Garment categories 4.8 Licenses: Advance license, Advance Intermediate License, special imprest license, CCP and REP. 4.9 Government Organizations that help export and import: MSME, EDC, CCI, DOI/DITC, EPC and textile Committee. Their role and important functions 4.10 Important private organizations like CMAI and WTC.	**CO2** **CO4**
TSO 5a. Prepare an impressive company profile. TSO 5b. Prepare Quotations. TSO 5c. Prepare invoices. TSO 5d. Reproduce a marker. TSO 5e. Prepare Delivery challans. TSO5f. Prepare Debit & Credit notes. TSO5g. Prepare accounts statements. TSO5g. Register businesses. TSO5h. Work with documentation agents. TSO 5i. Work with freight forwarders. TSO 5j. Scrutinize orders for any conflicting clauses. TSO 5 K Prepare documents.	**Unit-5.0 Documentation** 5.1 Making a company profile. 5.2 Quotations. 5.3 Invoices: Proforma, final & Consular. 5.4 Challans. 5.5 Working with document agents and freight forwarders. 5.6 Registrations required for an export firm 5.7 Important steps for processing an order **Documents at Pre- Shipment stage**- entering into contact, Order scrutiny, Procuring and Processing goods as per specs, Booking shipping space, Central excise clearance, Pre-shipment clearance, shipping instructions to freight forwarders, Dispatching to proper port, Port & Customs clearance, Obtaining documents from freight forwarder, Certificate of Origin, Advising importer and submitting documents to bank for collection. ADS 5.8 **Final Export documents**- Commercial and Regulatory.	**CO2** **CO4** **CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	5.8.1 Commercial Documents: Principal & Auxiliary Documents 5.8.1.1 Principal: Commercial Invoice, Packing list, Bill of Lading, Certificate of inspection, Certificate of Insurance, Certificate of Origin, Bill of Exchange and shipment advise. 5.8.1.2 Auxiliary Commercial documents: Proforma invoice, Intimation for Inspection, Shipping Instructions, Insurance declaration, shipping order, Mate's receipt, Application for certificate of Origin, Letter to bank for negotiation. 5.8.2 Regulatory Documents: Central excise invoice, AR4, shipping bill, Export Application, Receipt for payment of port charges, vehicle ticket, Exchange control declaration form, Freight payment certificate and Insurance payment certificate. 5.9 Documents such as Order form, Delivery challan, Debit & Credit notes and Accounts statement.	

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: (Not Applicable)

L) Suggested Term Work and Self Learning: S2452505

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

1. Cost CMT problems
2. Cost a garment for Manufacturer
3. Cost a garment for Retailer
4. Cost a garment for Wholesaler
5. Cost a garment for Designer
6. Make a company profile
7. Prepare Quotations
8. Prepare Proforma Invoice
9. Prepare Final Invoice
10. Issue an Order form
11. Preparing Debit Note
12. Prepare Credit Note
13. Prepare Accounts statement

b. Micro Projects:

1. Cost of a given garment from sourcing fabric to making the product. Submit a report
2. Conduct Market Research of different states of India (each student is given a different state)
3. Market Research of different countries (each student is given a different country)

c. Other Activities:

1. Seminar Topics:
   - Presentations of fabrics & garments available in India
   - Presentations of fabrics & garments available around the world.
   - Pros & Cons of Exporting
   - Pros & Cons of Importing
2. Visits:
   - Visit to MSME
   - Visit to EDC
   - Visit to CCI,
   - Visit to DOI/DITC,

3. Self-Learning Topics:
   - Plan an innovative garment, work out its cost & plan the target market, marketing strategies & submit a report.
   - Identify the available EPCs in your city/state.
   - Search office of textile committee & prepare a report on the jobs they take up.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	30%	20%	40%	35%	10%	-	-
CO-2	20%	20%	10%	65%	20%	-	-
CO-3	20%	20%	10%	-	20%	-	-
CO-4	10%	20%	-	-	30%	-	-
CO-5	20%	20%	40%	-	10%	--	-
Total Marks	**30**	**70**	**20**	**20**	**10**	**-**	**--**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentages given are approximate.
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Apparel Costing	12	CO3	14	4	4	6
Unit-2.0 EXIM.	10	CO2, CO4	14	4	4	6
Unit-3.0 Market Research	08	CO2, CO4, CO5	14	4	4	6
Unit-4.0 Policies & Procedures	08	CO3	14	4	4	6
Unit-5.0 Documentation	10	CO2, CO4	14	4	4	6
Total	**48**	**-**	**70**	**20**	**20**	**30**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical): (Not Applicable)

