Curriculum of Diploma Programme

in

Agricultural Engineering

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

State Board of Technical Education
(SBTE), Bihar

Semester – III
Teaching & Learning Scheme

Course Codes	Category of course	CourseTitles	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				
2411301	**PCC**	**Soil Science & Soil Mechanics**	2	1	-	2	5	4
2411302	**PCC**	**Agricultural Machinery and Equipment's**	2	1	-	2	5	4
2411303	**PCC**	**Heating, Ventilation & Air Conditioning** (HVAC)	3	-	4	2	9	6
2418105	**BCC**	**Fundamentals of IT and C Programming** (ELX, ELX (R), AE,)	3	-	4	2	9	6
2400006	**NRC**	**Environmental Education and Sustainable Development** (Common for All Programmes)	1	-	1	1	3	2
2411306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	2	2	4	2
2411307	**PCC**	**Operation and Maintenance of Farm Machineries, Tools and Equipment's**	-	-	4	2	6	3
2411308	**PCC**	**Soil Testing Practices**	-	-	4	2	6	3
Total			**11**	**2**	**19**	**15**	**47**	**30**

Note: Prefix will be added to Course Code if applicable (T for Theory Paper, 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 - III
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)	
2411301	**PCC**	**Soil Science & Soil Mechanics**	30	70	20	30	-	-	150
2411302	**PCC**	**Agricultural Machinery and Equipment's**	30	70	20	30	-	-	150
2411303	**PCC**	**Heating, Ventilation & Air Conditioning** (HVAC)	30	70	20	30	20	30	200
2418105	**BCC**	**Fundamentals of IT and C Programming** (ELX, ELX (R), AE)	30	70	20	30	20	30	200
2400006	**NRC**	**Environmental Education and Sustainable Development** (Common for All Programmes)	15	-	10	-	10	15	50
2411306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	**-**	-	10	15	10	15	50
2411307	**PCC**	**Operation and Maintenance of Farm Machineries, Tools and Equipment's**	-	-	20	30	20	30	100
2411308	**PCC**	**Soil Testing Practices**	-	-	20	30	20	30	100
Total			**135**	**280**	**140**	**195**	**100**	**150**	**1000**

Note: Prefix will be added to Course Code if applicable (T for Theory Paper, 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 : **2411301(T2411301/S2411301)**

B) Course Title **:** Soil Science & Soil Mechanics

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

D) Rationale **:**

A Diploma holder technician of agricultural Engineering must be fully aware that soil serves as the natural media for plant growth. The Physical, chemical, biological, and fertility properties of soils are very important to understand for different applications of agri. Engineering. The maintenance of nutrient value of the soil is essential to have good yield of crop.

The information pertaining to soils can be used by farmers and ranchers to help determine whether a particular soil type is suited for crops, vegetation, livestock or maintenance of soils and what type of soil management might be required. This course is designed to provide basics of soil science as well as soil related physical properties which are needed to a agriculture engineer.

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

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

CO-1 Explain how the soils are formed and how does soil act as a medium of plant growth.
CO-2 Analyze the soils for chemical properties and its nutrition values
CO-3 Elaborate the concept plant nutrients in the soil
CO-4 Test the soil for its physical and index properties.
CO-5 Explain permeability compaction and bearing capacity of soil and its factors affecting.

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
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H) Assessment Scheme:

Course code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
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Legend:

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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: T2411301

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Classify rocks into three major groups. TSO 1b. Explain the Soil forming processes TSO 1c . Apply the rule of soil farming factors and processes in the soil formation. TSO 1d. Determine physical chemical and biological properties of various soils and their impact on plant growth. TSO 1e. Explain basic composition and components of soil. TSO 1f. Describe the role of microorganisms in plant growth TSO 1g. Describe the impact of l air temperature on plant growth	**Unit-1.0 Soil and Its Formation and Soil Constituents** 1.1 Introduction - composition of earth crust. 1.2 Rocks- Igneous rocks, Sedimentary rocks, Metamorphic rocks. 1.3 Soil farming process- weathering of rocks physical weathering, Chemical weathering, biological weathering 1.4 Soil constituent and its components. 1.5 Soil air and temperature. 1.6 Factors affecting aeration & soil temperature. 1.7 Soil organic matter- importance source and decomposition of soil organic matter and C:N ratio	**CO 1**
TSO 2a. Determine soil suitability for crop production. *TSO 2b.* Carry out tests for various soil properties e.g water retention cations exchange capacity. *TSO 2c.* Classify the method of textual analysis. TSO 2d. Classify of soil structure based on shape, arrangement, aggregates. TSO 2e. Elaborate the factors influencing genesis of soil structure like climate, soil, tillage, organic matter, microbes. TSO 2f. Explain various forms of soil water. TSO 2g. Compare of three types of water movement in soil. TSO 2h. Classify soil microorganisms. TSO 2i. Identify various microorganisms responsible for plant growth. TSO 2j. List the advantage and disadvantage of soil microorganisms.	**Unit-2.0 Physical Properties of Soil and Microorganism** 2.1 Soil texture- Soil texture in relation to soil classification effects of soil texture on crop production. 2.2 Soil structure- Factors affecting soil structure, type of soil structure, effect of soil structure on other physical properties of soil. 2.3 Soil porosity- factors affecting soil porosity importance of pore space in agriculture. 2.4 Soil colour- Colour producing compounds in soil, importance of soil colour in agriculture. 2.5 Soil density 2.6 Soil micro-organisms classification of soil micro-organisms beneficial function of soil microorganisms and harmful effects	**CO 2**
TSO 3a. Explain pH values & pH scale. TSO 3b. List the importance of soil pH value TSO 3c. Explain the role of essential and beneficial minerals nutrient that are crucial for growth. TSO 3d. Eliminate the elements and plants responsible to abnormalities of growth. TSO 3e. Distinguish between soil fertility & soil productivity. TSO 3f. Explain the type of problematic soil. TSO 3g. Discuss possible measures for management of problematic soil. TSO 3h. Distinguish between Soil quality & soil health. *TSO 3i.* List the difference between manures & fertilizers. *TSO 3j.* Classify manures & fertilizers.	**Unit-3.0 Soil Ph and Its Nutrient** 3.1 Importance of soil PH. 3.2 Factors affecting soil PH. 3.3 Essential plant nutrients classification role of nutrients. 3.4 Deficiency symptoms of nutrients. 3.5 Forms in which nutrients are taken by plants. 3.6 Sources of plant nutrients in soil. 3.7 Problem soil Saline, Acid, alkaline soil. 3.8 Reclamation / management of acid Saline, alkali soil. 3.9 Manure and fertilizer- Introduction importance and classification.	**CO 3**
TSO 4a. Define basic properties of soil. *TSO 4b.* Explain various physical properties of given soil sample. *TSO 4c.* Analyze behavior of soil at different water content. *TSO 4d.* Identify the different size of soil with the grain size distribution. *TSO 4e*. Explaining Indian standard system of soil classification.	**Unit-4.0 Basic Properties of Soil and Its Classification** 4.1 Soil mass water content density unit weight of soil solid. 4.2 Specific gravity void ratio porosity degree of saturation. 4.3 Atterberg's limits- type of a Atterberg's limit. 4.4 Method of determination of liquid limit.	**CO 4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 4f. Explain the relationship between liquid limit, plastic limit and shrinkage limit using Atterberg limit test values *TSO 4g.* Perform sieve analysis different size of soils	4.5 Method of determination of plastic limit. 4.6 Grain size distribution- Sieve analysis stock's law and hydrometer analysis (Basic concepts only). 4.7 Classification of soils based on descriptive idea grain size Indian standard soil and MIT classification.	
TSO 5a. Explain laminar flow condition of water in the soil *TSO 5b.* Demonstrate the flow of water through soil by comparing between constant head & variable head permeameter. *TSO 5c.* List the factor affecting permeability of soil. *TSO 5d.* Describe the removal of air from the soil with the help of compaction. *TSO 5e.* Analyze the factor affecting the soil compaction. *TSO 5f.* Describe the type of roller used compaction. *TSO 5g.* Describe different type of bearing capacity of soil. *TSO 5h.* List the factor affecting the bearing capacity of soil. *TSO 5i.* Explain different methods of determination of bearing capacity of soil.	**Unit-5.0 Soil Permeability Compaction and Bearing Capacity of Soil** 5.1 Definition of permeability **constant** head permeability 5.2 Darcy's law 5.3 Constant head permeameter variable head permeameter. 5.4 Factors affecting permeability of soil. 5.5 Soil compaction definition of compaction effect of compaction on property of soil. 5.6 Factors affecting the soil compaction OMC method of soil compaction used in field by static and variable roller. 5.7 Bearing capacity of soil different type of bearing capacity of soil factors affecting the bearing capacity of soil method of determining bearing capacity of soil by pure load test.	**CO 5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: (Not Applicable)

L) Suggested Term Work and Self Learning: S2411301 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments:

i. Collect the soil sample from farm and perform test for its physical properties
ii. Determine bearing capacity of soil by plate load test.
iii. Identify soils, rocks & minerals from the given sample
iv. Determination of grain size analysis by Sieving (Dry Sieve analysis)
v. Determination of Soil pH of given soil sample
vi. Determination of bulk density, particle density & Porosity of Soil.

b. Micro Projects:

i. Help framers with the soils nutrient values to increase the yields.
ii. Collect the soil for determine its nutria values.
iii. Analysis of soil and plant sample for N,P,K,Ca,Mg,S.
iv. Test of permeability of different type of soil and to copare the permeability on the basis of grain size.
v. Determine total nitrogen, P2O5 & K2O content in Soil.
vi. Determine water content of given Soil sample.
vii. Determine field density of Soil by core cutter.
viii. Identify of nutrient deficiency symptoms of crops in the field.

c. Other Activities:

- Test a soil sample in kvk and ATMA office.
- Determination of organic carbon of Soil.
- Determination of shear parameter by direct shear test.
- Determination of permeability by constant head permeameter.

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%	20%	10%	10%	-	-	-
CO-2	20%	20%	15%	15%	25%	-	-
CO-3	20%	20%	25%	25%	25%	-	-
CO-4	25%	20%	25%	25%	20%	-	-
CO-5	20%	20%	25%	25%	30%	-	-
Total Marks	**30**	**70**	**20**	**20**	**10**	-	-
			50				

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The 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 Soil and its formation and Soil Constituents	10	CO1	14	4	4	6
Unit-2.0 Physical properties of soil and Microorganism	12	CO2	14	4	4	6
Unit-3.0 Soil PH and its Nutrients	9	CO3	14	4	4	6
Unit-4.0 Basic Properties of Soil and its Classification	9	CO4	14	4	2	8
Unit-5.0 Soil Permeability Compaction and Bearing Capacity of Soil	8	CO5	14	4	4	6
Total	**48**	**-**	**70**	**20**	**18**	**32**

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

O) Suggested Assessment Table for Laboratory (Practical): (Not Applicable)

P) Suggested Instructional/Implementation Strategies: Visit to commercial Nurseries /Agricultural Universities /KVK.

