Curriculum of Diploma Programme

in

Food Processing & Preservation

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

State Board of Technical Education (SBTE), Bihar

Semester – II
Teaching & Learning Scheme

Course Codes	Category of course	Course Titles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
2449201	**PCC**	**Food Microbiology**	03	-	04	02	09	06
2449202	**PCC**	**Processing of Cereals and Pulses**	03	-	04	02	09	06
2449203	**PCC**	**Fundamentals of Nutrition**	03	-	04	02	09	06
2449204	**PCC**	**Principles of Food Engineering**	03	-	04	02	09	06
2400102C	**ASC**	**Applied Physics -C** (FPP, GT, CACDDM, TE)	03	-	04	02	09	06
Total			**15**	**-**	**20**	**10**	**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)

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 - II
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)	
2449201	**PCC**	**Food Microbiology**	30	70	20	30	20	30	200
2449202	**PCC**	**Processing of Cereals and Pulses**	30	70	20	30	20	30	200
2449203	**PCC**	**Fundamentals of Nutrition**	30	70	20	30	20	30	200
2449204	**PCC**	**Principles of Food Engineering**	30	70	20	30	20	30	200
2400102C	**ASC**	**Applied Physics -C** (FPP, GT, CACDDM, TE)	30	70	20	30	20	30	200
Total			**150**	**350**	**100**	**150**	**100**	**150**	**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 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.

A) Course Code : 2449201(T2449201/P2449201/S2449201)

B) Course Title : Food Microbiology

C) Pre- requisite Course(s) :

D) Rationale :

This course aims to provide students with a comprehensive understanding of microorganisms in food technology. Students will examine the morphological and physiological characteristics of yeast, molds, and bacteria to identify relevant microorganisms. They will develop practical skills in using laboratory equipment, preparing media, and conducting microbial analysis. Students will also learn to quantify microbial counts, analyze causes of spoilage in food products, and characterize foodborne illnesses. This will enable students to ensure food safety, prevent spoilage, and contribute to public health.

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** Examine morphological & physiological characteristics of yeast, molds, and bacteria.
- **CO-2** Use various lab equipment's and prepare media required for microbial analysis of food
- **CO-3** Enumerate microbial count using plating techniques
- **CO-4** Analyze the causes and characterize spoilages in various food products.
- **CO-5** Analyze the causes and characterize various food born illness.

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/ Developmentof 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		
CO-2	3	2	-	2	2	-	2		
CO-3	3	3	2	2	-	-	2		
CO-4	3	3	3	-	-	-	-		
CO-5	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				
2449201	Food Microbiology	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.

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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)
		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)	
2449201	Food Microbiology	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:

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- 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: T2449201

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Define Microbiology & state names of its disciplines *TSO 1b.* Describe general characteristics of major groups of microorganisms *TSO 1c.* Explain Importance of microorganism in foods *TSO 1d.* Explain factors affecting growth of microorganisms *TSO 1e.* Identify sources of microbial contamination in food. *TSO 1f.* Draw neatly labelled diagram of compound microscope and state function of each part. *TSO 1g.* Describe staining techniques	**Unit-1.0 Introduction to Food Microbiology** 1.1 Definition of Microbiology and its disciplines 1.2 General Characteristics of Major groups of microorganisms-Bacteria, Fungi, Algae, Protozoa, Viruses 1.3 Importance of microorganisms in food 1.4 Factors affecting growth of microorganisms 1.5 Microbial contamination of food 1.6 Construction & working of compound microscope, Types of lenses, magnification, Resolution power, Limit of resolution 1.7 Staining techniques-Simple staining and Differential staining (Gram staining)	**CO1, CO2**
TSO 2a. Draw and explain morphological characteristics of mold *TSO 2b.* Identify Physiological Characteristics of Molds *TSO 2c.* Draw and explain morphological characteristics of yeast *TSO 2d.* Identify Physiological Characteristics of Yeast *TSO 2e.* Draw and explain morphological characteristics of bacteria *TSO 2f.* Identify Physiological Characteristics of bacteria *TSO 2g.* Classify of microorganism based on temperature, oxygen , water activity (moisture) requirement for growth *TSO 2h.* Outline major groups of bacteria important in food bacteriology	**Unit-2.0 Characteristics Yeast, Mold & Bacteria** 2.1 Cultural, Morphological & Physiological Characteristics of Molds 2.2 Cultural, Morphological & Physiological Characteristics of Yeast 2.3 Cultural, Morphological & Physiological Characteristics of Bacteria 2.4 Structure of bacterial cell wall, gram-positive and gram-negative bacteria 2.5 Classification of microorganisms based on temperature, oxygen , water activity (moisture) requirement for growth. 2.6 Major groups of bacteria important in food bacteriology	**CO1**
TSO 3a. Identify common ingredients of culture media and state their function. *TSO 3b.* Classify culture media based on composition and purpose of use. *TSO 3c.* Give composition of Nutrient agar & Nutrient broth *TSO 3d.* Explain methods of sterilization used in microbiology lab.	**Unit-3.0 Pure Culture Isolating Technique** 3.1 Definition of Culture media & Pure Culture, Nutritional requirements of microorganism, Common ingredients of culture media and their functions, 3.2 Types of culture media based on composition and purpose.	**CO2, CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3e. Explain Two class and three class sampling plans as per ICMSF *TSO 3f.* Explain pure culture isolation techniques and state their differences *TSO 3g.* Explain serial dilution method	3.3 Composition of Nutrient agar & Nutrient broth, Blood agar, MacConkey agar 3.4 Methods of sterilization- Flaming, incineration, Hot air oven and autoclave method. 3.5 Two class and three class sampling plans as per ICMSF 3.6 Isolation of pure culture using Pour plate, Streak Plate and Spread Plate Technique 3.7 Serial dilution, calculation of microbial count.	
TSO 4a. Identify causes of spoilage in foods and state the chemical changes caused by microorganism in food. *TSO 4b.* Outline causes and characteristics of spoilages observed in cereal & cereal products *TSO 4c.* Outline causes and characteristics of spoilages observed in fruits & vegetable products *TSO 4d.* Outline causes and characteristics of spoilages observed in Milk & Milk Products. *TSO 4e.* Outline causes and characteristics of spoilages observed in Canned Food Products *TSO 4f.* Explain types of Spoilage in Canned Foods.	**Unit-4.0 Food Spoilage** 4.1 Causes of spoilage, Chemical changes caused by microorganisms in food 4.2 Causes and characteristics of spoilages observed in cereal & cereal products-Grains, Floors & Bread-Moldiness, Ropiness, Red bread, Chalky bread 4.3 Causes and characteristics of spoilages observed in fruits & vegetable products, Juices-Mold growth, Fermentation 4.4 Causes and characteristics of spoilages observed in Milk & Milk Products- Souring, Gas production, Proteolysis, Ropiness, Color & flavor changes 4.5 Causes and characteristics of spoilages observed in Canned Food Products-Flipper, Springer, Soft swell, Hard swell, Breather 4.6 Spoilage in Canned Foods-TA Spoilage, Flat-Sour Spoilage, Sulphide Spoilage	**CO4**
TSO 5a. Classify& differentiate different Food born illnesses *TSO 5b.* Identify characteristics of Staphylococcal Intoxication and Botulism *TSO 5c.* Identify characteristics of Salmonellosis, Clostridium perfringes illness, Bacillus cereus gastroenteritis, E.coli infection *TSO 5d.* Define mycotoxins and state their significance.	**Unit-5.0 Food Born illnesses** 5.1 Definition- Food Poisoning, Classification & differentiation of Food born illnesses 5.2 Characteristics of Staphylococcal Intoxication and Botulism-. Microorganism involved, Incubation period, Symptoms, Foods involved and Control measure 5.3 Characteristics of Salmonellosis, Clostridium perfringes illness, Bacillus cereus gastroenteritis, E.coli infection--. Microorganism involved, Incubation period, Symptoms, Foods involved and Control measure 5.4 Food poisoning due to mycotoxins-Aflatoxin, Patulin, Ochratoxin, ATA.	**CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2449201

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use different equipment's, instruments, tools, and glassware used in food microbiology laboratory *LSO 1.2.* Explain construction, working and application of various lab equipment	1.	Demonstrate working of different equipment's, instruments, tools, and glassware used in food microbiology laboratory • Autoclave • Hot air oven • Bunsen burner • Laminar flow • Incubator • Water bath • Magnetic stirrer • Colony counter • Inoculation loop and needle • Micropipette • Culture tubes • Petri plates	CO2
LSO 2.1. Use compound microscope for microscopic examination	2.	Demonstrate working of compound light microscope using specimen slides of fungi and bacteria	CO1, CO2
LSO 3.1. Use Hot air oven for sterilization of glass wares *LSO 3.2.* Outline process parameters using Hot air oven	3.	Sterilize given glass wares using Hot air oven method • Petri plates • Beakers • Test Tubes • Conical Flasks • Glass rod • Pipette	CO2, CO3
LSO 4.1. Prepare media for cultivation of microorganisms. *LSO 4.2.* State composition of Nutrient media & Nutrient broth	4.	Prepare general purpose media (Nutrient media & Nutrient broth) for cultivation of microorganisms.	CO2, CO3
LSO 5.1. Use Autoclave for sterilization of culture media *LSO 5.2.* Outline the process parameters for sterilization using Autoclave	5.	Sterilize given culture media using Autoclave method • Nutrient agar media • Nutrient Broth	CO2, CO3
LSO 6.1. Perform isolation pure culture of microorganism using Streak plate technique	6.	Isolate of pure culture of microorganism using Streak plate & Spread plate technique	CO2, CO3
LSO 7.1. Perform isolation of pure culture of microorganism using Spread plate technique *LSO 7.2.* Differentiate between Spread plate and Pour plate technique	7.	Isolate of pure culture of microorganism using Pour plate technique	CO2, CO3
LSO 8.1. Calculate microbial load in given food sample *LSO 8.2.* Perform serial dilution for calculating microbial load	8.	Determine viable microbial load in given sample using serial dilution method and pour plate technique	CO2, CO3
LSO 9.1. Analyze characteristics of spoilage observed in given food products	9.	Examine the characteristics of spoilage observed in given food products , when stored for long period without preservation	CO4

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
		• Milk-Souring, gas production, ropiness, Color & Flavor changes • Bread-Moldiness, Ropiness • Fruit juice- Moldiness, Fermentation • Canned Mango pulp (punctured)- Hard swell, Soft swell, Flipper, Springer	
LSO 10.1. Calculate TPC of bacteria in given food sample	10.	Determine total number of bacteria in given food sample using Total Plate Count (TPC) method.	CO2, CO3, CO4
LSO 11.1. Analyze characteristics of food born illnesses	11.	Prepare a chart describing microorganism involved, incubation period, symptoms, foods involved and control measure for various food born illnesses • Staphylococcal Intoxication and Botulism • Salmonellosis, Clostridium perfringes illness, Bacillus cereus gastroenteritis, E.coli infection	CO5