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software: (Not Applicable)

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Apparel Costing	M. Krishan Kumar	Abhishek Publications; 2011th edition (1 January 2011) ISBN-10 : 8182478936 ISBN-13 : 978-8182478930
2.	Methods and Techniques Of Costing	Prof. M.E. Thukaram Rao	New Age International (P) Ltd., Publishers, Edition 1 ISBN 9788122430400
3.	Export Import Procedures Documentation and Logistics	by C Rama Gopal,	New Age International Publishers 2nd Edition ISBN 9789395161244
4.	IMPORT EXPORT PROCEDURES & DOCUMENTATION	DR. DEV RAJ	Rajat Publication ISBN-13 9788178804330 ISBN-10 8178804330

(b) Online Educational Resources:

1. https://www.investopedia.com/articles/investing/100813/interesting-facts-about-imports-and-exports.asp
2. https://techpacker.com/blog/design/everything-you-need-to-know-about-garment-costing-and-pricing/
3. https://fashion2apparel.com/costing-in-apparel-industry/
4. https://www.amazon.in/Export-Made-Very-Easy-Business-ebook/dp/B00XGE8GX0
5. https://www.amazon.in/Export-Management-Justin-Paul/dp/0198089406
6. https://www.flipkart.com/practical-guide-start-export-import-business-unlock-your-future/p/itmeza84f7zzf3yb

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. https://www.researchgate.net/publication/370957628_Handbook_of_Textile_and_Apparel_Costing
2. https://woodheadpublishingindia.com/BookDetails.aspx?BookID=215
3. https://agoa.info/images/documents/5168/apparel_export_guide2006.pdf
4. https://www.linkedin.com/pulse/most-important-guide-garment-export-all-information-one-place-

******

A) Course Code **: 2452506 (P2452506/S2452506)**

B) Course Title **:** Minor Project

C) Pre-requisite Course(s) **:**

D) Rationale **:**

Project work plays a very important role in engineering education in developing core technical skills, soft skills and a higher level of cognitive, psychomotor and affective domain skills. It encourages the critical thinking process in the students. Project work is normally done when students have acquired sufficient knowledge, skills and attitude and are able to integrate all these, entirely in a new situation or task to solve the problems of the industries/real world. Project work also develops many soft skills like confidence, communication skills, creative ability, inquisitiveness, learning to learn skills, lifelong learning skills, problem-solving skills, management skills, positive attitude, ethics etc.

In diploma programme of state of Bihar, minor project is being carried out at 5th semester where all aspects of project planning will be deal in detail.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

- **CO-1** Identify a real-world problem in the form of a project to be developed.
- **CO-2** Perform literature survey related to the identified area/problem.
- **CO-3** Identify preliminary resource requirements (Equipment, Tools, Software, Manpower, Services)
- **CO-4** Prepare project synopsis for the identified problem/project title within stipulated time period.

F) Suggested Course Articulation Matrix (CAM):

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**
CO-1	3	2	-	-	-	-	1		
CO-2	3	2	-	-	-	2	1		
CO-3	3	2	-	2	-	2	1		
CO-4	3	-	-	-	-	3	1		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2452506	Minor Project	-	-	02	02	04	02

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2452506	Minor Project	-	-	10	15	10	15	50

Legend:

PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Suggested Implementation Plan of Minor Project:

Suggested implementation plan of minor project along with guidelines to teachers and students are mentioned below. For effective implementation of the project work in totality, different steps are to be carried out at different stages of the comprehensive project work.

- Project Planning. } (**Minor Project**)
- Design, development and execution of the project.
- Quality of report writing and presentation. } (**Major Project**)

In this semester, under the minor project work, the students are guided and monitored to undertake Project planning steps as mentioned below. While, the remaining steps of project implementation will be carried out during major project work in next the semester.

1.0 Guidelines to Students for Implementation of Minor Project.

Students are guided to undergo following steps under the minor project. Teachers are advised to guide the students on each and every step.