Q) List of Major Laboratory Equipment, Tools and Software: (Not Applicable)

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Soil Mechanics and Foundation	B.C. Punania	Standard book house, ISBN-978-8170087915
2.	Soil Mechanics and Foundation Engineering	Santosh Kumar garg and Sk Mukherjee.	Khana publisher ISBN-978-8174092755
3.	Nature and Properties of Soil	Ray R.weil Nyle C.Brady	Pearson education ltd. ISBN-9789356062719
4.	Text Book of Soil Science	T.D. Biswas & S.K. Mukherjee	Tata McGraw Hill publishing company Ltd. ISBN- 97800746204344
5.	Introductory of soil science	Dilip kumar das	Kalyani Publishers ISBN- 9327257545

(b) Online Educational Resources:

1. https://IISS.icar.gov.in
2. https://ecoursesonline.iasri.res.in/
3. https://vikaspedia.in/agriculture.
4. https://nbsslup.icar.gov.in

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

(c) Others:

1. https://www.youtube.com/watch?v=Lce1DJLj-6A
2. https://www.youtube.com/watch?v=aROshd2x5NU
3. https://www.youtube.com/watch?v=UoD-cUMkRZY.
4. Practical manual on analysis of soil physical parameters.

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A) Course Code : 2411302(T2411302/S2411302)

B) Course Title : Agricultural Machinery and Equipment's

C) Pre- requisite Course(s) :

D) Rationale :

The new era agricultural engineering is depending on machines and equipment that is felt necessary to get high productivity and yield. The basic knowledge, understanding and skills are needed for agricultural diploma pass out. Therefore, equipping the students with technical knowledge and skills required for the operation of tillage, sowing and intercultural and plant protection machinery needed for agricultural farms and also train the students with skills required for the operation maintenance and evaluation of harvesting, threshing, machinery needed for agricultural farms.

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

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

CO-1. Use primary tillage equipment to prepare desirable soil.
CO-2. Use secondary tillage equipment to Improve seed bed by better pulverization of soil.
CO-3. Prepare specific surface configurations of sowing, planting, inter cultivation and plant protection.
CO-4. Select the harvesting and threshing equipment as per the requirement.
CO-5. Manage farm equipment's effectively and efficiently.

F) Suggested Course Articulation Matrix (CAM):

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

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

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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: T2411302

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1a Prepare desirable soil structure for deep seedbeds suitable for different types and crops. *TSO.1b* Prepare specific surface configuration for planting, irrigation, drainage & harvesting operation. *TSO.1c* Classify the tillage system consists of a sequence of operations that manipulate the soil in order to produce a crop. *TSO.1d* Apply methods of ploughing a land. *TSO.1e* List the functions of primary tillage equipment. *TSO.1f* Describe the components of MB plough and Disc plough *TSO.1g* Compare between MB Plough & disc plough. *TSO.1h* *E*xplain various types of primary tillage implements like subsoiler, Chisel plough, MB Plough, Disc plough.	**Unit-1.0 Tillage** 1.1 Definition of tillage. 1.2 Objective of Tillage. 1.3 Classification of Tillage (i) Primary (ii) Secondary 1.4 Tillage system- Intensive, Reduced, Consolidation. 1.5 Classification of the Tillage system. 1.6 Ploughing of land terminologies 1.7 Method of ploughing of land- Gathering, Casting, One-way ploughing, Two-way ploughing. 1.8 Mould board plough and its component. 1.9 Type of share and mould board 1.10 Adjustment of mould board plough 1.11 Disc plough purpose type and its adjustment 1.12 Chisel plough, subsoiler and Rotary plough.	CO 1
TSO.2a Create proper soil tilth for seeding & planting. *TSO.2b* Improve the seed bed by greater pulverization of the soil. *TSO.2c* Explain various types of harrow used in the field for harrowing operation. *TSO.2d* Conserve moisture through destruction of weeds and to cut up crop residue. *TSO.2e* Enhance the plant growth by applying liquid on plants to control the pest and diseases or spraying micronutrients *TSO.2f* Describe basic components of the sprayer. *TSO.2g* Classify the sprayer based upon the volume of liquid handled. *TSO.2h* Explain the components and type of duster. *TSO.2i* List the Differences between sprayer and duster.	**Unit-2.0 Secondary Tillage Equipment and Weed Control** 2.1 Objective of secondary tillage. 2.2 Harrow and its type. 2.3 Type of disc Harrow and its parts. 2.4 Adjustment of disc harrow. 2.5 Cultivator type and its adjustment. 2.6 Sprayer- function, purpose, and its components. 2.7 Type of a sprayer- High volume sprayer, Low volume sprayer, ultra-low volume sprayer 2.8 Duster- function, purpose, and its components. 2.9 Type of duster- Plunger type, Knapsack type, Rotary type, Power operator duster.	CO 2
TSO.3a Describe the method of sowing of seed. *TSO.3b* List the Function of seed cum fertilizer drill. *TSO.3c* Classify the seed metering mechanism Used in seed drill. *TSO.3d* Explain the procedure of calibration of seed cum fertilizer drill. *TSO.3e* Explain the functions and components of the planter. *TSO.3f* Explain the procedure of calibration of planter. *TSO.3g* List the differences between seed drill and planter. *TSO.3h* Motivate farmers to reduce their labour expenses and increase their efficiency. *TSO.3i* Encourage seed germination by mulching the field and helping it to retain its moisture.	**Unit-3.0 Sowing at Planting Equipment** 3.1 Sowing definition function and its method. 3.2 Seed drill function type and its component. 3.3 Seed cum fertilizer drill function. 3.4 Type of seed metering mechanism- Fluted feed type, 3.5 Internal double run type, Cell feed mechanism, Brush feed mechanism, Picher wheel mechanism, Star wheel mechanism, Auger feed mechanism. 3.6 Type of furrow openers- Shovel type, Shoe type, Disc type. 3.7 Calibration of seed drill and related numerical/problem. 3.8 Planter function and its component. Seed metering device in a planter- cutoff mechanism, Knock out mechanism. 3.9 Potato planter- Automatic and semi-automatic. 3.10 Transplanter- Manual rice planter and Self-propelled paddy transplanter. 3.11 Happy seeder function and its components	CO 3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.4a Classify the harvesting tools according to power applications *TSO.4b* List the functions of mower *TSO.4c* Explain alignment and registration of mower. *TSO.4d* Explain the terms related to harvesting operations. *TSO.4e* Describe each component of combine harvester. *TSO.4f* List the various components of power thresher. *TSO.4g* List the advantages of harvester. *TSO.4h* Explain the construction and working of chaff cutter. *TSO.4i* Explain cause of damage and remedy of power thresher	**Unit-4.0 Harvesting and Threshing Tools and Equipment** 4.1 Harvesting introduction and its method. 4.2 Type of harvesting equipment- Manually operated tools, Animal drawn implements, Power driven machines. 4.3 Mower and its type 4.4 Alignment and registration of mower. 4.5 Reaper type construction and working. 4.6 Terms connected with harvesting operation. 4.7 Threshing- Principle of threshing. 4.8 Power thresher function and its component. 4.9 Terminology connected with Power thresher. 4.10 Troubleshooting in power thresher. 4.11 Combine-harvester-thresher type, function, principle.	CO 4
TSO.5a Perform cost analysis per hour of operation of a tool /implement / machine. *TSO.5b* Calculate total cost of operation of an implement & tool involves two costs namely 1) Fixed cost 2) Variable cost. *TSO.5c* Calculate the tax and other expenditure based on the actual investment. *TSO.5d* Explain machinery or implement / equipment matched with tractor H P. *TSO.5e* Calculate the field efficiency & field capacity.	**Unit-5.0 Economic & Management of Farm Equipment** 5.1 Cost of operation of farm machinery - problems and 5.2 Calculation of fixed cost and variable cost. 5.3 Selection of tractors and implements for different agricultural operations. 5.4 Factors that affect the size of machinery needed for estimation of power required implement /machine. 5.5 Field capacity and Field efficiency. 5.6 Estimation of draft and drawbar power. 5.7 Farm equipment advantages and disadvantages.	CO 5

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: (Not Applicable)

L) **Suggested Term Work and Self Learning: S2411302** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

i. Prepare a report of different primary tillage and secondary tillage equipment.
ii. Prepare a plan for management of agriculture machinery management.
iii. Determine the field capacity and field efficiency of the given implements
iv. Prepare Troubleshoot the power thresher
v. Label the major component of self-propelled paddy transplanter
vi. Identify and describe different parts of given farm machines & equipment.
vii. Describe Identify the different components of happy seeder.

b. Micro Projects:

i. Conduct a market survey of different kind of farm implement and prepare a comparative statement on various aspects.
ii. Develop a unique model of different implements and equipment's.
iii. Prepare a model of self-propelled paddy transplanter

iv. Replace cylinder of thresher according to crop threshed
v. Perform the alignment and registration of mower

c. Other Activities:

1. Seminar Topics:
   - Entrepreneurship development to establish custom hiring agro service centre.
   - Advancements in farm implements.
   - Appropriate mechanization Technology For energy management in agriculture.

2. Visits:
   - Visit nearby local manufacturer and workshop vendor of fam machinery like rotavator cultivator etc

3. Self- learning topics:
   - Study of advanced technology of agriculture machinery and equipment's.
   - Research and development done by CIAE.
   - Application of automation in the area of agriculture.
   - Appropriate mechanization Technology For energy management in agriculture.

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%	30%	15%	-	-	-	-
CO-2	10%	15%	10%	25%	25%	-	-
CO-3	15%	10%	15%	25%	25%	-	-
CO-4	30%	30%	30%	25%	25%	-	-
CO-5	30%	15%	30%	25%	25%	-	-
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

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

Note:
- The 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 Tillage	12	CO 1	20	6	7	7
Unit-2.0 Secondary Tillage Equipment and Weed Control	10	CO 2	15	4	5	6
Unit-3.0 Sowing at Planting Equipment	9	C0 3	10	3	3	4
Unit-4.0 Harvesting and Threshing Tools and Equipment	9	CO 4	15	4	6	5
Unit-5.0 Economic & Management of Farm Equipment	8	CO5	10	3	3	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): (Not Applicable)

P) Suggested Instructional/Implementation Strategies: Visit to commercial Nurseries /Agricultural Universities /KVK.