L) Suggested Term Work and Self Learning: S2449201 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. Demonstrate proficiency in using laboratory equipment such as autoclaves, incubators, and microscopes
2. Prepare different types of growth media commonly used for microbial analysis, including selective and differential media
3. Characterize the sensory attributes and changes associated with spoilage in different food samples, including color, odor, texture, and taste
4. Conduct a literature review on specific foodborne pathogens and their characteristics, focusing on their virulence factors and modes of transmission

c. Other Activities:

1. Seminar Topics:
    - Comparative analysis of physiological characteristics of yeast, molds, and bacteria.
    - Isolation and characterization of pure culture
    - Examination of Culture media based on type, composition and application
2. Visits: Visit nearby tool room/industry with food microbiology laboratory. Prepare report of visit with special comments of methods, equipment's, media and techniques used in microbial analysis of food.
3. Self-Learning Topics:
    - Staining techniques
    - Major groups of bacteria important in food bacteriology

- Composition of Nutrient agar, Nutrient Broth, MacConkey agar
- Spoilage in canned products
- Food poisoning due to mycotoxins

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%	20%	20%	20%	**20%**	20%
CO-2	20%	20%	20%	20%	20%	**20%**	20%
CO-3	25%	25%	20%	20%	20%	**20%**	20%
CO-4	30%	30%	20%	20%	20%	**20%**	20%
CO-5	10%	10%	20%	20%	20%	**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 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 Introduction to food microbiology	8	CO1, CO2	10	2	4	4
Unit-2.0 Characteristics Yeast, Mold & Bacteria	10	CO1	14	6	6	8
Unit-3.0 Pure culture isolating Technique	10	CO2, CO3	18	6	6	8
Unit-4.0 Food Spoilage	12	CO4	21	4	4	2
Unit-5.0 Food Born illnesses	8	CO5	7	2	4	4
Total	**48**	**-**	**70**	**20**	**24**	**26**

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.	Demonstrate working of different equipment's, instruments, tools, and glassware used in food microbiology laboratory • Autoclave • Hot air oven • Bunsen burner • Laminar flow • Incubator • Water bath • Magnetic stirrer • Colony counter • Inoculation loop and needle • Micropipette • Culture tubes • Petri plates	CO2	60	30	10
2.	Demonstrate working of compound light microscope using specimen slides of fungi and bacteria	CO1, CO2	60	30	10
3.	Sterilize given glass wares using Hot air oven method • Petri plates • Beakers • Test Tubes • Conical Flasks • Glass rod • Pipette	CO2, CO3	60	30	10
4.	Prepare general purpose media (Nutrient media & Nutrient broth) for cultivation of microorganisms.	CO2, CO3	30	60	10
5.	Sterilize given culture media using Autoclave method • Nutrient agar media • Nutrient Broth	CO2, CO3	60	30	10
6.	Isolate of pure culture of microorganism using Streak plate & Spread plate technique	CO2, CO3	60	30	10
7.	Isolate of pure culture of microorganism using Pour plate technique	CO2, CO3	60	30	10
8.	Determine viable microbial load in given sample using serial dilution method and pour plate technique	CO2, CO3	30	60	10
9.	Examine the characteristics of spoilage observed in given food products , when stored for long period without preservation • Milk-Souring, gas production, ropiness, Color & Flavor changes • Bread-Moldiness, Ropiness • Fruit juice- Moldiness, Fermentation Canned Mango pulp (punctured)-Hard swell, Soft swell, Flipper, Springer	CO4	60	30	10
10.	Determine total number of bacteria in given food sample using Total Plate Count (TPC) method.	CO2, CO3, CO4	30	60	10
11.	Prepare a chart describing microorganism involved, incubation period, symptoms, foods involved and control measure for various food born illnesses • Staphylococcal Intoxication and Botulism • Salmonellosis, Clostridium perfringes illness, Bacillus cereus gastroenteritis, E.coli infection	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 Instruments:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Autoclave	Approx. 80-120 L,Fully Automatic PID Control ± 0.1 °C • LED display for temperature and remaining time, Maximum 123°C ,Temperature Accuracy : ± 0.5 °C at 121 ° C, 15 -20 psi • ANALOG PRESSURE GAUGE (0 - 400 psi pressure guage) indicating actual pressure	1,4, 5,8,10
2.	Hot air oven	Approx. 200 liters, Temperature should be thermostatically controlled • It should be Ambient +5°C to 250°C with temperature setting accuracy ±0.5 °C with forced air circulation for temperature uniformity • Separate PT 100 sensor and display for temperature (LED) • Safety alarms	1,3, 4, 5,8,10
3.	Bunsen Burner	Fuel type: Natural gas or LPG, adjustable flame with stainless steel	1,6,
4.	Laminar Flow	Minimum 4 ft (w)x 2 ft (h) x 2f,HEPA filter-The filters should have • Size: 30” x 18” x 3” • Type: Separator less type, Mini-Pleats HEPA Media • Media: Ultra clean glass fiber paper • Particle Retention: 0.3 Micron • Efficiency: 99.997% or better • Initial Pressure: 16 mm WG • Grade : H13 rating, Particle Retention • 0.3 Micron, UV lamp • Pre-mounted UV lamp (30 W) with separate switch with UV light hours run indicator	1,3, 4, 5,8,10
5.	Incubator	Capacity • 340 Liters 5. Temperature Range • 5°C to 60°C with digital controller, • Temperature increments 0.1° C 6. Control Accuracy • ± 0.1 °C or better (at 60°C). 7. Distribution Accuracy/uniformi ty • ± 1 °C or better (at 37°C).	1,6,7,8,10
6.	Water Bath	Temperature Range: +20°C to 99°C • Temperature Accuracy: ± 0.2 °C at 37 .0°C • Temperature Uniformity: ± 0.5 °C at 37 .0°C • Digital LED display for operating status of TEMP • Over-Temperature Cut-Off • Temperature calibration function	1,6,7,8,10
7.	Magnetic Stirer	Adjustable speed control, compatible with various sizes of stir bars.	1, 8,10
8	Inoculation loop and needle	Made of heat-resistant material (e.g., nichrome wire) with a loop or needle shape for transferring and streaking microbial cultures.	6, 8, 10
9	Micropipette	Capacity /Volume 20-200 micro liter (Variable) 100-1000 micro liter (Variable) 1-10ml (Variable)	1, 6,7,8,10
10	Compound Microscope	4 objective lenses including 100x oil immersion Mechanical slide holder for easier slide handling 4 magnification levels: 40x, 100x, 400x, 1,000x	1,2

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		Coaxial coarse/fine focus for easier focusing	
11	L-shaped glass rod	Made of borosilicate glass, L-shaped design for convenient spreading of liquids in laboratory settings.	6,8,10

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Food Microbiology	Frazier, W.C. and Westhoff, D.C. (2003)	, Tata McGraw Hill, Inc., 18th Edition New York. **ISBN**-10. 9781259062513
2.	Microbiology	M.J.Pelczar	Tata McGraw Hill, Inc., New York ISBN 0074621017
3.	Basic Food Microbiology	Banwart, G.J.	AVI Publishing Co. Inc., Westport, Connecticut ISBN 9781468464535
4.	Handbook of Analysis and Quality Control for Fruit and Vegetable Products	S. Ranganna	Tata McGraw-Hill ISBN 9780074518519
5	Microbiology laboratory Manual	N. Varghese, Joy P.P.	KERALA AGRICULTURAL UNIVERSITY PINEAPPLE RESEARCH STATION Vazhakulam, Muvattupuzha, Ernakulam District, Kerala, PIN-686 670

(b) Online Educational Resources:

1. https://www.youtube.com/watch?v=shWayTlt4hk
2. https://www.youtube.com/watch?v=8va4id8BA0o
3. https://www.youtube.com/watch?v=Stx50CQjt6A&list=PLcCIZORoVQgh7kKVPA-cEbVun1vaWHE4f
4. https://www.youtube.com/watch?v=81dAOt5mT8A&list=PLcCIZORoVQgh7kKVPA-cEbVun1vaWHE4f&index=4
5. https://www.youtube.com/watch?v=_1wKCygLkig&list=PLcCIZORoVQgh7kKVPA-cEbVun1vaWHE4f&index=7
6. https://www.youtube.com/watch?v=NV9i_jTxwaM&list=PLcCIZORoVQgh7kKVPA-cEbVun1vaWHE4f&index=17
7. https://www.youtube.com/watch?v=aPIqUAQAy6M

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. Basic Practical Microbiology – A Manual, published by Microbiology Society, London UK ISBN 95368 383 4
2. Analytical Food Microbiology: A Laboratory Manual, Perry, J. J., WaiteCusic, J. G., Yousef, A. E. (2022). United Kingdom: Wiley. ISBN:9780470425114
3. Manual of methods of analysis-Microbiological Examination of food and water by FSSAI, India

A) Course Code : **2449202(T2449202/P2449202/S2449202)**

B) Course Title : Processing of Cereals and Pulses

C) Pre- requisite Course(s) : Fundamentals of Food Sciences and Technology

D) Rationale :

This course imparts knowledge of anatomical structure, composition, nutritional value, and milling technology of Major cereals and pulses in India. It deals with different milling technology, process parameters, equipments, and value addition on cereals and Pulses by secondary processing. This knowledge shall be used for selecting proper ingredients, equipment, and FSSAI standards to prepare the particular type of cereal and Pulse base products. The knowledge gained through this course will help the students to take up a course on bakery Technology.