1.1 Identification of Area/Problem and Project Titles
1.2 Literature Survey
1.3 Identification of Outcomes of the Project
1.4 Identification of the recourses required.
1.5 Preparation of Synopsis
1.6 Presentation of Synopsis

1.1 Identification of Project Titles and Allocation Methodology:

Though the teachers and students, both are involved in identification of project titles, but the prime responsibility of identification of project titles goes to the respective teachers involved in implementing the course or programme. Teachers are fully aware of course/programme curriculum and they are also aware of related industrial problems hence, they try to explore the possibility of identification of project titles through these problems.

These small industrial problems in the form of project titles may be brought into the laboratories or workshop of institutions of a specific programme, which are equipped with all necessary facilities and resources to carry out the project work. These labs or workshop can function as miniature industry to solve the industrial problems in the form of simulated industrial projects. These projects may be integrated problem of courses or programme.

Criteria for Identification of Project Titles.

The identification of problem statement must be based on the following criteria:

- Environmental Considerations
- Simulated/Automated Industry's/ Improvised Process
- Application or Utility in the World of Work.
- Relevance to the Curriculum
- Mapping of Outcomes of Project with Pos and PSOs (if applicable)
- Feasibility of Implementation of the Project

1.2 Literature Survey:

Literature survey on the project title needs to be done through journals, websites, open source technologies available, discussion with the practicing engineers/industry persons and other relevant sources available.

1.3 Outcomes of the Project:

The project guide should ensure that the project outcomes are written properly as clear, specific, measurable and attainable statements. The outcomes formulated will decide the overall scope or course of action, depth and breadth of the project and implementation plan.

1.4 Identification of the recourses required:

Students under the guidance of teacher should try to identify all the resources required for the completion of the project like equipment, devices, experimental test rig, software, computer, persons to be contacted, suppliers, funds, availability of internal/external lab. The sample size has to be delimited and decided as per the time limit allotted, feasibility and many other considerations.

1.5 Preparation of Synopsis:

The students at the end of the semester are expected to submit 'Project Synopsis' after interaction with guide, as per the guidelines and format provided.

1.6 Presentation of Synopsis:

After developing the synopsis, student(s) should prepare a Power Point Presentation and present the same in front of examiner, guide and audience. Quality of presentation of data need to be ensured using the following criteria through Rubric-

- Clarity in Communication and Presentation
- Voice Audibility
- Use of Media and Methods
- Satisfying the Queries of Audience
- Attainment of Outcomes

2.0 Guidelines to Teachers for Implementation of the Minor Project:

The teacher alongwith the students should identify the different types of project title(s) as per need of the client as mentioned below:

- Prototype Development
- Experimentation Type
- Software Development Type
- Solving Industrial Problem Type
- Market Survey Type
- Feasibility Study Type
- Simulation Based
- Application Type
- Product Type
- Research Type
- Review Type

The project must be feasible. The guide allocated for each project are responsible for the quality of student's work, on different criteria including the synopsis writing which can be monitored on continual

basis.

The guide must ensure that the feasibility of the project, the availability of resources/ software technology, sufficiency of time, finance and requirements during each and every step or activity of project work in advance.

J) Assessment of the Minor Project:

Continual Monitoring and feedback mechanism should be developed by the guide. An assessment plan on weekly progress/updates, action taken on different criteria and sub-criteria of the project work is suggested below. Path-breaking teachers who think out of the box are required to guide, monitor and evaluate the project work.

For objective, valid and reliable assessment, different tools of assessment such as a checklist, rating scale, assessment rubric, observation schedule, portfolio assessment, incidental records etc. need to be prepared. Even the students may bee courage to adopt self-assessment techniques using the assessment rubrics.

The students need to be assessed continuously based on the below mentioned assessment criteria at project planning stage. The Project guide must prepare detailed rubric(s) for each criterion to have valid and reliable assessment.

Assessment Scheme for Minor Project

S. No.	Suggested Assessment Criteria	Suggested Weightage (%)
1.	Identification of Area/Problem Statement	10
2.	Literature Survey	20
3.	Formulation of Project Title	10
4.	Clarity in Formulation of Outcomes of The Project	10
5.	Preparation of Synopsis	30
6.	Presentation of Synopsis	20
	Total	**100**

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