Q) List of Major Laboratory Equipment, Tools and Software: (Not Applicable)

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Element of Agricultural Engineering	Dr. Jagdishwar shay	Standard publisher Distributor ISBN-978-8180142048
2.	Farm power and machinery Engineering	R. suresh Sanjay kumar	Standard publisher Distributor ISBN-978-8180142116
3	Farm power and machinery.	Er Sanjay kumar	Kalayani publisher, ISBN-9327287258.
4.	Farm machinery Design	D.Sharma and S. Mukesh	Jain brothers ISBN-97881836018879

(b) Online Educational Resources:

1. https://ecourses.icar.gov.in/
2. http://ecoursesonline.iasri.res.in/
3. https://fmttibudni.gov.in

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 of different implements
2. WWW.tnau.com

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A) Course Code : 2411303(T2411303/P2411303/S2411303)

B) Course Title : Heating Ventilation & Air Conditioning (HVAC)

C) Pre- requisite Course(s) :

D) Rationale :

The main purposes of a Heating, Ventilation and Air-Conditioning (HVAC) system are to help maintain good indoor air quality (IAQ) through adequate ventilation with filtration and provide thermal comfort. This course provides foundational knowledge for working in the heating and air conditioning field by studying the occupational environment while learning about tools, instruments, and equipment and also explore the properties of various refrigeration systems along with the proper techniques and procedures for managing these systems.

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

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

CO-1. Apply principles of thermodynamics.
CO-2. Estimate heat load for the given application
CO-3. Use refrigeration cycle.
CO-4. Select HVAC components and ventilation system as per the requirement
CO-5. Select Refrigerant and insulating material
CO-6. Use standard techniques to troubleshoot refrigeration systems

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2411303	Heating Ventilation & Air Conditioning	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)	
2411303	Heating Ventilation & Air Conditioning	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: T2411303

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1a Explain the effect of addition or subtraction of heat to materials- expansion and contraction *TSO.1b* Explain the effect of temperature, pressure and volume in refrigeration and air conditioning. *TSO.1c* Distinguish between phases of matter solid, liquid and gas *TSO.1d* Describe the given HVAC system *TSO.1e* Apply Dalton's law of partial pressure for the given situation *TSO.1f* Describe the basic components and their functions in a simple vapour compression refrigeration cycle *TSO.1g* Apply gas laws for the given situation *TSO.1h* Solve problems on Fourier law of heat conduction *TSO.1i* Solve problems Stefen-Boltzman laws of radiation.	**Unit:1.0 Fundamentals of HVAC** 1.1 Classification of HVAC system -All Air system, all water system, Air-Water system, Unitary Refrigerant based, function of HVAC system, 1.2 Thermodynamics: Concepts, Laws, Phase diagram, Open and closed systems 1.3 Mechanism of Heat transfer in Conduction, Convection and Radiation, effect of addition and subtraction of heat • Conduction-Introduction, Fourier law of heat conduction for isotropic material; Thermal conductivity • Convection: Introduction, Newton's law of cooling; Simple problems • Radiation: Stefen-Boltzman laws of radiation, 1.4 Types and properties of fluids, Laminar and Turbulent Flows, Pressure head, Bernoulli's theorem, Flow measurements, Pressure drop calculations, Power transmission through pipes and ducts 1.5 Gas laws such as a. Boyle's law, Charles' law, Dalton's law of partial pressure 1.6 Types of HVAC Systems- • Split HVAC systems • Hybrid Heat Split HVAC systems, • Duct-free or Ductless HVAC systems, and • Packaged heating and air HVAC systems. 1.7 Codes and standards, meaning of IS, need of international classification of standards for refrigeration and air conditioning, various national and international standards for heating, ventilation and air conditioning	**CO1**
TSO.2a Calculate Unit of refrigeration & Coefficient of performance. *TSO.2b* Draw P-V & T-S diagram of Air-refrigeration cycle. *TSO.2c* Explain the working of given refrigeration cycle. *TSO.2d* Explain standard components of refrigeration systems and the basic elements of refrigeration cycles. *TSO.2e* Describe the basic components present in heating and cooling systems *TSO.2f* Describe conditions of Refrigerant at various points in the given circuit. *TSO.2g* Solve the given Problems based on refrigeration cycle	**Unit-2.0 Refrigeration Systems** 2.1 Definition of Refrigeration; refrigerating effect, Principles of refrigeration, unit of refrigeration, standard components of refrigeration systems, methods of refrigeration, Coefficient of performance. 2.2 Refrigeration Cycles - Carnot cycle of refrigeration (ideal cycle), Bell-Coleman cycle of refrigeration, their COP and Conditions for its highest value, Temperature limitations. Representation of these cycles, in P-V, T-S and P H diagrams with their flow diagrams, 2.3 Vapour compression system: Standard vapour compression cycle, wet and dry Compression, Effect of sub cooling and super heating, Effect of temperature and pressure on COP of the cycle, application of vapor compression cycle.	**CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	2.4 Vapor Absorption System: Cycle of operation, Construction and working of refrigerator based on this system 2.5 Applications of Refrigeration and Air conditioning: Air conditioning, Cold Storage, Process cooling, Transport refrigeration	
TSO.3.a Measure psychrometric properties using psychrometric, anemometer i.e. DBT, WBT, RH, air flow etc *TSO.3.b* Explain Psychrometric processes on Psychrometric chart. *TSO.3.c* Calculate HVAC Heat Load as per ISHRAE standards *TSO.3.d* Describe different comfort parameters. *TSO.3.e* Calculate heat load for the given application *TSO.3.f* Use psychrometric chart to determine the following: a. Relative humidity b. Dew point temperature c. Humidity ratio d. Enthalpy per unit mass of air, etc.	**Unit- 3.0 Psychrometry and Heat Load Estimation for Refrigeration System** 3.1 Psychrometry-definition of psychrometric terms, air-water mixtures properties, use of psychrometric chart, various psychrometric processes – six processes, mixing, air washers, bypass factors of coil load calculations, Sensible Heat Ratio (SHR), LHR, Total Heat of Rejection (THR) and determination of Apparatus dew point temperature (ADP), enthalpy calculations, plotting of air conditioning processes in chart. 3.2 Thermal comfort-Factors affecting human comfort, Comfort parameters, Comfort chart, ASHRAE standards 3.3 Heat load design data-location, Weather data, Orientation, Solar Radiation - U factors and shading coefficients of building envelopes, Heat Gain through envelopes – Infiltration and ventilation loads – outside and inside design conditions, Internal loads 3.4 Heat load estimation • Air conditioning -data collection for heat load: equivalent temperature difference, daily range etc., study of drawings, procedure for heating and cooling load estimation: dehumidified air quantity, ETH, ESHF, GTH, Interpretation of heat load estimations. • Refrigeration cooling load calculation for cold storages- product storage, temperatures, design input data-respiration load, pull down time, infiltration, daily loading, internal loads, u – factors for thermal envelope. procedures for estimation of cooling load, hands on exercise	**CO3**
TSO.4a Classify the different air compressors *TSO.4b* Differentiate between the given types of compressors *TSO.4c* Distinguish between hermetic, semi-hermetic and open type compressors (sealed and open compressors) *TSO.4d* Explain the principle of operation of given type of compressors	**Unit-4.0 HVAC Components and Ventilation System** 4.1 Compressor -Types and classification of compressors, Constructional details and working of reciprocating, rotary, centrifugal, screw, scroll compressors, Selection of compressors for different applications. 4.2 Condenser-Types and working of different condensers, Air cooled condensers,	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.4e Explain the steps for cooling motor windings in a given compressor *TSO.4f* Explain compression in a rotary compressor by stationary blade and rotary valve *TSO.4g* Select condenser, evaporators, expansion devices, auxiliary components and lubrication system as per the requirement. *TSO.4h* Explain the principle and working of given type of condenser *TSO.4i* Analyse the differences among ventilation of Restaurant, Parking & residence kitchen.	4.3 Water cooled condensers - shell and tube, shell and coil, double pipe, Selection and application, fouling factors and factors affecting condenser performance. 4.4 Evaporators -Types of evaporators, DX, flooded, finned, plate, falling film – heat transfer estimation – selection and application, factors affecting evaporator performance 4.5 Expansion Devices-Types of expansion devices – capillary, TEV, EEV, Automatic EV, Float valve, orifice and distributors – Selection and application 4.6 Auxiliary components-Solenoid valves, filters, dryers, relief valve, back pressure valves, accumulators, HP, LP and OP controls, receivers, oil separators, oil coolers, purge valves, Temperature and humidity controls. 4.7 Overall Systems -Air side loop, Chilled water loop, Refrigeration loop, heat rejection loop and control loop 4.8 lubrication systems-Selection of refrigerant lubricant, compatibility of lubricant with refrigerant fluid, refrigeration oil with additives, the effect of refrigerant on lubricant density, solvent and cleaning. 4.9 Cables and Wiring: Cry cables, economics of cryo cables, A.C. super conducting cables,liquid N2 cooled cables, Liquid H2 cooled cables, super magnet, electric generator, minimal, insulated cables, installing cables 4.10 Ventilation system- Natural Ventilation and Mechanical Ventilation, limitation for natural ventilation, Types of ventilation – single sided ventilation, cross ventilation, stack ventilation 4.11 Supply system: Air intake system, Filters heating & cooling equipment's, Fans, Ducts, Grills, Diffusers for distribution of air at workplace.	
TSO.5a Follow correct handling practices for various refrigerants *TSO.5b* Use thermal insulation to prevent cooling leakage *TSO.5c* Select materials for duct design. *TSO.5d* Select refrigerant as per the requirement *TSO.5e* Use thermal and acoustic insulation for different air ducts. *TSO.5f* Identify standard refrigerants used in common commercial applications *TSO.5g* Explain the accepted procedures for safe handling and disposal of common refrigerants.	**Unit- 5.0 Refrigerants and Insulation** 5.1 Refrigerants, cooling media and liquid absorbents, azeotropic and zeotropic, numbering of refrigerants. 5.2 Requirement for refrigerant, classification based on working principle, safety and chemical composition, desirable properties of refrigerants-thermodynamic properties, safe working properties, physical properties. 5.3 Important refrigerants, secondary refrigerant, anti-freeze solution 5.4 Selection of refrigerant, refrigerants properties and commonly used refrigerant	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.5h Explain the greenhouse effect of refrigerants *TSO.5i* Identify the potential health and safety hazards associated with the handling and use of refrigeration materials and equipment. *TSO.5j* Select the lubricating oils for refrigeration system *TSO.5k* Classify various types of refrigerants such as R12, R22, R502, R717 according to their properties e.g. freezing point, boiling point, colour code	5.5 Greenhouse effect, Global warming, Future Refrigerants 5.6 Insulator: Introduction, desired properties of ideal insulating material, factors effecting the thermal conductivity, 5.7 Types of insulating material, reflective insulating blinds, laprock – a thermal acoustic and fire insulation, natural insulator, transparent heat insulator, heat transfer through insulation used for A.C 5.8 Economical thickness of insulation, low temperature insulations, importance of relative humidity for the selection of the insulations, air distribution for reducing heat loss	
TSO 6a. Interpret the installation instruction *TSO 6b.* Prepare preventive maintenance plan for the given system *TSO 6c.* Explain steps for servicing of motor and blowers used in different air conditioning system. *TSO 6d.* Perform servicing and maintenance of different types of air filters. *TSO 6e.* Diagnose fault and give remedial measures on a given system *TSO 6f.* Describe Installation and servicing procedure for the given system. *TSO 6g.* Identify the various components of a given system *TSO 6h.* Test electrical components and make wiring. *TSO 6i.* Describe the servicing procedure of A.H.U, damper, check air flow, De-scaling of condenser and CT servicing. *TSO 6j.* Troubleshoot the given system	**Unit 6.0 Maintenance and Troubleshooting of HVAC Equipment's** 6.1 Installation • Refrigeration and Air-conditioning plant layout, • Parameters affecting the location, organizational approach. • Erection methodology, foundation, padding, safety precautions, air handling equipment's, locations in the systems, • corrosion, noise, vibration monitoring and control 6.2 Codes and Standards related to HVAC&R Projects, Instruments requirements – Pressure, Temperature, Flow, Air Quality, Power, Harmonics etc. 6.3 General and specific testing and its procedures for constant air volume systems, variable air volume systems, return air systems, fans and fan performance 6.4 Pipe installation work, pumping down the system, purging the system, starting the plant 6.5 System analyzer, transferring and handling liquid refrigerant 6.6 Maintenance • Preventive maintenance schedule of HVAC equipment's and systems, • Maintenance check list	**CO6**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2411303