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** Demonstrate wheat grain processing to produce raw material for food preparation.
- **CO-2** Describe the Corn processing steps with process parameters.
- **CO-3** Outline the manufacturing process of rice as per the FSSAI standards.
- **CO-4** Use of nutritional important cereal grains in food preparation.
- **CO-5** Prepared the processed pulses and utilize them to prepare value-added products

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		
CO-2	3	-	-	2	2	-	2		
CO-3	3	-	-	2	2	-	2		
CO-4	3	-	-	2	-	-	2		
CO-5	3	-	-	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:

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				
2449202	Processing of Cereals and Pulses	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)	
2449202	Processing of Cereals and Pulses	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: 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: T2449202

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Draw the anatomical structure of wheat kernel. *TSO 1b.* Describe the chemical composition of wheat grain. *TSO 1c.* Enlist the types of wheat grain. *TSO 1d.* Enlist factors required consideration for wheat storage. *TSO 1e.* State principle of the tempering process on wheat grain. *TSO 1f.* Draw the manufacturing process flow sheet of refined wheat flour production. *TSO 1g.* Give the FSSAI standards for Wheat grain.	**Unit-1.0 Processing of Wheat** 1.1 Anatomical Structure of Wheat Kernel. 1.2 Composition of Wheat. 1.3 Types and Grades of Wheat. 1.4 Wheat Storage. 1.5 Wheat Milling Process and equipments: Cleaning, Tempering, Break rollers, Classifier, Reduction rollers, Bleaching, Enrichment, and Packaging. 1.6 Production process flow sheet of atta, Refined Flour, and Semolina 1.7 FSSAI standards for Wheat, Atta, and Maidha. 1.8 By-product of Wheat milling and its utilization	**CO1**
TSO 2a. Name the different parts of corn grain and give the chemical composition. *TSO 2b.* Enlist types of corn and their uses. *TSO 2c.* Describe the manufacturing process of corn protein production. *TSO 2d.* Draw the wet and Dry corn milling process flow sheet. *TSO 2e.* State the principle of corn starch and protein separation. *TSO 2f.* Describe the manufacturing process of high-glucose corn syrup with a flow sheet. *TSO 2g.* Describe the manufacturing process of cornflakes with a flow sheet. *TSO 2h.* Enlist the by-products in corn milling.	**Unit-2.0 Processing of Corn** 2.1 Anatomical Structure of the Corn Kernel. 2.2 Types of Corn. 2.3 Composition of Corn 2.4 Dry Corn Milling - Production process and equipment's. 2.5 Wet Corn Milling - Production process and equipments. 2.6 Manufacturing Process of Corn Starch, dextrose, and Modified Starch. 2.7 Manufacturing Process of Corn Syrup-High glucose, High Maltose and High Fructose corn syrup. 2.8 Corn Flakes production process flow sheet. 2.9 FSSAI standards for whole corn flour, corn starch and corn grits. 2.10 By product of Corn milling and its utilization	**CO1, CO2**
TSO 3a. Draw the anatomical structure of the rice kernel. *TSO 3b.* State the advantage of parboiling paddy. *TSO 3c.* Describe the CFTRI method of parboiling. *TSO 3d.* Describe the chemical composition of rice. *TSO 3e.* Compare brown rice and White rice. *TSO 3f.* Enlist the rice grading parameters. *TSO 3g.* Describe the manufacturing process of quick-cooking rice with a flow sheet.	**Unit-3.0 Processing of Rice** 3.1 Anatomical Structure of the Rice Kernel 3.2 Composition of Rice 3.3 Parboiling of paddy:- Main objective, Parboiling process, and flow sheet of commercial parboiling. 3.4 Rice milling:-Processing steps and equipment-Cleaning sieves, Paddy grader, Huller, Husk Separator, polisher, and rice grader. 3.5 Manufacturing Process of Quick Cooking, Canned, Puffed, and Flaked Rice 3.6 By-product of rice milling and its utilization.	**CO3, CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3h. State the role of the polisher in rice milling process.		
TSO 4a. Enlist the types of barley grain and their uses. *TSO 4b.* Describe the manufacturing process of malted barley grain with processing parameters. *TSO 4c.* Give the nutritional value of Millet and sorghum. *TSO 4d.* State the application of barley malt in food processing.	**Unit-4.0 Processing of Other Cereals** 4.1 Barley: Types, Composition, and Manufacturing Process of Barley Malt and Malt Syrup. 4.2 Sorghum: Composition, Wet milling process, Production process of sorghum Malt. 4.3 Millets: Types, Composition, Nutritional Value, and Milling of Millets.	**CO3, CO4**
TSO 5a. Enlist the types of pulses produce in India. *TSO 5b.* Explain the nutritional value of pulses. *TSO 5c.* How to control the antinutritional factors in pulses. *TSO 5d.* Describe the dal manufacturing process by wet milling. *TSO 5e.* Name the equipments used in the pulses dal milling process. *TSO 5f.* Draw the flow sheet of the advanced dal milling process. *TSO 5g.* Describe the manufacturing process of Besan and its packaging. *TSO 5h.* State the advantage of quick cooking pulses.	**Unit-5.0 Processing of Pulses** 5.1 Types of Pulses. 5.2 Nutritional Value. 5.3 Anti-nutritional Factors of Pulses and its Control. 5.4 Pulses Dal manufacturing process- Wet and Dry milling process- 5.5 Advance dal manufacturing process. 5.6 Manufacturing Process of Pulses Flour. 5.7 Processes products of pulses- Whole and dehusked fried namkeen, Roasted Namkeen, Quick cooking Pulses, and Instant Pulses powder	**CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2449202

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use of a Micrometer and Weight balance. *LSO 1.2.* Calculate the % of contaminants and density of the grain.	1.	Determine the Physical properties of wheat. • Grain Size • 1000 Kernel weight • % of dockage • Color • Hardness • Kernel density • Bulk density	CO1
LSO 2.1. Use of Hot air oven and analytical balance. *LSO 2.2.* Identify the quality of wheat on the basis of moisture and gluten content.	2.	Analysis the quality of wheat on the basis of • Moisture • Gluten	CO1
LSO 3.1. Operate the hammer mill / Grinder *LSO 3.2.* Calculate the % of yield and cost of product per kg.	3.	Determine the % of the yield of atta by milling of wheat grain by hammer mill / Disc mill	CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 4.1. Select good quality of corn. *LSO 4.2.* Apply the cleaning process to the corn. *LSO 4.3.* Use of size reduction and shifting equipment.	4.	Determine the % of the yield of corn flour by dry milling process.	CO2
LSO 5.1 Operate the size reduction equipment LSO 5.2 Select the packaging and labeling the prepared product.	5.	Prepare the corn grits/flakes.	CO2
LSO 6.1 Operate the rice huller machine LSO 6.2 Determine the % of the yield of brown rice	6.	Prepare the brown rice by parboiling and milling process. • Parboiling of paddy • Milling of parboiled paddy	CO3
LSO 7.1 Use of puffing /flaking /oven machine LSO 7.2 Formulate the proportions of ingredients.	7.	Prepare the puffed/flaked rice /Gluten-free rice cake.	CO3
LSO 8.1 Select the appropriate proportion of grains. LSO 8.2 Operate the cleaning, size reduction, and shifting equipment.	8.	Preparethe mixed cereal grain flour / baby Food / Infant food (Any one)	CO1, CO2, CO3, CO4
LSO 9.1 Use of a hammer mill, oven, Cooker and weight balance. LSO 9.2 Select the proper conditions for soaking, germination, killing and cooking.	9.	Prepare the barley /sorghum malt extract.	CO4
LSO 10.1 Selection of proper proportion of ingredients. LSO 10.2 Use pasta/noodle-making machine and oven.	10.	Prepare the pasta /noodle by using multi-grains flour.	CO1, CO2, CO3, CO4, CO5
LSO 11.1 Use of size reduction machine. LSO 11.2 Determine the % of the yield of dal.	11.	Prepare the dal from any one Pulse.	CO5
LSO 12.1 Use of Oven and namkeen-making machine. LSO 12.2 Select the proper conditions for baking /frying/drying operations.	12.	Prepare one value-added product (Fried / baked/ namkeen/Papad) from Pulses	CO5
LSO 13.1 Select the proper proportion of cereals and pulses flour. LSO 13.2 Use of size reduction, mixing, cooking, drying and Packaging unit operation	13.	Prepare one instant product from Cereal and Pulses. • Instant khichadi / Instant dal / Instant mix pulses dal etc.	CO3, CO4, CO5

L) **Suggested Term Work and Self Learning: S2449202** 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 different types of cereal and Pulses in the local market and determine the % contamination present.
2. Apply the milling process on cereal and pulses and estimate the minimum cost of the product per kg.
3. Prepare the value-added product from Pulses.
4. Prepared the Instant food products from cereal and Pulses combination.
5. Apply the recent processing technology and prepare traditional cereal and pulses base products.
6. Collect the information on cereal and pulses processing equipment's information.

c. Other Activities:

1. Seminar Topics:
    - FSSAI standards for Cereal, Pulses, and their products.
    - By-Products and its Utilization in Cereal and Pulses Milling.
    - Cost estimation of cereal and pulses processing products.
    - Recent milling technology for cereal grains.
    - Value added products from the Pulses.

2. Visits: Visit nearby Cereal and Pulses milling Industry /Breakfast product preparation Industry. Prepare report of visit with respect to raw material quality, processing equipment, processing parameters, FSSAI standers and Packaging.

3. Self-Learning Topics:
    - Cleaning and Sorting Process of grains.
    - Physical properties of Cereal grain and Pulses.
    - Advance milling equipment.
    - Color sorter for Rice.
    - FSSAI standers for Cereal and Pulses.

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%	20%	20%	20%	20%
CO-2	20%	25%	25%	25%	25%	20%	20%
CO-3	20%	15%	20%	20%	20%	20%	20%
CO-4	15%	15%	15%	15%	15%	20%	20%
CO-5	25%	25%	20%	20%	20%	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 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: The 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 Processing of Wheat	10	CO1	14	2	4	4
Unit-2.0 Processing of Corn	12	CO2	16	6	6	8
Unit-3.0 Processing of Rice	8	CO3	12	6	6	8
Unit-4.0 Processing of Other Cereals	08	CO4	12	4	4	2
Unit-5.0 Processing of Pulses	10	CO5	16	2	4	4
Total	**48**	**-**	**70**	**20**	**24**	**26**

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 Physical properties of wheat. • Grain Size • 1000 Kernel weight • % of dockage • Color • Hardness • Kernel density Bulk density	CO1	30	60	10
2.	Analysis the quality of wheat on the basis of • Moisture • Gluten	CO1	40	50	10
3.	Determine the % of the yield of atta by milling of wheat grain by hammer mill / Disc mill	CO1	30	60	10
4.	Determine the % of the yield of corn flour by dry milling process.	CO2	30	60	10
5.	Prepare the corn grits/flakes.	CO2	30	60	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
6.	Prepare the brown rice by parboiling and milling process. • Parboiling of paddy • Milling of parboiled paddy	CO3	30	60	10
7.	Prepare the puffed/flaked rice /Gluten-free rice cake.	CO3	30	60	10
8.	Preparethe mixed cereal grain flour / baby Food / Infant food (Any one)	CO4	40	50	10
9.	Prepare the barley /sorghum malt extract.	CO4	40	50	10
10.	Prepare the pasta /noodle by using multi-grains flour.	CO4	40	50	10
11.	Prepare the dal from any one Pulse.	CO5	30	60	10
12.	Prepare one value-added product (Fried / baked/ namkeen/Papad) from Pulses	CO5	30	60	10
13.	Prepare one instant product from Cereal and Pulses. Instant khichadi / Instant dal / Instant mix pulses dal etc.	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.	Weighing Machine	One Digital weight balance up to 20kg and One digital analytical balance up to 500gm maximum	All
2.	Hot air oven	Laboratory Hot air Oven with slandered specification, Temperature maximum-250 degree Cel.	2,10,11,12
3.	Pulverize/Hammer mill	Hammer mill for grains- 3 to 5 HP power, with slandered Specification	3,4,7, 8
	Disc Flour Mill	Commercial Automatic Atta Chakki- 3Hp , SS body with slandered Specification	3,4,7, 8
	Corn flakes / grits machine	Semi-Automatic -SS body- 5hp Maize Pulverizer with slandered Specification	05
4.	Rice mill -Huller	Rice Huller with Polisher- 3 / 5 HP motor with SS body with slandered Specification	6
5.	Steam Cooker	50 liter capacity, SS-Body with gas / electric power.	9

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
6.	Pasta /Noodle extruder	Small laboratory Size, 3Hp motor, SS Body with slandered Specification	10
7.	Mini dal Mill	Mini dal mill machine -3 HP motor, SS body, with slandered Specification	11
	Namkeen Making Machine	Small size Namkeen making machine with oil frying system – 2 Hp motor, SS Body with slandered Specification	12

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Handbook of cereal science and Technology	Klaus J. Lorenz, Karel kulp	Marcel Dekker, Inc 270 Madison Avenue, New York 2006 ISBN 0-8247-8358-1
2.	Bakery science and Cereal Technology	Neelam Khetarpaul, Raj Bala Grewal, Sudesh jood	Daya Publishing House New Delhi 110002ISBN : 8170353505
3.	Foods facts and principles	Manay, S. & Shadaksharaswami	New Age International PVT Publishers New Delhi ISBN-10: 8122422152
4.	Post Harvest Technology of Cereals Pulses and Oilseeds	CHAKRAVERTY A.	Publisher : OXFORD & IBH PUBLISHING, ISBN-13 : 978-8120409699
5	Pulses: Processing and Product Development	A. Manickavasagan (Editor), Praveena Thirunathan	Springer; 1st ed. 2020 editionISBN-13-978-3030413750

(b) Online Educational Resources:

1. https://youtu.be/ESEYZC4NZHw (Composition and Processing of cereals)
2. https://youtu.be/-mDzkbczvaw (Technology of cereals, pulses & oilseeds)
3. https://youtu.be/hyELy7CNzCQ (Processing Technology of Cereals, Pulses and Oilseeds Rice Milling)
4. https://youtu.be/-25RWBg1GJ4 (Processing of Pulses)
5. https://youtu.be/xdtaDjpbYjI (Corm Milling)

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

A) Course Code **: 2449203(T2449203/P2449203/S2449203)**

B) Course Title **:** Fundamentals of Nutrition

C) Pre- requisite Course(s) **:** Fundamentals of Food Sciences and Technology

D) Rationale **:**

The importance of good food and its relationship with health has been well-known and practiced since ancient times. Human Nutrition is a core subject in Food Technology, which outlines one of the basic needs of the human body. It introduces students to the types of nutrients, their roles, functions, sources, utilization in the human body and ill effect on health if balance and moderation are not maintained. With the advent of technology, food consumption patterns are changing and students need to be kept abreast of the changing food habits and their adverse influence on health. The latest RDA tables, the healthy eating plate, and reading food labels for Nutrition facts have been included so that students can make wise decisions and can modify their diet to solve the problem of Nutrient deficiency and maintain a normal healthy life.

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 Define terms related to human nutrition and classify nutrients.
CO-2 Outline the sources, functions, and digestion, absorption, and deficiency disorders of macronutrients.
CO-3 Outline the classification, sources, functions and deficiency disorders of micronutrients.
CO-4 Calculate calorific value of food and energy needs of body as per RDA.
CO-5 Formulate a balanced diet for different stages of normal life cycle.

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/ 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		
CO-2	3	-	-	-	-	-	3		
CO-3	3	3	-	-	2	-	3		
CO-4	3	3	3	2	3	3	2		
CO-5	3	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	Teaching & Learning Scheme (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2449203	Fundamentals of Nutrition	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)	
2449203	Fundamentals of Nutrition	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: 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: T2449203

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Define the terms Nutrition and nutrients. *TSO 1b.* Describe factors influencing our food consumption. *TSO 1c.* Define main terms related to nutrition. *TSO 1d.* Describe signs of Good nutritional status and poor nutritional status. *TSO 1e.* Classify nutrients into macro and micronutrients. *TSO 1f.* State the functions of nutrients. *TSO 1g.* Explain food guide pyramid and food plate. *TSO 1h.* Enlist the 15 dietary guidelines for good health.	**Unit-1.0 Introduction to Nutrition** 1.1 General introduction of nutrition. 1.2 Factors influencing food consumption. 1.3 Definition of food, nutrition, nutrients, under-nutrition, overweight, obesity, malnutrition, diet therapy, nutrient dense food, junk food, nutritional status, signs of good nutritional status and poor nutritional status. 1.4 Nutrients: Classification of nutrients, Functions of nutrients. 1.5 Food guidelines for good health: Food guide pyramid, My plate for the day (NIN), 15 Dietary Guidelines for good health.	**CO1**
TSO 2a. Describe the human Digestive system. *TSO 2b.* Explain digestion and absorption of carbohydrates. *TSO 2c.* Describe the basic chemical composition and classification of carbohydrates. *TSO 2d.* Explain the role and functions of carbohydrates. *TSO 2e.* Enlist out the sources of carbohydrates. *TSO 2f.* Explain digestion and absorption of protein. *TSO 2g.* Describe the basic chemical composition and classification of protein. *TSO 2h.* Explain the role and functions of protein. *TSO 2i.* List out the sources of protein. *TSO 2j.* Describe any two deficiency disease of protein. *TSO 2k.* Explain digestion and absorption of fats. *TSO 2l.* Describe the basic chemical composition and classification of fats. *TSO 2m.* Explain the role and functions of fats. *TSO 2n.* List out the sources of cholesterol and trans fats.	**Unit-2.0 Role and Functions of Nutrients** **(Macronutrients)** **2.1 Digestive system:** Diagram of Digestive system, Functions of each organ of digestive system. **2.2 Carbohydrates:** • Basic Chemical composition • Classification. • Functions • Digestion and absorption. • Sources and RDA • Role of dietary fiber. • Deficiency and excess. **2.3** Protein • Basic Chemical composition • Essential amino acids • Classification. • Functions • Digestion and absorption. • Sources and RDA • Supplementary value of proteins • Deficiency and excess. **2.4 Fats** • Basic Chemical composition • Classification. • Essential fatty acids and omega – 3 fatty acids • Functions • Digestion and absorption.	**CO1, CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	• Sources and RDA • Cholesterol. • Trans fats • Deficiency and excess	
TSO 3a. Define vitamins and give its classification with suitable example of each. *TSO 3b.* Define minerals and give its classification with suitable example of each. *TSO 3c.* Define vitamin .A, write down the sources, functions and deficiency of vitamin-.A. *TSO 3d.* Give the scientific name of B complex group also gives its sources, functions, and deficiencies. *TSO 3e.* Describe the sources, role and functions of, deficiency of vitamin C. *TSO 3f.* Explain the role and functions, deficiency of vitamin D and vitamin K. *TSO 3g.* Describe the functions, sources, deficiency of calcium and phosphorous. *TSO 3h.* List out the minor minerals and explain any two of them. *TSO 3i.* Explain the food sources and functions of water.	**Unit-3.0 Role and Functions of Micronutrients and Water** **3.1Vitamins:** • Basic Chemical composition • Classification. • Sources. • Role and functions. • Deficiency and excess **3.2 Minerals** • Classification. • Sources. • Role and functions. • Deficiency **3.3 Water:** • Water balance**.** • Sources in our diet. • Functions in the body. • Deficiency and daily intake	**CO3, CO4**
TSO 4a. Explain the Basic Five Food groups, sources with its size of serving, no of serving. *TSO 4b.* Determine your own energy needs. *TSO 4c.* Plan diets using the Five food groups *TSO 4d.* Define RDA (Recommended Dietary Allowances) requirements of nutrients for Indian Reference Man and Woman. *TSO 4e.* Locate RDA for various nutrients and understand factors affecting RDA. *TSO 4f.* Define energy and Kilocalorie. Also, State units of energy. *TSO 4g.* Describe Basal metabolic rate (BMR) with its influencing factors. *TSO 4h.* Judge the calorific value of food, list out and calculate energy values of food. *TSO 4i.* Explain the working principle of Bomb calorimeter instrument with its well labeled sketch. *TSO 4j.* Draw the table of nutritional information panel with one example of product. *TSO 4k.* Define the health claims and give two examples. *TSO 4l.* Write the labelling guidelines as per FSSAI for Salt packaging. *TSO 4m.* Define the fortified food and give two examples.	**Unit-4.0 Food and our Body** 4.1 • Food groups source size of serving, no of serving from each of the following: • Body building food group • Protective food group • Energy food group • Cereals and millets group • Other fruits and vegetables **4.2 Recommended Dietary Allowances (RDA):** • Definition of RDA • Factors influencing RDA • Uses of RDA. **4.3 Energy requirements of the body:** • Units of energy. • BMR and factors affecting BMR, • SDA • Calorific value of food, Bomb calorimeter, • Estimating own energy needs. **4.4 Nutritional Labeling** • Nutrition facts • Energy calculation • Health Claims • Fortified foods • Logo for Vegetarian/Non-vegetarian foods • Labelling guidelines for salt, oil, gluten free food.	**CO3, CO4**
TSO 5a. Plan a balanced diet during pregnancy.	**Unit-5.0 Nutritional Requirement during the Normal Life Cycle**	**CO4, CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 5b. Explain the diet requirements for pregnant Lactating woman to meet their enhanced nutritional needs. *TSO 5c.* Describe nutrition in the early growth period of life cycle. *TSO 5d.* Describe supplementary foods for infants. *TSO 5e.* Describe nutrition requirements for the elderly. *TSO 5f.* Explain the principles of meal planning for preschool children.	5.1 Pregnancy. 5.2 Lactation. 5.3 Infancy. 5.4 Childhood. 5.5 Adolescence. 5.6 Adulthood. 5.7 Geriatric nutrition (old age)	