Practical/Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO1.1	Determine thermal conductivity of the give material	1.	Determine thermal conductivity of given metal rod	CO1
		2.	Determine thermal conductivity of insulation powder	CO1
LSO1.2	Determine heat transfer coefficient	3.	Determine heat transfer coefficient of natural convection	CO1
		4.	Determine heat transfer coefficient of forced convection.	CO1
LSO1.3	Operate the Stefan Boltzmann Apparatus with different kinds of body.	5.	Determine Stefan Boltzman constant	CO1
LSO 2.1	Use vapour compression refrigeration test rig	6.	Calculate COP of vapour compression refrigeration system on vapour compression refrigeration test rig	CO2
LSO 2.2	Use vapour absorption refrigeration test rig	7.	Calculate COP of vapour absorption refrigeration system on vapour absorption refrigeration test rig.	CO2
LSO 2.3	Calculate the COP of domestic refrigerator	8.	Determine COP of domestic refrigerator	CO2
LSO 2.4	Calculate the efficiency for given refrigeration equipment's.	9.	Calculate the efficiency of the refrigeration equipment's (compressors, condensers, evaporators, thermostat valves etc.)	CO2
LSO 2.5	Calculate the cooling capacity and COP and bypass factor, Refrigerating capacity and Power input of the given refrigeration system A.C.	10.	Determine COP and cooling capacity of window air conditioning system.	CO2
		11.	Determine COP, cooling capacity and bypass factor of air conditioning test rig	CO2
		12.	Determine bye pass factor of a cooling coil	CO2
LSO 2.6	Calculate humidifying efficiency	13.	Determine humidifying efficiency of evaporative cooler.	CO2
LSO 2.7	Calculate cooling load	14.	Determine cooling load for a given situation	CO2
LSO 2.8	Calculate (a) input (c) C.O.P. of a given refrigeration system	15.	Determine (a) refrigerating capacity (b) power input (c) C.O.P. of a given refrigeration system	CO2
LSO 3.1.	Use sling psychrometer and aspiration psychrometer	16.	Determination of psychrometric properties of air with the help of a sling psychrometer and aspiration psychrometer.	CO3
LSO 3.2.	Use digital psychrometer	17.	Determination of psychrometric properties of air with the help of a digital psychrometer	CO3
LSO 4.1	Carry out servicing, dismantling, checking different parts of different types of commercial compressor, re-placing worn out parts, Check lubrication system. Assemble & check performance	18.	Dismantle different types of commercial compressor and check the parts	CO4
		19.	Replace worn out parts and check lubrication system	CO4
		20.	Assemble and check performance.	CO4
LSO 4.2	Use Anemometers	21.	Measure air flow using anemometers	CO4
LSO 5.1	Select insulation material	22.	Insulate Ducts for the given system	CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
	23.	Install and pack thermal and acoustic insulation of different air ducts	CO5
LSO 5.2 Identify refrigerant cylinder from color coding	24.	Identify refrigerant cylinders and colour coding of gas cylinder	CO5
LSO 6.1. Descale and clean and flush evaporator and condenser	25.	Perform Cleaning and flushing evaporator and condenser with dry nitrogen	CO6
	26.	Perform de scaling of condenser (internals &externals) used in different appliances.	CO6
LSO 6.2. Use different methods to detect leak in refrigeration system	27.	Detect Leak in a given refrigeration system.	CO6
LSO 6.3. Use refrigerant charging unit	28.	Charge refrigerant in a given refrigeration unit.	CO6
LSO 6.4. Maintain different types of air filters	29.	Perform servicing of different types of air filters	CO6
LSO 6.5. Trouble shoot Package AC with air cooled Condenser	30.	Diagnose fault in a package AC with Air cooled Condenser	CO6
LSO 6.6. Trouble shoot package AC with water cooled condenser	31.	Diagnose fault in a package A.C. with water cooled condenser	CO6
LSO 6.7. Use preventive maintenance schedule to maintain refrigeration system	32.	Pump down the given refrigeration system, top up oil and gas and check temperature and pressure.	CO6
LSO 6.8. Maintain motor, blowers and fan used in air conditioning system.	33.	Perform servicing of motor, blowers and fan used in different air conditioning system.	CO6
LSO 6.9. Maintain log book	34.	Prepare log book based on daily operation	CO6
LSO 6.10. Reclaim refrigerant from refrigeration system	35.	Reclaim refrigerant from a dead system and evacuate dry and recharge the system.	CO6
LSO 6.11. Repair leaks in refrigeration system	36.	Locate and repair leaks in the refrigeration system.	CO6

L) Suggested Term Work and Self Learning: S2411303 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:

i. Explain the reversed carnot cycle with P-V & T-S diagram.
ii. Explain the different types of compressor & evaporators.
iii. Explain the working of sling psychrometer.
iv. Explain the working of winter A.C. system.
v. Explain different kinds of heat exchanger

b. Micro Projects:

i. Prepare the sling psychrometer by thermometer.
ii. Find out the different properties of moist air of your classroom by sling psychrometer.
iii. Find the COP of refrigeration and A.C. system working between same temperature difference.
    a. Prepare a model for showing all modes of heat transfer.
iv. Conduct an experiment for different factors affecting air conditioning in different whether condition.

c. Other Activities:

1. Seminar Topics:

- Show the working of air refrigeration system.
- Show the working of vapour compression refrigeration system.
- Show the working of vapour absorption refrigeration system.
- Show the working of year-round A.C. system.

2. Visits:

- Visit to a power plant and prepare a report for visit and study the refrigeration system components and heat exchanger components.
- Visit to an automobile company. Prepare a report for visit and study the refrigeration system and Radiator.
- Visit nearby (a) Ice Plant (b) cold storage plant (c) control air conditioning system and collect information regarding methods of refrigeration used, their technical specifications and their application and prepare comparison chart.

3. Self-Learning Topics:

- Types of condenser & evaporators.
- Types of A.C. systems.
- Types of fins.
- Types of heat exchangers.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	10%	-	10%	10%	10%
CO-2	20%	20%	20%	20%	20%	20%	20%
CO-3	15%	15 %	15 %	20%	15 %	10%	10%
CO-4	20%	20%	20%	20%	20%	20%	20%
CO-5	15%	15%	15%	20%	15%	20%	20%
CO-6	20%	20%	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 Fundamentals of HVAC	8	CO1	8	3	1	4
Unit-2.0 Refrigeration systems	8	CO2	14	3	5	6
Unit-3.0 Psychrometry and heat load estimation for refrigeration system	8	CO3	10	3	4	3
Unit-4.0 HVAC components and ventilation system	8	CO4	14	3	4	7
Unit-5.0 Refrigerants and Insulation	8	CO5	10	4	3	3
Unit -6.0 Maintenance and Troubleshooting of HVAC equipment's	8	CO6	14	4	4	6
Total	**48**	**-**	**70**	**20**	**21**	**29**

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

O) Suggested Assessment Table for Laboratory (Practical):

S. No	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Determine thermal conductivity of given metal rod	CO1	40	50	10
2.	Determine thermal conductivity of insulation powder	CO1	40	50	10
3.	Determine heat transfer coefficient of natural convection	CO1	40	50	10
4.	Determine heat transfer coefficient of forced convection.	CO1	40	50	10
5.	Determine stefan boltzman constant	CO1	40	50	10
6.	Calculate COP of vapour compression refrigeration system on vapour compression refrigeration test rig	CO2	40	50	10
7.	Calculate COP of vapour absorption refrigeration system on vapour absorption refrigeration test rig.	CO2	40	50	10
8.	Determine COP of domestic refrigerator	CO2	40	50	10
9.	Calculate the efficiency of the refrigeration equipment's (compressors, condensers, evaporators, thermostat valves etc.)	CO2	40	50	10
10.	Determine COP and cooling capacity of window air conditioning system.	CO2	40	50	10
11.	Determine COP, cooling capacity and bypass factor of air conditioning Test Rig	CO2	40	50	10