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2449203

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Refer my plate and draw the sketch. *LSO 1.2.* Prepare the corrective action plan for perfect my plate.	1.	Evaluate your own plate based on what you ate during the entire day by refer to 'My Plate' diagram. Note the differences if any, and write down the corrective action you plan to take	CO1
LSO 2.1. Identify the fiber rich food list by using NIN dietary guidelines. *LSO 2.2.* Find the RDA of fiber. *LSO 2.3.* Prepare and calculate the fiber rich breakfast two dish plan.	2.	Plan a diet of two fiber rich dish, by using NIN Dietary Guidelines.	CO2
LSO 3.1. Market survey and collect the sample. *LSO 3.2.* Read the nutritional label and enlist the details. *LSO 3.3.* Identify the good product with respect the fat and fiber.	3.	Choose any five packaged bakery food items and note down the types of fatty acids/fats mentioned in the Nutrition facts. Also note the name of fat/oil used in the product. Rank these foods on the basis of their fat and fiber content.	CO2
LSO 4.1. Identify the protein rich raw materials by using NIN dietary guidelines. *LSO 2.4.* Prepare and calculate the protein rich breakfast two dish plan as per RDA for specific age group.	4.	Plan a diet of two Protein rich dish, by using NIN Dietary Guidelines.	CO2
LSO 5.1. Prepare the chart on depicting sources, functions, RDA and deficiency, symptoms of Vitamins A and D.	5.	Design a chart depicting sources, functions, RDA and deficiency, symptoms of Vitamins A and D.	CO3,
LSO 6.1. Market survey and collect the sample. LSO 6.2. Read the nutritional label and enlist the details. LSO 6.3. Calculate the sodium fulfillment as per RDA.	6.	Determine the sodium content on the labels of any ten packets of farsan/chips/salted nuts/pickles/sauce etc and calculate % of RDA for sodium fulfilled by a serving of savoury snacks.	CO3,
LSO 7.1. Select the sample. *LSO 7.2.* Determine the Vit-C contain by Titration method.	7.	Estimate Vitamin C from given food sample.	CO3,
LSO 8.1. Use Bomb calorimeter. *LSO 8.2.* Determine the Energy value of given sample.	8.	Determine the energy value of food by using Bomb calorimeter	CO4,

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 9.1. Determine the Overweight/ Underweight by BMI index	9.	Calculate your own BMI and assess your health status.	CO3, CO4
LSO 10.1. Use NIN dietary guidelines. *LSO 10.2.* Identify the Calcium requirement as per RDA. *LSO 10.3.* Enlist the Calcium rich food list.	10.	Identify the calcium requirements of an adolescent boy by using RDA table and. list the foods and its quantity needs to be consumed to meet your RDA for calcium.	CO3, CO4
LSO 11.1. Use NIN dietary guidelines. *LSO 11.2.* Enlist the ingredients for snack recipe. *LSO 11.3.* Calculate the energy, protein, fat, calcium and iron content of any healthy snack of your choice.	11.	List down the ingredients used in your favorite snack recipe and refer to the 'Food Composition Table' to calculate the energy, protein, fat, calcium and iron content of any healthy snack of your choice.	CO2, CO3, CO4
LSO 12.1 Market survey and collect the sample. LSO 12.2 Read the Food package label and enlist the details. .	12	Collect five packets of your favorite food from local market. Note down which nutrients are mentioned in the Nutrition Facts, Best before date, logos for fortification, logo for veg/non-veg food and explain why mentioning these is necessary	CO2, CO3, CO5
LSO 13.1 Use NIN dietary guidelines chart. LSO 13.2 Prepare the plan for preschool children as per the need of protein fortified with calcium.	13	Identify and select a food group to Formulate a (protein fortified with calcium) supplement for preschool children to meet required energy needs and calculate calorific values of it to fix the dose of per serving.	CO2, CO4
LSO 14.1 Use NIN dietary guidelines chart. LSO 14.2 Prepare the plan diet as per RDA.	14	Plan a balanced diet for a 75 years old Man giving reasons for your choice of foods.	CO5

L) Suggested Term Work and Self Learning: S2449203 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:

i. Plan a diet for 26 years old adult reference Man of heavy type work planned with 3200 kcal and 75 g protein. (refer master list of calorific value of different food groups, work type co-factor table)
ii. Plan a diet for 26 years old adult reference Woman of heavy type work planned with 2800 kcal and 50 g protein. (refer master list of calorific value of different food groups, work type co-factor table)
iii. Identify and select food group to formulate protein rich supplement for pregnant woman to meet energy requirement 2500 k.cal and protein 59 gm (you can use food exchange list method)
iv. Identify and select food group to formulate balanced diet supplement for Lactating woman to meet energy requirement 2750 k.cal (2200+550) and protein 70gm (45+25) (you can use food exchange list method)
v. Identify and select food group to Formulate a (carbohydrate fortified with vitamins and minerals) supplement for 6-month infant to meet required energy kcal needs and calculate calorific values of it to fix dose of per serving.

vi. Identify and select food group to Formulate a (protein fortified with calcium) supplement for preschool children to meet required energy kcal needs and calculate calorific values of it to fix dose of per serving.
vii. Identify and select food group to Formulate a (protein fortified with calcium and iron) supplement for Adolescent 14 year's girl of to meet required energy kcal needs and calculate calorific values of it to fix dose of per serving.
viii. Identify and select food group to Formulate a balanced diet of Calcium rich supplement for 65 years old Man to meet required energy kcal needs and calculate calorific values of it to fix dose of per serving.
ix. Explain the diet plan requirement for preschool going child energy requirements 2000 kcals protein 40 grams.
x. Design a menu plan for an adult Man (requirement 2400 kcal, protein 55g) and woman (2200 kcal and protein45g)

c. Other Activities:

1. Seminar Topics:
   - Functional Foods
   - Nutraceuticals Foods
   - Nutritional Labeling guidelines
   - Health and Nutritional claims

2. Visits: Nil

3. Self-Learning Topics:
   - Role and functions of nutrients (Macronutrients and Micronutrients)

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%	-	10%	15%	20%
CO-2	20%	25%	20%	25%	20%	25%	20%
CO-3	25%	30%	20%	25%	25%	25%	20%
CO-4	20%	15%	25%	25%	25%	25%	20%
CO-5	20%	15%	20%	25%	20%	10%	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 (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Nutrition	6	CO1	10	2	4	4
Unit-2.0 Role and Functions of Macronutrients	14	CO1, CO2	20	6	6	8
Unit-3.0 Role and Functions of Micronutrients and Water	12	CO3, CO4	20	6	6	8
Unit-4.0 Food and Our Body.	08	CO3, CO4	10	4	4	2
Unit-5.0 Nutrition during Normal Life Cycle	08	CO4, CO5	10	2	4	4
Total	**48**	**-**	**70**	**20**	**24**	**26**

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.	Evaluate your own plate based on what you ate during the entire day by refer to 'My Plate' diagram. Note the differences if any, and write down the corrective action you plan to take	CO1	40	50	10
2.	Plan a diet of two fiber rich dish, by using NIN Dietary Guidelines.	CO2	40	50	10
3.	Choose any five packaged bakery food items and note down the types of fatty acids/fats mentioned in the Nutrition facts. Also note the name of fat/oil used in the product. Rank these foods on the basis of their fat and fiber content.	CO2	40	50	10
4.	Plan a diet of two Protein rich dish, by using NIN Dietary Guidelines.	CO2	40	50	10
5.	Design a chart depicting sources, functions, RDA and deficiency, symptoms of Vitamins A and D.	CO3	40	50	10
6.	Determine the sodium content on the labels of any ten packets of farsan/chips/salted nuts/pickles/sauce etc and calculate % of RDA for sodium fulfilled by a serving of savoury snacks.	CO3	40	50	10
7.	Estimate Vitamin C from given food sample.	CO3,	40	50	10
8.	Determine the energy value of food by using Bomb calorimeter	CO3,	40	50	10
9.	Calculate your own BMI and assess your health status.	CO3, CO4	40	50	10
10.	Identify the calcium requirements of an adolescent boy by using RDA table and. list the foods and its quantity needs to be consumed to meet your RDA for calcium.	CO3, CO4	40	50	10
11.	List down the ingredients used in your favorite snack recipe and refer to the 'Food Composition Table' to calculate the energy,	CO2, CO3, CO4	40	50	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
	protein, fat, calcium and iron content of any healthy snack of your choice.				
12.	Collect five packets of your favorite food from local market. Note down which nutrients are mentioned in the Nutrition Facts, Best before date, logos for fortification, logo for veg/non-veg food and explain why mentioning these is necessary	CO2, CO3, CO5	40	50	10
13.	Identify and select food group to Formulate a (protein fortified with calcium) supplement for preschool children to meet required energy needs and calculate calorific values of it to fix dose of per serving.	CO2, CO4	40	50	10
14.	Plan a balanced diet for a 75 years old Man giving reasons for your choice of foods.	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.	Analytical Weight balance	Analytical weight balance, accuracy 0.1gm, maximum weight-500gm	7,8
2.	Digital Weight balance	Accuracy-1 gm maximum weight-100kg.	9
3.	Bomb Calorimeter	Working (Operating) Temperature-15-70°C, Storage Temperature- 0-70°C, Temperature Resolution- 0.000001°C Reproducibility/Repeatability-0.1% RSD, Resolution - 0.0001 MJ/Kg, Results per hour 10 samples per hour using 2 bayonet bomb vessels Measuring range max-99MJ, 99,000,00 Joules Working temperature min-0°C Working temperature max-50°C With all accessories	8

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Nutrition and dietetics	Shubhangini A Joshi	Tata McGraw-Hill Publishing Company Limited, New Delhi, ISBN 0-07-047292-0
2.	Food Science and Nutrition	Sunetra Roday	Oxford University Press, New Delhi, 3rd Edition,
3.	Dietary Guidelines for Indians	--	NIN, Hyderabad 2011
4.	Indian Food composition Tables	--	NIN, Hyderabad 2017
5.	Human nutrition.	Vinodini Reddy	Oxford and IBH publishing Co.P.V.T.LTD.ISBN-81-204-1582-5
6.	Food facts and principles	A Shakuntala Manay	New AGE International(p)Limited.ISBN978-81-224-2215-3
7.	Ditetics	B Shrilaxmi	New AGE International(p)Limited ISBN-81-224-0576-2

(b) Online Educational Resources:

1. https://www.nal.usda.gov/ (National Agricultural library)
2. https://www.youtube.com › watch (Introduction to Nutrition)
3. https://www.youtube.com/watch?v=vjoeaQlooV4 and https://www.youtube.com/watch?v=P4JKgmQk8-I (Relationship between Food, Nutrition and Health)
4. https://www.youtube.com/watch?v=8QDVxmL0_L8- (Digestion, absorption and utilization of Nutrients)
5. https://www.nin.res.in/ (National Institute of Nutrition)
6. https://www.youtube.com/watch?v=SgU--CWLkxE (Digestion, absorption and utilization of Nutrients)

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. Open online courses (MOOCs) / Swayam

******

A) Course Code **: 2449204(T2449204/P2449204/S2449204)**

B) Course Title **:** Principles of Food Engineering

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

D) Rationale **:**

Food engineering is a multidisciplinary area that applies engineering combined with the knowledge of product properties by developing processes and equipment to convert agricultural raw materials and ingredients into safe food for consumers. This course essentially imparts the knowledge of food engineering principles in food processing, such as thermodynamics, steam boiler, characteristics of fluids, basic equation in fluid flow, heat transfer, refrigeration process and psychometric. This knowledge shall be used for control the process parameters, maintenance of equipment's and develop food processing line.

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 students will be able to-

CO-1 Define the terms in thermodynamic and properties of steam.
CO-2 Describe the construction, working of steam boiler and its parts with sketch.
CO-3 Calculate the basic properties of fluids by using fluid flow equations.
CO-4 Calculate the rate of heat transfer by conduction and convection.
CO-5 Apply the refrigeration and psychometric principle for food storage

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/ Developmentof 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	-	1	2	2	-	2		
CO-2	3	2	3	3	3	2	2		
CO-3	3	3	2	2	3	-	2		
CO-4	3	3	2	2	2	-	2		
CO-5	3	2	2	3	1	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				
2449204	Principles of Food Engineering	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)	
2449204	Principles of Food Engineering	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: 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: T2449204

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Define the basic properties fluid. *TSO 1b.* Define the Zeroth and first law of thermodynamic. *TSO 1c.* Solve the basic problems on absolute pressure and Specific heat *TSO 1d.* Solve the basic problems on characteristic gas law. *TSO 1e.* Draw the P-V chart of Isochoric, Isothermal, Isobaric, Adiabatic and Polytrophic gas process. *TSO 1f.* Draw the graphical diagram of temperature vs heat added constant stem production process. *TSO 1g.* Define the properties of steam.	**Unit-1.0- Fundamental of Thermodynamics** 1.1 **Basic Properties**-Definition of-Pressure, Volume, Temperature, work, Heat, Energy and Enthalp., 1.2 Law of thermodynamics- Zeroth, first and Second, perfect gas laws. 1.3 Characteristic gas equation, Specific Heat, Gas processes- Isochoric, Isothermal, Isobaric, Adiabatic and Polytrophic process. 1.4 **Properties of Steam**-Formation of stem at constant pressure process. 1.5 Definition of enthalpy of water, enthalpy of latent heat, enthalpy of dry saturated steam, enthalpy of superheated stem, wet steam.	**CO1**
TSO 2a. List the part of boiler. *TSO 2b.* Classify the types of Boiler. *TSO 2c.* Compare water tube and fire tube boiler *TSO 2d.* Draw the sketch of Cochran boiler *TSO 2e.* Draw the sketch of one advance high pressure boiler. *TSO 2f.* Describe the construction and working of water level indicator and pressure gauge. *TSO 2g.* Draw the sketch of leaver safety and dead weigh safety valve.	**Unit-2.0 Steam Boilers** 2.1 **Steam boiler** -Boiler common terms, Classification of boiler, construction, working and sketch of fire tube and water tube boiler-Simple vertical boiler, Cochran boiler, locomotive boiler and babcock and wilcox boiler, High Pressure Boiler-La mont boiler and Benson boiler. 2.2 **Boiler mountings and accessories** –Construction, working and sketch of Dead weight ,spring loaded and lever Safety valve, water level indicator, pressure gauge and fusible plug, Super heater, Air pre heater and economizer.	**CO1, CO2**
TSO 3a. Define the properties of liquid food. *TSO 3b.* Derive the equation of continuity equation. *TSO 3c.* Define the laminar and turbulent flow. *TSO 3d.* Describe the construction and sketch of venture meter and orifice meter. *TSO 3e.* Derive the equation of venture meter. *TSO 3f.* Describe the pressure measurement devices. *TSO 3g.* Describe the construction, working and sketch of centrifugal pump. *TSO 3h.* Draw the sketch of reciprocating pump. *TSO 3i.* List the application of vacuum producing device. *TSO 3j.* Describe the working of steam Jet injector.	**Unit- 3.0 Fluid Flow** **3.1 Introduction** -Definition of mass density, Weight density, Specific volume, Specific gravity, Viscosity and Kinematic viscosity. **3.2** Basic equation of fluid, Bernoulli's equation and its application pressure and flow measurement devices-Venturi-meter, orifice meter, Pitot tube Rota –meter, classification of fluid. **3.3 Pumps-** Construction, working and sketch of reciprocating, centrifugal, rotary, mono and Lobe pump for fluid flow and Vacuum producing devices.	**CO1, CO2, CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	3.4 Vacuum Producing devices-Application of vacuum producing devices in food processing, steam Jet injector, Reciprocating pump and Positive displacement device.	
TSO 4a. Describe the modes of heat transfer. *TSO 4b.* Derive the conduction heat equation transfer through single wall and three plain composite walls. *TSO 4c.* Solve the basic problems on conduction heat transfer. *TSO 4d.* Define the thermal conductivity and insulating material. *TSO 4e.* Describe the convection heat transfer equation. *TSO 4f.* Solve the problems on log mean temperature difference. *TSO 4g.* Define the terms related in radiation heat transfer. *TSO 4h.* Name the heat exchanger used for food processing.	**Unit-4.0 Heat Transfer** **4.1 Conduction** - Modes of heat transfer, Fourier's law, equation of heat transfer to plain wall and composite wall, Definition of Thermal conductivity, equation of Heat flow through cylinder, Thermal Insulation, basic problems on conduction heat transfer. **4.2 Convection** –Definition of convection, Types of convection with examples, equation of Heat transfer coefficient, Types of fluid flow in heat exchanger and equation of log mean temperature difference, Problems on log mean temperature difference. **4.3 Radiation-**Definition of Absorption, Transmission and Reflection, black body, white body, transparent body, Advantage of solar drying, solar drying system types with sketch.	**CO1, CO2, CO3, CO4**
TSO 5a. List the application of refrigeration in food processing. *TSO 5b.* Define the one unit of refrigeration and coefficient of performance. *TSO 5c.* Describe the working of vapor compression refrigeration system with sketch. *TSO 5d.* Draw the sketch of Vapor absorption refrigeration system. *TSO 5e.* State the principle of compressor, condenser and expansion valve. *TSO 5f.* Compare the quick and slow freezing process. *TSO 5g.* Draw the freezing curve. *TSO 5h.* Compare the conveyor freezer with cryogenic freezing. *TSO 5i.* Draw the psychometric chart. *TSO 5j.* Determine the relative humidity by using psychometric chart.	**Unit-5.0 Refrigeration and Psychometric** **5.1 Principles of Refrigeration:** Application of refrigeration in food industry, One unit of refrigeration, C.O.P. refrigerants classification, properties of common refrigerants, Vapor compression refrigeration system. **5.2** Working principle of compressor, Condenser and expansion valve, T-s and p-h Diagram and vapor absorption refrigeration system5.2 Construction, working and a sketch of Conveyors- Belt, Roller, Chain, Wheel, Magnetic, Slat, Chute or gravity and Screw. **5.3 Freezing Methods-**Definition of freezing, application of frozen storage in food industry, Freezing curve for water and binary system, Construction and working of freezer equipments-Air blast freezer , multi-plate freezer ,Conveyor freezer, Scraped surface freezer fluidized bed freezer, immersion freezer and cryogenic freezer . **5.4 Psychometric**- Definition of dry air, Humidity ,Relative Humidity, Dry bulb temperature, wet bulb temperature, dew point temperature , Sling psychomotor and Psychometric chart .	**CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2449204

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Use of manometer tube & pressure gauge.	1.	Measure the pressure by using manometer and pressure gauge	CO1
LSO 2.1 Use of steam stable LSO 2.2 Compare the standard chart.	2.	Solve the problems based on general gas equation and specific heat.	CO1
LSO 3.1. Sketch the standard boiler *LSO 3.2.* Uses of boilers	3.	Draw the sketch of boiler mountings and accessories.	CO2
LSO 4.1. Sketch the fire tube boiler *LSO 4.2.* Sketch water tube boiler.	4.	Draw the sketch of one fire tube boiler and one water tube boiler.	CO2
LSO 5.1. Use of viscometer, specific gravity bottle. *LSO 5.2.* Calculate the density, specific gravity and viscosity of sample liquid.	5.	Determine the density, Specific gravity and viscosity of given liquid food sample.	CO3
LSO 6.1. Use Bernoulli's equation	6.	Prove the Bernoulli's theorem.	CO3
LSO 7.1 Use of orifice meter *LSO 7.2* Calculate the co-efficient of discharge.	7.	Determine the Co-efficient of discharge of Orifice meter.	CO3
LSO 8.1. Use of ventui-meter *LSO 8.2.* Calculate the co-efficient of discharge	8.	Determine the Co-efficient of discharge of Ventui- meter.	CO3
LSO 9.1. Use of steam stable.	9.	Solve the problems related to conduction heat transfer and log mean temperature difference.	CO4
LSO 10.1. Use of hot air oven, vacuum oven, incubator	10.	Determine temperature of hot air oven, vacuum oven, dryer and incubator by dry bulb thermometer and calibrate the same.	CO4
LSO 11.1 Use of heat exchangers LSO 11.2 Sketch the heat exchangers.	11.	Draw the sketch of heat exchangers used in food processing.	CO4
LSO 12.1 Use of refrigerator and deep freezer.	12.	Preserve the food sample by slow freezing and quick method and observe the quality changes after thawing.	CO5
LSO 13.1 Use of psychometrics chart.	13.	Determine the relative humidity by using psychometrics chart.	CO5

L) Suggested Term Work and Self-Learning: S2449204 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:

i. Prepare the chart of Units, Conversions, prefixes and basic properties of thermodynamics.
ii. Prepare the chart of boiler mountings and accessories with sketch.
iii. Prepare a model of heat exchanger / Jacketed kettle / vacuum pan cooking kettle.
iv. Handle and maintain the small refrigeration system in laboratory or water cooler.
v. Prepare the refrigeration system charts and refrigeration cycle.
vi. Prepare a chart of flow and pressure measurement devices sketch.
vii. Prepare a chart of types of pump and vacuum producing device.
viii. Design the model of processing of food by heating and cooling process.

c. Other Activities:

1. Seminar Topics:
   - Types of boilers.
   - Properties of steam.
   - Classification of boilers.
   - Application of vacuum producing devices.

2. Visits: Visit nearby Fruit Processing/Cashew Processing/ Cereal Milling/ Bakery/ beverage processing Industry.

3. Self-Learning Topics:
   - Heat transfer videos and lecturers
   - Working principles of compressor, condenser videos and Lectures.
   - Various Food Industry processing steps by videos.