S. No	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
12.	Determine bye pass factor of a cooling coil	CO2	40	50	10
13.	Determine humidifying efficiency of evaporative cooler.	CO2	40	50	10
14.	Determine cooling load for a given situation	CO2	40	50	10
15.	Determine (a) refrigerating capacity (b) power input (c) C.O.P. of a given refrigeration system	CO2	40	50	10
16.	Determination of psychrometric properties of air with the help of a sling psychrometer and aspiration psychrometer.	CO3	40	50	10
17.	Determination of psychrometric properties of air with the help of a digital psychrometer	CO3	40	50	10
18.	Dismantle different types of commercial compressor and check the parts	CO4	40	50	10
19.	Replace worn out parts and check lubrication system in compressor	CO4	40	50	10
20.	Assemble and check performance of compressor	CO4	40	50	10
21.	Measure air flow using anemometers	CO4	40	50	10
22.	Insulate Ducts for the given system	CO5	40	50	10
23.	Install and pack thermal and acoustic insulation of different air ducts	CO5	40	50	10
24.	Identify refrigerant cylinders and colour coding of gas cylinder	CO5	40	50	10
25.	Perform cleaning and flushing evaporator and condenser with dry nitrogen	CO6	40	50	10
26.	Perform de scaling of condenser (internals &externals) used in different appliances.	CO6	40	50	10
27.	Detect Leak in a given refrigeration system.	CO6	40	50	10
28.	Charge refrigerant in a given refrigeration unit.	CO6	40	50	10
29.	Perform servicing of different types of air filters	CO6	40	50	10
30.	Diagnose fault in a package AC with air cooled condenser	CO6	40	50	10
31.	Diagnose fault in a package A.C. with water cooled condenser	CO6	40	50	10
32.	Pump down the given refrigeration system, top up oil and gas and check temperature and pressure.	CO6	40	50	10
33.	Reclaim refrigerant from a dead system and evacuate dry and recharge the system	CO6	40	50	10
34.	Locate and repair leaks in the refrigeration system	CO6	40	50	10
35.	Perform servicing of motor, blowers and fan used in different air conditioning system.	CO6	40	50	10
36.	Prepare log book based on daily operation	CO6	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.	Vapour Compression Refrigeration Test Rig	Rated Current: 4.5 Amps - Input Power: 1.0 Kw - Supply: 220-240 Volts, 50 Hz, 1 Phase - Cooling Capacity: 450 Watts at Rated Test Conditions (1/8 Tr)	06
2.	Vapour Absorption Refrigeration Test Rig	System components & specifications: Gross volume 40-50 liters, Mains Operation 220 – 240 volts AC, Power Rating 65-70 W, Refrigerant NH3+ H2O + Hydrogen, Ammeter Digital, 0 – 20 A AC, Voltmeter Digital, 0 – 300 V AC, Temperature Indicator Digital Temperature Indicator, -50 to 150°C with TSS, Thermocouples Teflon coated Cr –Al (K-type)-8 nos. Experimental Capability Carnot, Theoretical & Actual COP, Manual Self-explanatory Instruction manual, sample calculation & 134A chart	07
3.	Air-Conditioning Refrigeration Test Rig	Electric supply Single Phase, 220 V AC, 50 Hz., 10 Amp, Floor area: 2 m x 1m TECHNICAL DETAILS: Compressor: Hermitically sealed compressor. Capacity 1 Ton Condenser: Air cooled compatible to 1 Ton compressor Condenser Cooling fan: Compatible capacity with permanent lubricated motor. Pressure Gauges: 2 Nos. Evaporator: Compatible to 1 Ton, made of copper tube and aluminum fins fitted with compatible capacity fan. Safety Control: over load and over current protection for Compressor with Time delay circuit. Expansion Device: Capillary Tube compatible capacity. Temperature Sensor: RTD PT-100 Type. Temperature Measurement: Digital Temperature Indicator with multi-channel switch. All other accessories like Hand shut off valves, filter drier and Thermostat, Pressure gauges will be provided. All the accessories will be mounted as rigid base frame made of M.S. and it will be powder coated.	08, 09, 10,11,12,13, 14,15

S. No.	Name of Equipment,Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
4.	Thermal conductivity apparatus	At least 12 inches long metal rod that can be made up of either steel, brass or copper. Make sure that every wire has the same thickness. Stove, Water, burner, Four digital thermometers	01, 02
5.	Natural Convection Apparatus	-	03
6.	Forced Convection Apparatus	-	04
7.	Stefan Boltzmann Apparatus.	1. Water heating tank provided with electric immersion heater. 2. Hemisphere made of copper sheet, 200mm. dia. Surrounded water jacket of 250mm. Dia. 3. Test disc made of copper 20mm. dia. provided with thermocouple at the center. 4. Multichannel digital temperature indicator 0-200 C with 0.1C least counts to measure the temperature of hemisphere and disc. 5. Audible buzzer with timer to ring at every 5 seconds. A technical manual accompanies the unit.	05
8.	Sling psychrometer	-	16
9.	Digital psychrometer	-	17
10.	Refrigerant Leak Detector	Detectable Gases: R-134a, R-404A, R-407C, R-410A, R-22 etc. Sensitivity: H L R-22,134a 6g/year 30g/year R-404A, 407C, 410A 8g/year 40g/year Alarm Method: Buzzer, Tricolor LED bar Indicator. Power Usage: 4 AA size (6V DC) Alkaline Batteries Snake Tube length: 40cm (15.5”) Dimension / Weight: 173 x 66 x 56 mm (approximately 400g) Accessories: Alkaline batteries (AA) X 4 pcs User manual, leak check bottle, carry case. Battery Life: Approximately 40hrs normal use. Auto power OFF:10 minutes Warm-Up Time: Approximately 90 seconds Operating Temperature & Humidity: 0 ~40 °C, < 80% RH Refrigerant Leak Detector 4 Storage Temperature & Humidity: -10 ~60 °C, < 70% RH Altitude: < 2000M (6500’)	27,28,32, 33,34
11.	Compressor	Reciprocating compressor, rotary compressor, centrifugal compressor, screw compressor, scroll compressors	18,19,20
12.	Anemometers	• Full Metal Construction, Direct Digital Reading, Option for Air Temperature Measurement • Air Velocity Transmitters (4-20 Ma 0/P), Air Velocity Monitors (Static Panel Type) And Air Velocity Switches • Weight: Sensor 280 grams, Instruments 500 grams. • Air velocity: 0.25-15 mtr / sec, Least count: 0.01 Extended to 50 mtrs. / Sec. on request, Least count: 0.1 • Air temperature measurement (optional): 0-100 C	21

S. No.	Name of Equipment,Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		• Operating Temperature- 0 - 55 C for continuous use, 0 - 100 C instantaneous reading	
13.	Different types of Refrigerant cylinders	-	24
14.	Evaporator	Dry Expansion Evaporator, Flooded Evaporator,	25
15.	Different types of condenser	Air-cooled Condenser, Water Cooled Condenser, Evaporative Condenser	26
16.	Different types of Motor, blowers and fan used in refrigeration system	-	35
17.	Different types of Air filters	-	29
18.	Packaged air conditioner with air cooled	-	30
19.	Packaged air conditioner with water cooled	-	31

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Refrigeration & Air Conditioning	R. K. Rajput	S. K. Kataria & Sons, 2016 ASIN: B08GY8G7QN
2.	Basic and Applied Thermodynamics,	P Nag	McGraw Hill Education, 2nd edition, 2017 ISBN-13 : 978-0070151314
3.	Engineering Thermodynamics	R.K. Singal, Mridul Singal, Rishi Singal	Dreamtech Press, 2020 ISBN-13 : 978-9389698664
4.	Refrigeration and Air Conditioning	Manohar Prasad	New Age International Pvt Ltd, Third Edition, 2021, ISBN-13 : 978-8122436945
5.	Refrigeration and Air Conditioning	C. P. Arora	McGraw Hill Education, Fourth Edition, 2021 ISBN-13: 978-9390385843
6.	A Practical Approach to Air Conditioning and Refrigeration	Shankar Kumar Chatterjee	Notion Press, 1st edition, 2021 ISBN-13 : 978-1685866679
7.	Heat Transfer (SIE)	J. Holman Souvik Bhattacharya	McGraw Hill Education, 10th Edition, 2017 ISBN-13 : 978-0071069670
8.	A Course in Refrigeration and Air-Conditioning	S. Domakundawar Arora	General, 2018 ASIN: B07NJ1VH8P
9.	Heat and Mass Transfer -Fundamentals and Applications	Yunus A. Cengel Afshin J. Ghajar	McGraw Hill Education, 6th Edition, 2020, ISBN-13 : 978-9390185283
10.	Heat Transfer	J. P. Holman Souvik Bhattacharya	Tata McGraw Hill Education, 10th Edition, 2017 ISBN-13 : 978-0071069670

(b) Online Educational Resources:

1) https://archive.nptel.ac.in/courses/112/107/112107208/
2) https://archive.nptel.ac.in/courses/112/105/112105129/
3) https://archive.nptel.ac.in/courses/112/108/112108149/
4) https://www.youtube.com/watch?v=qa-PQOjS3zA
5) https://www.teachmint.com/dashboard - CLASSROOM ID- 485904969

(c) Others:

1) Lab manuals
2) ISHRAE standard book for refrigeration and air conditioning
3) ASHRE hand book for refrigeration and air conditioning
4) International standards in refrigeration and air conditioning, UNEP (united Nations environment program)
5) Refrigeration and air conditioning data book, new age international publication

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

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A) Course Code : 2418105(T2418105/P2418105/S2418105)

B) Course Title : Fundamentals of IT and C Programming
(ELX, ELX (R), AE)

C) Pre- requisite Course(s) :

D) Rationale :

Information technology is a term that describes the entire range of information generation, storage, transmission, retrieval, and processing. Most organizations in the industry, business, non-profit organizations, and government departments now rely heavily on their information systems (IS) and information technology (IT). Thus, student must possess basic skills to use Information technology and Information systems.

Looking to the current IT practices in business it is also necessary for student to learn basic programming skills that includes building logic, develop algorithms and then write programs. The 'C' has been widely used as a general-purpose language to develop basic and advanced applications,

Hence this course is designed keeping in view the development of a basic understanding of programming skills in students with the help of the 'C' programing language. The course is designed to create a base to develop foundation skills in IT and programming languages.

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** Appraise computer systems and its applications for various educational, business, and industrial domain.
- **CO-2** Setup a small computer Network.
- **CO-3** Write 'C' Program to solve given arithmetic expression
- **CO-4** Develop 'C' program Using control structure
- **CO-5** Develop 'C' programs using arrays.
- **CO-6** Create functions in C programs for modular programming approach.