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%	22%	20%	25%	20%	20%	20%
CO-2	20%	20%	25%	25%	25%	25%	20%
CO-3	20%	23%	20%	25%	20%	25%	20%
CO-4	20%	20%	20%	25%	20%	20%	20%
CO-5	20%	15%	15%	--	15%	10%	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 (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0- Fundamental of Thermodynamics	8	CO1	14	4	4	6
Unit-2.0 Steam Boilers	10	CO1, CO2	12	4	4	4
Unit-3 Fluid Flow	10	CO1, CO2, CO3	16	4	6	6
Unit-4.0 Heat Transfer	12	CO1, CO2, CO3, CO4	14	4	4	6
Unit-5.0 Refrigeration and Psychometric	08	CO5	14	4	6	4
Total	**48**	**-**	**70**	**20**	**24**	**26**

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. N0.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Measure the pressure by using manometer and pressure gauge	CO1	30	60	10
2.	Solve the problems based on general gas equation and specific heat.	CO1	30	60	10
3.	Draw the sketch of boiler mountings and accessories.	CO2	30	60	10
4.	Draw the sketch of one fire tube boiler and one water tube boiler.	CO2	30	60	10
5.	Determine the density, Specific gravity and viscosity of given liquid food sample.	CO3	30	60	10
6.	Prove the Bernoulli's theorem.	CO3	30	60	10
7.	Determine the Co-efficient of discharge of Orifice meter.	CO3	40	50	10
8.	Determine the Co-efficient of discharge of Ventui- meter.	CO3	40	50	10
9.	Solve the problems related to conduction heat transfer and log mean temperature difference.	CO4	40	50	10
10.	Determine temperature of hot air oven, vacuum oven, dryer and incubator by dry bulb thermometer and calibrate the same.	CO4	30	60	10
11.	Draw the sketch of heat exchangers used in food processing.	CO4	60	30	10
12.	Preserve the food sample by slow freezing and quick method and observe the quality changes after thawing.	CO5	60	30	10
13.	Determine the relative humidity by using psychometrics chart.	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.	U-tube manometer set of standard specification	Laboratory U-tube manometer standard specification.	1
2.	Bourdon pressure gauge with all fittings of standard specification	Pressure gauge with all fittings of standard specification	1,2,4
3.	Weight balance of standard specification	Weight balance of standard specification.	All
4.	Ostwald's viscometer of standard specification	Ostwald's viscometer of standard specification.	5
5.	Brookfield viscometer of standard specification	Brookfield viscometer of standard specification.	5
6.	Specific gravity bottle of standard specification	Specific gravity bottle of standard specification.	5
7.	Bernoulli's theorem apparatus of standard specification	Bernoulli's theorem apparatus of standard specification.	6
8.	Venturimeter apparatus of standard specification.	Venturi-meter apparatus of standard specification.	8
9.	Orifice meter apparatus of standard specification.	Orifice meter apparatus of standard specification.	7
10.	Glass thermometer of standard specification.	Glass thermometer of standard specification.	9
11.	Infrared thermometer of standard specification.	Infrared thermometer of standard specification.	All
12.	Blast freezer of standard specification.	Blast freezer of standard specification.	12
13.	Models of boilers and its parts of standard specification.	Standard specification.	10,11

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	A Course in Heat and Mass Transfer	Arora and Domkundwar	Dhanpat Rai Publishing Co Pvt Ltd 2003 ISBN: 9788177000290
2	A Textbook of Fluid Mechanics and Hydraulic Machines	R. K. Bansal	Luxmi Publication (P) Ltd New Delhi.2005, ISBN:978-81-318-08153
3	Elements of heat engines	R.C.Patel and C.J.Karamchandani	Acharya Book Depot, Vadodara ISBN:1234567145375
4	Food Processing Principles and Applications	Ramaswamy H and Marcotte	M CRC Press 2005, ISBN 9781587160080
5	Textbook of Refrigeration and Air Conditioning	R.S. Khurmi	S.Chand Pub. Ltd New Delhi. 2006 ISBN 9788121927819

(b) Online Educational Resources:

1) https://youtu.be/08aJpz_ZiMg (Lecture on basic thermodynamics)

2) https://youtu.be/e_OhHeF45JU (Lecture on Water tube boiler)

3) https://youtu.be/lKBqTOgOQTM (Lecture on Boiler mounting and accessories)

4) https://youtu.be/AdhWBb7j55c (Lecture on fluid flow Introduction)

5) https://youtu.be/GBrUvNar6tE (Lecture on Bernoulli's equation)

6) https://youtu.be/RWgbqCmE8DY (Lecture on venturi-meter)

7) https://youtu.be/uvw2vO8Lh0s (Lecturer on Orific-meter)

8) https://youtu.be/EpbuI6CbMRU?list=PL9RcWoqXmzaLnlGN39w2-1jyFyI_ALVa3 (Lecturer on Properties of fluids)

9) https://youtu.be/sHmjE21Fp9w (Lecturer on Manometer)

10) https://youtu.be/q6UVlhEBhpk (Lecturer on Modes of heat transfer)

11) https://youtu.be/1pGW0h1nm9s (Lecturer on Conduction heat transfer)

12) https://youtu.be/jc_hL_tSFzo (Lecturer on Heat exchangers)

12) https://youtu.be/62_WIhwcfQo (Lecturer on Dryer)

13) https://youtu.be/4mWsRUr0A7A (Lecturer on Introduction of refrigeration)

14) https://youtu.be/qAOJzp7ckGo (Lecturer on Psychometrics chart)

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. Animation videos regarding the construction and working of various unit operations equipment's.
2. Lab Manuals

A) Course Code : 2400102C(T2400102C/P2400102C/S2400102C)

B) Course Title : Applied Physics – C (FPP, GT, CACDDM, TE)

C) Pre- requisite Course(s) :

D) Rationale :

As a subject Physics includes large numbers of diverse topics, related to materials, energy and their interactions that exists in the world around us. It empowers us to explain the different physical phenomena by observation and prediction. Engineering Diploma graduates are required to use of principles of physics in various fields of engineering and technology are given prominence in the course content. This course will help the diploma engineers to apply the basic concepts and principles of physics for solving various broad-based engineering problems and comprehend different state of art technology-based applications.

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 errors in measurements of physical quantity with precision.

CO-2 Apply the concept of force, work and energy in different engineering situations

CO-3 Apply the concepts and principles of rotational and wave motion in various textile and allied engineering problems.

CO-4 Select relevant materials for industrial applications based on its physical properties.

CO-5 Apply the basic concepts of modern physics for solving engineering problems.

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/ Developmentof 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	1	-	2	-	1	2		
CO-2	3	2	2	1	-	1	1		
CO-3	3	2	2	1	1	1	1		
CO-4	3	2	2	1	1	1	1		
CO-5	3	1	1	2	-	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)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400102C	Applied Physics - C	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)	
2400102C	Applied Physics - C	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: 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: T2400102C

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Distinguish between fundamental and derived physical quantity. *TSO 1b.* Estimate the errors in the measurement of given physical quantity. *TSO 1c.* Derive dimensional formula of a given physical quantity. *TSO 1d.* Apply dimensional analysis for inter conversion of units.	**Unit-1.0 Unit and Measurements** 1.1 Physical quantities, fundamentals and derived units and system of units 1.2 Accuracy, precision and errors (systematic and random) in measurements, Method of estimation of errors (absolute and relative) in measurement, propagation of errors, significant figures 1.3 Dimensions and dimensional formulae of physical quantities, Principle of homogeneity of dimension in an equation 1.4 Applications of dimensions: conversion from one system of units to other, corrections of equations and derivation of simple equations. 1.5 Ancient astronomical instruments: Chakra, Dhanuryatra , Yasti and Phalaka yantra . (IKS)	**CO1**
TSO 2a. Explain the terms force, impulse and momentum. *TSO 2b.* Apply the concept of conservation of linear momentum in various situations. *TSO 2c.* Apply the concept of friction in various engineering situations. *TSO 2d.* Calculate the net work done conservative and non-conservatives forces *TSO 2e.* Apply the concept of conservation of energy in various situations. *TSO 2f.* Derive the expression for power in terms of force and velocity.	**Unit-2.0 Force, Work, Power & Energy** 2.1 Force, momentum, impulse, conservation of linear momentum, recoil of gun & rocket propulsion 2.2 Friction: coefficient of friction, static, kinetic and limiting friction, law of friction, Advantages and limitations due to friction. methods to remove friction 2.3 Work: Types (zero work, positive & negative work), work done by conservative and non-conservatives force 2.4 Energy: Kinetic energy, work energy theorem, potential energy, conservation of energy and its applications.	**CO2**
TSO 3a. Explain circular motion and various terms related to circular motion. *TSO 3b.* Distinguish between translational and rotational motion. *TSO 3c.* Explain the terms torque and angular momentum. *TSO 3d.* Apply the principle of conservation of angular momentum in given situation. *TSO 3e.* Differentiate between periodic motion and oscillatory motion. *TSO 3f.* Explain the various terms related to SHM. *TSO 3g.* Derive an expression for total energy of particle executing SHM.	**Unit-3.0 Circular, Rotational and SHM** 3.1 Circular motion, angular displacement, angular velocity, frequency, time period, angular acceleration, relation between angular & linear velocity and linear acceleration & angular acceleration 3.2 Translational and rotational motion, torque and angular momentum, conservation of angular momentum 3.3 Periodic and Oscillatory Motion 3.4 Simple Harmonic Motion (SHM): Displacement, velocity, acceleration, time period, frequency and their interrelation,	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	Kinetic and potential energy of particle executing SHM	
TSO 4a. Explain the stress-strain curve of a given elastic or plastic body. *TSO 4b.* Apply the concepts of surface tension and viscosity to solve a given engineering problems. *TSO 4c.* Explain the behavior of given fluids on the basis of their viscosity. *TSO 4d.* Determine the various modes heat transfer in a given engineering problem. *TSO 4e.* Apply the principle of calorimetry in various engineering situations.	**Unit-4.0 Physical Properties of Matter and Calorimetry** 4.1 Elasticity: Hooke's law, Coefficient of elasticity, Young's modulus, Bulk Modulus and modulus of rigidity, stress-strain curve, 4.2 Surface tension: cohesive and adhesive forces, Surface Tension, angle of contact, applications of surface tension, capillary action, effect of temperature and impurity on surface tension 4.3 Viscosity: Viscosity and coefficient of viscosity, Critical Velocity, Reynold's number, streamline and turbulent flow, Terminal velocity, Stokes law and effect of temperature on viscosity. 4.4 Calorimetry: concept of heat and its unit, principal of calorimetry, specific heat capacity, latent heat (fusion and vaporization), mechanical equivalence of heat.	**CO4**
TSO 5a. Apply the concept of photoelectric effect to explain the of photonic devices. *TSO 5b.* Explain Laser, components of laser and its various engineering applications. *TSO 5c.* Explain propagation of light in optical fiber and applications of optical fiber. *TSO 5d.* Describe the properties of nanomaterials and its various applications related to textile industries.	**Unit-5.0 Modern Physics** 5.1 Photoelectric effect; threshold frequency, work function, Stopping Potential, Einstein's photoelectric equation. 5.2 Lasers: Properties of Laser, Energy levels, ionization and excitation potentials; spontaneous and stimulated emission; population inversion, pumping methods, types of lasers: Ruby laser, engineering and medical applications of lasers. 5.3 Optical fibers: Total internal reflection, acceptance angle and numerical aperture, Optical fiber types, applications in telecommunication, medical field and sensors. 5.4 Nanotechnology: Properties (optical, magnetic and dielectric properties) of Nanomaterials and its application, Bhasma (Ancient Ayurveda, IKS)	**CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400102C