F) Suggested Course Articulation Matrix:

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2418105	Fundamentals of IT and C Programming	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)	
2418105	Fundamentals of IT and C Programming	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: T2418105

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe the anatomy of the Computer System. *TSO 1b.* List the different Input and Output devices. *TSO 1c.* Identify the different types of memory in computer systems. *TSO 1d.* Explain communication process between different components of a computer. *TSO 1e.* Describe the functionalities of a computer system. *TSO 1f.* Use Internet digital Platforms	**Unit-1.0 Basics of Computer System** 1.1 Computer System and its Components. - Generation of Computer - Anatomy of Computer Systems - Input and output device - Motherboard - Peripherals - Backend and Front end of System Unit 1.2. Storage device in Computer System - Primary Storage - Secondary Storage 1.3. CPU Components - Register - Control Unit - ALU 1.4. Types of Bus - Address Bus - Data Bus - Control Bus 1.5 Search Engine - Introduction - Search Query - Applications of Internet Digital Platforms (BHIM, Digi-Locker, m-paravian, NPTEL etc.)	**CO-1**
TSO 2a. Compare various computer network topologies *TSO 2b.* Differentiate types of networks. *TSO 2c.* Compare internet and intranet *TSO 2d.* Explain IP addressing system. *TSO 2e.* Explain functions of Networking Devices.	**Unit 2.0 Basic Network Concepts** 2.1 Network Topologies Bus, Mesh, Star, Ring, Hybrid 2.2 Types of Computer Networks LAN, WAN 2.4 Internet & Intranet IP Addressing system and URL, Internet, Intranet, Comparison between Intranet & Internet 2.3 DNS - Introduction, Need - Domain Names & its types 2.5 Networking Devices (Types and use) Switch, Router, Gateway, Modem, Repeater, Wireless Access Point, NIC	**CO-2**
TSO 3a. Write Algorithm to solve the given problem. *TSO 3b.* Write simple 'C' program to solve the given arithmetic expressions *TSO 3c.* Write a simple 'C' Program demonstrating the given data type conversion *TSO 3d.* Write I/O Statements for the given data. *TSO 3e.* Write a 'C' program using a decision-making structure for	**Unit 3.0 Basics of 'C' Programming and control structures** 3.1 Fundamentals of algorithms: Notion of an algorithm. Pseudo-code conventions like assignment statements and basic control structures. 3.2 Flowchart: Flowchart, Symbols of flowchart, Guidelines for preparing Flowchart 3.3 Introduction to C: General Structure of a 'C' program Data Concepts: Character set, tokens, keywords, Identifiers, Variables, Constant, data types, C operators, Arithmetic operators, Arithmetic expression, declaring variables, and data type conversion.	**CO-3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
two-way branching to solve the given problem. *TSO 3f.* Write a 'C' program using a decision-making structure for multi-way branching to solve the given problem. *TSO 3g.* Apply loop statements to solve the given iterative problem in 'C' program. *TSO 3h.* Use appropriate statements to change the program flow in the given loop.	3.4 Basic Input output: Input and Output statements, using printf() and scanf(), character input/output statements, Input/output formatting, Use of comments 3.5 Decision making and branching**:** Relational and logical operators, if statement, if else statement, nested if-else, if-else ladder' The switch statement 3.6 Looping: While loop, Do… While loop For loop, Go to statement, Use of break and continue statements	
TSO 4a. Write statements to read, write the given array. *TSO 4b.* Manipulate the given array of characters and numbers. *TSO 4c.* Use pointers to access memory locations for solving the given problem.	**Unit 4.0 Array and Pointer** 4.1 Characteristics of an array, One dimension and two-dimension arrays, Array declaration and Initialization 4.2 Array of characters, Operation on array Character and String input/output **Concepts of pointers: declaring, initializing, accessing.**	**CO-4**
TSO 5a. Use the given Library function. *TSO 5b.* Develop user defined functions for the given problem. *TSO 5c.* Write 'C' codes to pass the given function parameters using "call by value" and "call by reference" approach. *TSO 5d.* Write recursive function for the given problem.	**Unit 5.0 Concept and Need of Functions** Library functions: Math functions, String handling functions, other miscellaneous functions. Writing User defined functions, scope of variables. Parameter passing: call by value, call by reference. Recursive functions	**CO-5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2418105

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Install device driver. *LSO 1.2.* Install given software on your system. *LSO 1.3.* Perform Registration process of digital India platform.	1.	1.1 Identify specifications of various types of computer systems available in your institute. 1.2 Install Printer, scanner driver. 1.3 Install any two freeware or open-source software/tool by using web browser 1.4 Use Digital India Platforms: BHIM, Dig-Locker, m-parivahan, NPTEL.	CO-1
LSO 2.1. List various types of networking devices in your Institute. *LSO 2.2.* Make a small local area network.	2.	2.1 Connect two/three computers to form a network using wire/wireless connectivity and configure it.	CO-2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 3.1. Write and execute simple 'C' program. *LSO 3.2.* Use scanf() and printf() functions in 'C' programs. *LSO 3.3.* Write C Program using Decision Making and two-way branching statements. *LSO 3.4.* Write C Program using "switch-case" statement for multi-way branching. *LSO 3.5.* Use the "if" and "Switch" statements appropriately for decision making in C Program. *LSO 3.6.* Write and execute C programs using various types of loop statements to solve iterative problems.	3.	3.1 Write 3 different C –Program to demonstrate use of Arithmetic expression, constant, variable and Increment/ decrement operators. 3.2 Write a program to- a. Determine whether a given year is a leap year or not. b. Determine whether a string is palindrome. c. Find the greatest of the three numbers using conditional operators. d. Find if a given character is vowel (use if-else ladder). 3.3 Using switch statement- Write program to: Print day of week by taking number from 1 to 7. 3.4 Write Program to: a. Find sum of digits of a given number. b. Find Fibonacci series for given number. c. Write a program to produce the following output: 1 2 3 4 5 6 7 8 9 10	CO-3, CO-4
LSO 4.1. Write and execute C programs using one-dimension array. *LSO 4.2.* Write and execute C program using two-dimensional array.	4	4.1 Develop a Program to: a. Sort list of 10 numbers. b. Perform addition of 3x3 matrix.	CO-5
LSO 5.1. Write C program using different types of library functions to solve given problem. *LSO 5.2.* Write C program to Create and use user defined functions	5.	5.1 Develop Program to demonstrate: a. Use of String handling functions. b. Use of Mathematical functions. c. Use of other miscellaneous functions. 5.2 Develop a Program to: a. Create a function to find GCD of given number. Call this function in a program. 5.3 Find Factorial of given number using recursion.	CO-6

L) Suggested Term Work and Self Learning: S2418105 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. Identify specifications of various types of computer systems in your Institute.
2. Prepare a report on computer peripherals and its usage of your computer lab.
3. Prepare a presentation on network topology.
4. Prepare a survey report to identify various types of networking devices available in your Institute.
5. Make a calculator using 'C' programming.

c. Other Activities:

1. Seminar Topics: -
   - "Future of IT"
   - "Scope of 'C' programming in other Engineering disciplines"
2. Prepare a poster presentation on Computer hardware and peripherals.
3. Prepare a report on Open Source software available for Electronics Engineering.
4. Product Development: Development of projects for real life problem solution using 'C' programming.

d. Self-Learning Topics:

1. System and application software.
2. Scope of 'C' programming in real world.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		**Term Work Assessment (TWA)**			**Lab Assessment (LA)#**	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	**End Theory Assessment (ETA)**	**Term Work & Self Learning Assessment**			**Progressive Lab Assessment (PLA)**	**End Laboratory Assessment (ELA)**
			Assignments	**Micro Projects**	**Other Activities***		
CO-1	10%	10%	10%	100%	100%	10%	-
CO-2	10%	10%	10%			10%	-
CO-3	10%	10%	15%			25%	**30%**
CO-4	25%	25%	25%			25%	**40%**
CO-5	25%	25%	20%			15%	**30%**
CO-6	20%	20%	20%			15%	
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 Basics of Information System	5	CO-1	7	3	3	1
Unit 2.0 Basic Network Concepts	5	CO-2	7	3	2	2
Unit 3.0 Basics of 'C' Programming and control Structures	18	CO-3 and CO-4	28	8	8	12
Unit 4.0 Array and Pointer	12	CO-5	17	3	4	10
Unit 5.0 Concept and need of Functions	8	CO-6	11	3	2	6
Total	**48**	**-**	**70**	**20**	**19**	**31**

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

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Identify specifications of various types of computer systems available in your institute.	CO-1	40	50	10
2.	Install Printer driver.	CO-1	40	50	10
3.	Install any two freeware or open-source software/tool by using web browser	CO-1	40	50	10
4.	Use Digital India Platforms: BHIM, Dig-Locker, m-parivahan, NPTEL.	CO-1	30	60	10
5.	Connect two/three computers to form a network using wire/wireless connectivity and configure it.	CO-2	40	50	10
6.	Write 3 different C –Program to demonstrate Arithmetic expression, constant, variable and Increment/decrement operator.	CO-3	50	40	10
7.	Write a program to- a. Determine whether a given year is a leap year or not. b. Determine whether a string is palindrome. c. Find the greatest of the three numbers using conditional operators. d. Find if a given character is a vowel (use if-else ladder).	CO-3	50	40	10
8.	Write program to: Print day of week by taking number from 1 to 7.	CO-3	50	40	10
9.	Write Program to: (a) Find sum of digits of a given number. (b) Find Fibonacci series for given number. (c) Write a program to produce the following output:	CO-3	50	40	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
	1 2 3 4 5 6 7 8 9 10				
10.	Develop a Program to: a. Sort list of 10 numbers. b. Perform addition of 3x3 matrix.	CO-4	50	40	10
11.	Develop Program to demonstrate: a. Use of all String handling functions. b. Use of few Mathematical functions. c. Use of few other miscellaneous functions.	CO-5	50	40	10
12.	Develop a Program to: a. Create a function to find GCD of given number. Call this function in a program	CO-5	50	40	10
13.	Find Factorial of given number using recursion.	CO-5	50	40	10

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

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

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be 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** (No Generic) Give basic configuration or Latest	Relevant Experiment/Practical Number
1	Computer System	Any General-purpose Computer	All
5	Switch	4, 8, 12, 16 or 24 port switches with 100/1000 gbps data transfer speed	5
6	Ethernet cable	Cat 6, cat6e or above	5
8	Printer	Any printer dot matrix, inkjet or laser printer	2
9	C complier	Turbo C/ Dev C/Others	6-13

R) Suggested Learning Resources:

(a) Books:

S.No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Computer fundamentals and programming in C	Reema thareja	Oxford university press INDIA ISBN-10 : 9780199463732 ISBN-13 : 978-0199463732
2	Let us C	Yashavant Kanetkar	BPB publication, ISBN-10 : 8183331637 ISBN-13 : 978-8183331630
3	Programming in ANSI C	E. Balagurusamy	McGraw Hill education ISBN-10 : 935316513X ISBN-13 : 978-9351343202
4	Computer Fundamentals Concepts Systems and Applications 8th Edition (English, Paperback,	Priti Sinha, Pradeep Sinha	BPB Publications ISBN-13: 9788176567527 ISBN-10: 8176567523
5	Fundamentals of Computers	E Balagurusamy	McGraw Hill Education 2009, ISBN-10 : 9780070141605 ISBN-13 : 978-0070141605

(b) Open Educational Resources:

1. https://nptel.ac.in/courses/106104128
2. https://en.wikipedia.org/wiki/Networking_hardware
3. https://www.javatpoint.com/computer-fundamentals-tutorial
4. https://www.w3schools.com/c/

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

(c) Others:

1. Learning Header files
2. Lab Manuals

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A) Course Code : 2400006(T24000061/P2400006/S2400006)

B) Course Title : Environmental Education and Sustainable Development

(Common for all Programmes)

C) Pre- requisite Course(s) :

D) Rationale :

Every creature depends on nature for their survival. It is therefore, not only essential but also moral responsibility of all of us to keep our environment clean & in a good condition. The global environmental issues such as clean water and sanitation, affordable & clean energy, sustainable cities & communities, etc. are best addresses through sustainable development goals. Environmental education is one of the primary activities to spread the concept of sustainability on a broader scope. In India, environmental education is considered as mandatory for all segment of education including technical education. Every creature depends on nature for their survival. It is therefore, not only essential but also moral responsibility of all of us to keep our environment clean & in a good condition. The concept of sustainable development is closely associated with environmental education to promote developments. Considering importance of environmental education and sustainable development, it became necessary to provide basics of these areas to the engineering graduates. The knowledge gained through this course will help the diploma students to take engineering decisions aligned to ensure sustainability of environment for next generations through proper protection of environment.