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use Vernier caliper to measure the known and unknown dimensions of a given small object. *LSO 1.2.* Estimate the mean absolute error up to two significant figures.	1.	Vernier caliper	CO1
LSO 2.1. Use screw gauge to measure the diameter/ thickness of a given object. *LSO 2.2.* Estimate the mean absolute, relative and percentage errors up to three significant figures.	2.	Screw gauge	CO1
LSO 3.1. Use Spherometer to measure radius of curvature of given convex and concave mirror/surface. *LSO 3.2.* Estimate errors in the measurement.	3.	Spherometer	CO1
LSO 4.1. Determine the spring constant of a given spring.	4.	Spring Oscillator	CO2
LSO 5.1. Use mixture method to determine the specific heat capacity of given solid	5.	Specific heat of Solid	CO2
LSO 6.1. Use Searle's apparatus to determine the Young's modulus of a given wire	6.	Searle's apparatus	CO4
LSO 7.1. Apply Stokes law to determine the coefficient of viscosity of a given viscous liquid.	7.	Stokes law	CO3
LSO 8.1. Determine the inverse square law relation between the distance of photocell and light source v/s intensity of light source.	8.	Photo-electric cell experiment	CO3
LSO 9.1. Determine the Numerical Aperture (NA) of a given step index optical fiber	9.	Numerical Aperture of an optical fiber	CO5
LSO 10.1. Measure wavelength of a He-Ne/diode laser by using a plane diffraction grating.	10.	He-Ne/diode laser	CO5
LSO 11.1. Plot the graph between KE of Photo electron v/s frequency of incident light *LSO 11.2.* Determine the value of Plank's Constant (*h*) from the Graph between KE v/s frequency of incident light. *LSO 11.3.* Determine the variation of stopping potential w.r.t frequency of incident photon	11	Photo electric effect (virtual lab experiment)	CO5
LSO 12.1. Determine the wave length of different spectral lines of Hydrogen spectra	12	Emission Spectra of Hydrogen (virtual lab experiment)	CO5

L) Suggested Term Work and Self Learning: S2400102C 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 such as:

1. Use dimensional analysis to check the validity of equations or derive relationships between physical quantities.
2. Explain the importance of using consistent units in calculations and the consequences of unit errors.
3. Find the value of heat produced in a body due to loss of mechanical energy in different situation.
4. Explain the **conservation of PE to KE** and vice versa in a given physical situation.

5. Find the temperature of the mixture of two different liquids in thermal equilibrium for a given conditions.
6. Prepare a chart on lasers mentioning different characteristics along with applications(online)

b. Micro Projects:

1. Make prototype Vernier calipers and screw gauge of desired LC.
2. Collect wires/ fibers different materials and find the fracture point for required applications
3. Fiber optics: Demonstrate the phenomenon of total internal reflection.
4. LASER: Prepare model to demonstrate the properties and applications of LASER.
5. Viscosity: Collect 3 to 5 liquids and prepare a working model to differentiate liquids based on viscosity and demonstrate their applications.
6. Motion: Prepare model of ball rolling down on inclined plane to demonstrate the **conservation of energy** and motion of an object in inclined plane.
7. Prepare prototype Atwood machine
8. Use smartphone to measure the different physical quantity with the sensor applications.
9. Prepare list of photonic materials used for engineering applications.

c. Other Activities:

1. Seminar Topics:
    - Needs of measurements in engineering and science.
    - Applications of circular motions in daily life and engineering.
    - LASER: Production & applications in science, industry, medical and defense, holography.
    - Optical fibers: Construction and application in communication systems.
    - Synthesis and applications of nanomaterials in textile industry.
    - Applications of lasers in textile
2. Visits:
    - Visit nearby industry with Instrumentation, production and Laser/optical fibers facilities. Prepare report of visit with special comments Instrumentation technique and material used.
    - Visit planetarium, Science city and research institutions for exploring the experimental and research facilities available.

3. Self-Learning Topics:
    - Vectors and its properties with applications.
    - types of fundamental units, system of units
    - Newton's Laws of motion, momentum, inertia, impulse.
    - derivation of formula for moment of inertia
    - Force, work, energy, power, work-energy theorem, law of **conservation of energy**
    - Frictions and its types
    - Electromagnetic waves
    - Pressure, density, Pascal's law, atmospheric and gauge pressure
    - Work done in various Processes, Adiabatic constant ($C_p/C_v = \Upsilon$), Mayer's formula ($C_p - C_v = R$)
    - CO_2 Laser, Semiconductor LASER, He Ne laser.
    - CNT, Graphene, C_{60}

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	12%	12%	20%	20%	10%	30%	20%
CO-2	22%	22%	20%	20%	10%	15%	20%
CO-3	24%	24%	30%	20%	30%	25%	20%
CO-4	22%	22%	15%	20%	20%	10%	20%
CO-5	20%	20%	15%	20%	30%	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 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 (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Unit and Measurements	8	CO1	10	4	4	2
Unit-2.0 Force, Work, Power & Energy	10	CO2	14	4	4	6
Unit-3.0 Circular, Rotational and SHM	8	CO3	16	4	6	6
Unit-4.0 Physical Properties of Matter and calorimetry	12	CO4	16	4	6	6
Unit-5.0 Modern Physics	10	CO5	14	4	4	6
Total	**48**	**-**	**70**	**20**	**24**	**26**

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.	Vernier caliper	CO1	60	30	10
2.	Screw gauge:	CO1	60	30	10
3.	Spherometer.	CO1	60	30	10
4.	Spring Oscillator	CO3	50	40	10
5.	Specific heat of Solid	CO2	50	40	10
6.	Searle's apparatus	CO3	60	30	10
7.	Stokes law	CO3	50	40	10
8.	Photo-electric cell experiment	CO3	60	30	10
9.	Numerical Aperture of an optical fiber	CO5	40	50	10
10.	He-Ne/diode laser	CO5	50	40	10
11.	Photo electric effect (virtual lab experiment)	CO5	70	20	10
12.	Emission Spectra of Hydrogen (virtual lab experiment)	CO4	70	20	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.	Vernier-Caliper	Range: 0-15 cm, Resolution 0.01 cm.	1,8
2.	Micrometer screw gauge	Range 0-25 mm, Resolution 0.01 mm	2,7,8
3.	Spherometer	Vertical scale range -10mm to 10 mm, Graduation resolution 0.01 mm	3

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
4.	Spring oscillator	A spring, a measuring ruler, mass hanger and variable masses (50 gram, 100 gram) .	4
5.	Specific heat of solid	Calorimeter with stirrer, balance, thermometer and mass box	5
6.	Searle's apparatus	Two long steel wires of the same length and diameter, Brass rods, stopwatch, meter scale,0.5 kg slotted masses, hanger	6
7.	Stokes law	A long cylindrical glass jar, Transparent viscous fluid, stop watch, bob, glycerin, tube clamp stand, Meter scale, Spherical ball, Thread	7
8.	Photo-electric cell experiment	Photo cell mounted in the metal box, Lamp holder with 60W bulb, analog meters (500µA & 1000mV), wooden bench fitted with scale and connecting wires	8
9.	Numerical Aperture of an optical fiber	Laser Diode (2- 3 mW,632mm) Objective(10X), Optical fiber (1-meter-long), detector with BNC connector Auto arranging Multimeter, Screen with circular graduations, one circular base with linear and circular motion and optical bench	9
10.	He-Ne/diode laser	He-Ne Laser (output 0.5 –5.0mW, wavelength 632.8 nm power supply 240V, 50Hz) Or diode laser (2- 3 mW,632mm), Transmission grating 15000 lines/inch, photo detector with BNC connector and holder, screen with clamp type holder, knife edge with micrometer movement, digital multimeter, scale with mount	10
11.	Photo electric effect (virtual lab experiment)	https://vlab.amrita.edu/?sub=1&brch=195&sim=840&cnt=1	11
12.	Emission Spectra of Hydrogen (virtual lab experiment)	https://vlab.amrita.edu/?sub=1&brch=195&sim=359&cnt=1	12

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Concept of physics-1	H.C. Verma	Bharti Bhawan Publications, 2021 ISBN: 8177091875, 978-8177091878
2.	Concept of physics-2	H.C. Verma	Bharti Bhawan Publications, 2021 ISBN: 8177092324, 978-8177092325
3.	Text Book of Physics for Class XI (Part-I, Part-II)	N.C.E.R.T., Delhi	N.C.E.R.T., Delhi, 2019 ISBN: 81-7450-508-3(Part-I) & ISBN: 81-7450-566-0 (Part-II)
4.	Text Book of Physics for Class XII (Part-I, Part-II)	N.C.E.R.T., Delhi	N.C.E.R.T., Delhi, 2019 ISBN: 81-7450-631-4 (Part-I) & ISBN: 81-7450-671-3 (Part II)
5.	Engineering Physics	P. V. Naik	Pearson Education Ltd., 1993 ISBN: 817758362X,978-8177583625
6.	Applied Physics-I	Dr. Mina Talati & Vinod Kumar Yadav	Khanna Book Publishing (2021) ISBN : 978-93-91505-43-1
7.	Applied Physics-II	Dr. Hussain Jeevakhan	Khanna Book Publishing (2021) ISBN: 978-93-91505-57-8
8.	Engineering Physics	D. K. Bhattacharya & Poonam Tandon	Oxford University Press, ISBN: 0199452814, 978-0199452811

(b) Online Educational Resources:

1. https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype
2. www.nanowerk.com
3. https://www.open2study.com/courses/basic-physics-150315/
4. https://nptel.ac.in/courses/122107035
5. https://nptel.ac.in/courses/122104016
6. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
7. https://www.physicsclassroom.com/
8. https://phys.org/
9. https://vlab.amrita.edu/?sub=1
10. https://www.olabs.edu.in/?pg=topMenu&id=40
11. https://www.khanacademy.org/science/physics

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. Fundamentals of Physics, David Halliday, Robert Resnick and Jearl Walker
2. Engineering Physics, R.K. Gaur and S. L. Gupta
3. University Physics with Modern Physics, Sears and Zemansky
4. Physics for Scientists and Engineers with Modern Physics by Raymond A. Serway andJohn W. Jewett
5. Physics Laboratory Manual, David H Loyd

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