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

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

- **CO-1** Explain the importance of ecosystem for the protection of environment
- **CO-2** Use relevant air & water pollution control methods to solve pollution related issues
- **CO-3** Recognize relevant energy sources required for domestic & industrial application
- **CO-4** Analyze the issues of climate change and its impact on sustainability
- **CO-5** Apply engineering solutions/methods/legislations to reduce the activities that are harming the environment.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	-	-	-	2	-	2		
CO-2	3	2	2	2	2	-	2		
CO-3	3	-	-	-	3	-	2		
CO-4	3	3	-	2	2	-	2		
CO-5	3	-	3	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				
2400006	Environmental Education and Sustainable Development	01	-	01	01	03	02

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment(TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400006	Environmental Education and Sustainable Development	-	-	25	-	10	15	50

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: T2400006

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Differentiate aquatic & terrestrial ecosystem *TSO 1b.* Explain structure of ecosystem *TSO 1c.* Compare food chain & web chain *TSO 1d.* Describe carbon, nitrogen, Sulphur & phosphorus cycle *TSO 1e.* Explain causes & effect of global warming	**Unit-1.0 Ecosystem** 1.1 Aquatic & Terrestrial ecosystem 1.2 Structure of ecosystem 1.3 Food chain & Food web 1.4 Carbon, Nitrogen, Sulphur & Phosphorous Cycle 1.5 Global warming – Causes & Effects	**CO1**
TSO 2a. Explain environmental pollution & its sources. *TSO 2b.* Assess the causes of water & air pollution in a given area *TSO 2c.* Explain the effects of water & air pollution on human, plant & animal *TSO 2d.* Take appropriate measures to prevent the pollution problems at city /municipal areas *TSO 2e.* Determine the pollution level in the environment at different seasons.	**Unit-2.0 Air & Water Pollution** 2.1 Traditional pollution issues- Air, Water, Noise 2.2 Water pollution 2.2.1 Sources of water pollution 2.2.2 Effects of water pollution 2.2.3 Control of water pollution 2.2.4 Physical & chemical standard of domestic water as per Indian Standard 2.3 Air pollution 2.3.1 Sources of air pollution 2.3.2 Air pollutants 2.3.3 Effects of air pollution on human, plant & animal 2.3.4 Air monitoring system 2.3.5 Air pollution control	**CO2**
TSO 3a. Describe various types renewable sources of energy *TSO 3b.* Explain solar energy & methods of harnessing *TSO 3c.* Explain wind energy and its impact on environment *TSO 3d.* Explain characteristics of biomass & its digestion process *TSO 3e.* Describe new energy sources & their application	**Unit-3.0 Sustainability & Renewable Sources of Energy** 3.1 Concept of sustainable development 3.2 Renewable sources of energy for sustainable development 3.3 Solar Energy 3.3.1 Features of solar thermal & PV system 3.3.2 Solar pond, Solar water heater, Solar dryer and Solar stills 3.4 Wind Energy 3.4.1 Current status & future prospects of wind energy 3.4.2 Wind energy in India- Advantages and challenges of harnessing wind energy 3.4.3 Environmental benefits & limitations 3.5 Biomass 3.5.1 Types of Biomass energy sources 3.5.2 Energy content in Biomass of different types 3.5.3 Biogas production	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	3.6 Concept and advantages of hydroponics or aquaponics system to demonstrate soil less cultivation and integration of fish and plant cultivation. 3.7 Water conservation and sustainable development 3.8 New Energy Sources: Hydrogen energy, Ocean energy & Tidal energy	
TSO 4a. Describe impact of climate change on human life *TSO 4b.* Identify the factors contributing to climate change *TSO 4c.* Explain sustainable development goals to transform the world *TSO 4d.* Develop implementation strategies for action plan on climate change	**Unit-4.0 Climate Change and Sustainable Development** 4.1 Impact of Climate change 4.2 Factor contributing to climate change 4.3 Sustainable development Goals (SDGs) 4.4 Action Plan on Climate Change- India	**CO4**
TSO 5a. Identify the elements of a successful management system *TSO 5b.* Explain green building concept & its benefits *TSO 5c.* Apply 5R concept in a given building construction project *TSO 5d.* Explain various environment protection laws *TSO 5e.* Explain carbon foot-print & carbon credit	**Unit-5.0 Environmental legislation and Sustainable Building Practices** 5.1 Environment management system and Planning 5.2 Green Building concept 5.3 Green and sustainable building materials -5R concept 5.4 Environment protection acts, legislation and Laws 5.5 Zero carbon foot-print building for sustainable constriction.	**CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400006

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use of Air pollutant analyzer to determine the air pollution level *LSO 1.2.* Collect air samples for pollution level detection	1.	Determination of air pollutants harming local environment	CO2
LSO 2.1 Use of Water pollutant analyzer to determine the water pollution LSO 2.2 Collect water samples for pollution level detection	2	Determine the water pollutants harming local environment	CO2
LSO 3.1 Prepare report on EIA of a given context and area. LSO 3.2 Collection of stakeholders view on effect on environment about a particular project/activity.	3.	Carry out the Environmental Impact Assessment (EIA) for a given project /activity of development	CO1 CO3
LSO 4.1 Predict of possible factors causing effects of climate change LSO 4.2 Effect of Ice melting on sea water	4.	Assessment of the impact of climate change on local environment	CO1 CO4

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 5.1 Elaborate the uses of sustainable building materials, the considering 3R LSO 5.2 Trace of Carbon foot print due to construction of a small building	5.	Demonstration of sustainable building materials in lab/workshop	CO2 CO5
LSO 6.1 Set up sample recycling bins in the laboratory LSO 6.2 Appreciate the importance of recycling and environmental benefits LSO 6.3 Explain the importance of 3 R	6.	Demonstration of the recycling process for the different materials such as paper, plastic etc. for waste management	CO3
LSO 7.1 Explain the process of composting LSO 7.2 disseminate the use of composting process to near and dear for soil health and fertility for generating organic food	7	Setting up composting bins in the laboratory to demonstrate the process of composting organic waste	CO3
LSO 8.1 Calculate own water footprint for daily activities LSO 8.2 Explain the importance of reducing water consumption and conserve water resources.	8	Calculation of personal water footprint for daily water usage for activities like bathing, cooking and laundry.	CO3
LSO 9.1 Explore the alternative / renewable sources of energy in day to day life	9.	Develop bio mass energy in the laboratory	CO3 CO4
LSO 10.1 Explore the alternative / renewable sources of energy in day to day life	10.	Develop solar model in the laboratory	CO3
LSO 11.1 Explore the alternative / renewable sources of energy in day to day life	11.	Develop wind turbine model in the laboratory	CO4

L) Suggested Term Work and Self Learning: S2400006 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

1. Conduct a waste audit in your polytechnic. Categorize waste into different types such as plastic, paper, organic. Quantify the amount of each waste.

b. Micro Projects:

- Conduct of EIA of a project/activity such as construction of roads in the local area. Prepare a report on:
  (a) Environmental issues in your city
  (b) SDGs and environment related acts/laws applicable in your state and in India.
  (c) Current-status & future-prospects of Wind Energy
  (d) New energy sources

- Prepare a model of rain water harvesting system to demonstrate how rainwater can be collected and stored for various purposes such as irrigation and toilet flushing.
- Students may be asked in group to set up a small solar panel to compare the energy output under different lighting condition and angles to understand the concept of solar energy and its potential applications.

c. Other Activities:

1. Seminar Topics:
   - Climate change issue and problems
   - Sustainable development- Global practices
   - Factor affecting sustainability in India

2. Visits:
   Visit Pollution control Board of your city. Prepare report of visit with special comments of initiatives taken for protecting environment and ensuring sustainable development of the city.

   Organize a field trip to a nearby park for the students. Students can be observed different species of the plants, animals and insects. They may be asked to prepare report on importance of biodiversity conservation.

3. Self-Learning Topics:

   - Sustainable Development Goals
   - Climate change.
   - Pollution issues
   - Laws and legislation of environmental protection

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%	-	-	20%	20%
CO-2	-	-	10%	25%	-	10%	20%
CO-3	-	-	15%	25%	50%	15%	20%
CO-4	-	-	30%	50%	50%	15%	20%
CO-5	-	-	30%	-	-	40%	20%
Total Marks	**-**	**-**	**10**	**10**	**05**	**10**	**15**
			25				

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: (Not Applicable)

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 Air and water pollutants harming local environment	CO1	30	60	10
2.	Determine the water pollutants harming local environment	CO1	40	50	10
3.	Carry out the Assessment of Environmental Impact (EIA) for a given project /activity of development	CO1 CO3	30	60	10
4.	Assess the impact of climate change on local environment	CO1 CO4	30	60	10
5.	Demonstrate sustainable building materials in lab/workshop	CO2 CO5	30	60	10
6.	Demonstrate the recycling process for the different materials such as paper, plastic etc. for waste management	CO3	50	40	10
7.	Setting up composting bins in the laboratory to demonstrate the process of composting organic waste	CO3	50	40	10
8.	Calculation of personal water footprint for daily water usage for activities like bathing, cooking and laundry.	CO3	50	40	10
9.	Develop bio mass energy in the laboratory	CO3 CO4	30	60	10
10.	Develop solar model in the laboratory	CO3	30	60	10
11.	Develop Wind turbine model in the laboratory	CO4	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.	Air analyzer	Air Quality Meter Product Type: Measuring Instrument Analysis Time: 2 sec to 8-hour 59 min. 59 sec Automation Grade: Automatic	1
2.	Water Analyzer	Multi-Parameter Water Testing Meter Digital LCD Multi-Function Water Quality Monitor PH/EC/TDS/Salt/S. G/CF/ORP	2
3.	Sustainable Building Materials	As per availability in the market	2,5

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
4.	Solar energy Panel – KT	Solar Panel Kit 5 LEDs, 2 ON/Off Switch, Wire, 2 Crocodile Clip	7
5.	Bio mass/energy installation -kit	The Bio-energy Science Kit is a great way to find out how a direct ethanol fuel cell works.	6
6.	Wind power energy -Kit	4M wind turbine kit, to demonstrate power of wind and convert it into electricity by building your own turbine.	8
7.	Ice melting demo kit	Simple bowls of different sizes	--

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Ecology and Control of the Natural Environment	Izrael, Y.A.	Kluwer Academic Publisher eBook ISBN: 978-94-011-3390-6
2.	Renewable Energy Sources and Emerging Technologies	Kothari, D.P. Singal, K.C., Ranjan, Rakesh	PHI Learning, New Delhi, 2009 ISBN-13 - 978-8120344709
3.	Green Technologies and Environmental Sustainability	Singh, Ritu, Kumar, Sanjeev	Springer International Publishing, 2017 eBook ISBN 978-3-319-50654-8
4.	Coping with Natural Hazards: Indian Context	K. S. Valadia	Orient Longman ISBN-10: 8125027351 ISBN-13: 978-8125027355
5.	Introduction to Engineering and Environment	Edward S. Rubin	Mc Graw Hill Publications ISBN-10: 0071181857 ISBN-13: 978-0071181853
6.	Environmental Science	Subrat Roy	Khanna Book Publishing Co. (P) Ltd. ISBN-978: 93-91505-65-3

(b) Online Educational Resources:

1. http://www1.eere.energy.gov/wind/wind_animation.html
2. http://www.nrel.gov/learning/re_solar.html
3. http://www.nrel.gov/learning/re_biomass.html
4. http://www.mnre.gov.in/schemes/grid-connected/biomass-powercogen/
5. http://www.epa.gov/climatestudents/
6. http://www.climatecentral.org
7. http://www.envis.nic.in/
8. https://www.overshootday.org/
9. http://www.footprintcalculator.org/
10. https://www.carbonfootprint.com/calculator.aspx

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. www.nptel.iitm.ac.in
2. www.khanacademy

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A) Course Code : 2411306(P2411306/S2411306)

B) Course Title : Summer Internship -I (Common For all Programmes)

C) Pre- requisite Course(s) :

D) Rationale :

Diploma students are required to give exposure of their own diploma programme related industrial hardware, software and practices, just after completing one semester, so that they can correlate this industrial exposure with the concept being taught in the branch specific specialized engineering courses in forthcoming semesters. Mentors/Coordinators/ Teachers need to map the academic contents of the programme of study with the activities of this industrial exposure and are advised to follow the 'Whole to Part' approach to make the students aware about the potential industry's expected outcomes & setup ('Whole') from the diploma programme – and then teaching the related concepts ('Part') of the same in subsequent semesters. In this way before actually being exposed to academic input specific to diploma programmes, the students need to be sent to the nearby/local industries and also may be advised to explore information related to their programme of study using different sources related to potential employment opportunities of both wage and self-employment, job function, job position, nearby relevant industries and so on.

The summer internship will provide the direction to the students and also help in mind mapping to plan their futuristic course of action, after passing the diploma. This would also bridge the gap between their virtual imagination about the outcome of the programme and real happenings related to the diploma programme.

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** Comprehend the practices of identified industry or world of work related to diploma engineering programme of study.
- **CO-2** Map real equipment, processes, product, management, operations etc. to the course of study through various glimpses of input, process and output in different type of industries.
- **CO-3** Identify the probable enterprises /startups for futuristic planning and self-growth.
- **CO-4** Identify the probable job function and job position in their relevant programme of study.

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	-	-	1	-	-	1		
CO-2	3	-	-	1	-	-	1		
CO-3	3	-	-	-	1	-	2		
CO-4	3	-	-	-	1	-	2		

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2411306	Summer Internship -I	-	-	02	02	04	02

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2411306	Summer Internship -I	-	-	10	15	10	15	50

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) Suggested Instructional/Implementation Strategies: Mentors/ Coordinators/ Teachers need to plan and implement the summer internship in their respective programme as per the outcome expected from the programme. However in general, summer internship would help in exploring and exposing the student to the below mentioned dimensions of the world of work. These dimensions can further be explored in depth as per the need and advancement in respective programmes in later stages. Mentors/Coordinators/ Teachers need to map the academic contents of the programme of study with the activities of this industrial exposure and are

advised to follow the whole to part approach to make the students aware about the potential industry's expected outcomes & setup ('Whole') from the specific diploma programme and then teaching the related concepts ('Part') of the same in subsequent semesters.

- Industrial Layout
- Organizational Structure
- Corporate Communications
- Strategic, Rolling and Developmental plans
- Maintenance Procedures
- Inventory Control and Management System
- Purchase and Store Procedures
- Major Machinery, Tools, Equipment, Devices, Software, Control System etc.
- Product Development, Manufacturing, Packaging and Delivery
- Project Management
- Operation and Maintenance
- Warehouse Management
- Assembly Line
- Quality Assurance and Testing Cell
- Process/ Software Development/ Fabrication/ Construction Work Management
- Testing and Quality Assurance Practices
- Total quality management
- Calliberation and Certification practices
- Safety Practices
- Industrial Acts
- Industrial Grievances
- Behavioural Aspects
- Conduction of Meetings and Discussions
- Sales and Marketing Strategies
- Forecasting and Target Setting
- Production Planning and Control
- Storage Retrieved and Material handling Practices
- Automation and Control Facilities
- Enterprise Resource Planning (ERP)
- Supply Chain
- Customer Satisfaction Strategies
- Finance and Accounts
- Research and Development
- Promotion and Capacity Building Schemes
- Reduce, Reuse and Recycling Efforts and Policies
- Recognitions and Rewards
- After Sale Services
- Promotional Avenues
- Social Corporate responsibilities

J) Assessment of Summer Internship -I

S. No.	Criteria of Assessment	% of Weightage
1.	Maintaining the log book after having exposure to different types of industry/ world of work	15
2.	Preparing the list of job functions and job positions of relevant programme	20
3.	Identify the probable enterprise/ startup for futuristic planning	15
4.	Report writing of summer internship as per the prescribed format	30
5.	Presentation of Report	20
Total		**100**

Note: S. no. 1 to 3 shall be considered for progressive assessment. While S. No. 4 & 5 shall be considered for end term assessment

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A) Course Code : 2411307(P2411307/S2411307)

B) Course Title : Operation and Maintenance of Farm Machineries, Tools and Equipment's

C) Pre- requisite Course(s) :

D) Rationale :

This course aims to present the general aspects of operation and maintenance of agriculture equipment used within a higher service business. It introduces the concept of proper operation, maintenance and repair provision of machineries, equipment and tools. It explains the main principles of use and maintenance/ care of agriculture power sources, implements and machines most likely to be of interest to be of mechanization & service provides for small holder farmer.

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. Maintain the tractor and Power tiller for effective operations.
CO-2. Troubleshoot farm machinery/equipment's for repair and maintenance
CO-3. Use different types of attachments and implement with the tractor
CO-4. Operate tillage equipment, harvesting and threshing equipment effectively and efficiently.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2411307	Operation and Maintenance of Farm Machineries, Tools and Equipment's	-	-	04	02	06	03

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)	
2411307	Operation and Maintenance of Farm Machineries, Tools and Equipment's	-	-	20	30	20	30	100

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: (Not Applicable)

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2411307

Practical/Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1	Identify different makes and models of tractors	1.	Identify different makes, models and specifications of 4-wheeled tractors	CO1
LSO 1.2	Use tractor/power tiller for agricultural purpose.	2.	Identify different systems of tractor/power tiller like fuel supply system, lubrication system, ignition system, cooling system, electrical system, hydraulic system, final drive system, inlet and exhaust system, transmission system.	CO1
		3.	Check maintenance points and safety in tractor before starting a tractor.	CO1
		4.	Practice starting and stopping of the tractor following correct procedure.	CO1
		5.	Identify and take correct readings on instruments and gauges like fuel pressure gauge, oil pressure gauge, water temperature gauge, hour meter, hydraulic pressure gauge and temperature gauge fixed on control panel to indicate their operating conditions.	CO1
		6.	Operate Starter switch, light switch, horn button, fuel cut off controls fixed on tractors control panel.	CO1
		7.	Practice forward and reverse gears tractor driving under the instructor guidance.	CO1
LSO 1.3	Operate two wheeled tractors	8.	Operate two wheeled tractors (Power Tiller) with and without implement under the instructor guidance as per SOPs.	CO1
		9.	Practice hitching and de-hitching of implements	CO1
LSO 1.4	Perform routine maintenance	10.	Perform routine preventive maintenance of tractors as per given schedule	CO1
LSO 2.1	Use servicing and testing tools	11.	Identify different servicing and testing tools used for repair and maintenance of tractor/ power tiller and implements	CO2
LSO 2.2	Identify replace the faulty component of disc harrow	12.	Operate of disc harrow in field	CO2
		13.	Disassemble disc harrow	
		14.	Assemble disc harrow.	CO2
LSO 2.3	Identify and replace the faulty component of disc plough	15.	Operate of disc plough in field	CO2
		16.	Disassemble disc plough	CO2
		17.	Assemble Disc plough	CO2
		18.	Determine and adjust disc and tilt angle of disc plough	CO2
LSO 2.4	Perform hitching system of agricultural implements and trailers.	19.	Execute Hitching system of mounted and semi mounted implements as per requirement.	CO2
LSO 2.5	Trouble shoot the given tractor and implements	20.	Troubleshoot the given tractor for starting problem.	CO2
		21.	Identify fault in the given implements/ equipment's	CO2
LSO 3.1	Determine draft and fuel consumption	22.	Measure draft and fuel consumption for different implements under different soil conditions	CO3

Practical/Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 3.2	Determine nozzle discharge	23.	Measure nozzle discharge of sprayers & dusters.	CO3
LSO 3.3	Perform adjustment on given implements	24.	Perform adjustment on M.B. plough, disc plough, disc harrow and cultivator, chaff cutter as per the requirement.	CO3
LSO 3.4	Use cultivator for different type of functions	25.	Drive tractor with attaching cultivator as per the given requirement	CO3
LSO 3.5	Use mould board plough in the field	26.	Operate mould plough in the field	CO3
		27.	Assemble the different part of MB plough.	CO3
LSO 3.6	Protect farm equipment during off season.	28.	Store the farm equipment's in off seasons following the correct procedure of storage.	CO3
LSO 3.7	Use seed cum fertilizer drill for sowing and planting equipment	29.	Calibrate seed cum fertilizer drill before use in the field.	CO3
		30.	Operate seed cum fertilizer drill following the safety precautions.	CO3
		31.	Adjust seed cum fertilizer drill as per requirement.	CO3
LSO 3.8	Use sprayer for the given purpose	32.	Operate sprayer following the safety precautions.	CO3
LSO 3.9	Use plant protection equipment for the given requirement.	33.	Operate plant protection equipment as per the SOPs.	CO3
LSO 3.10	Store the tractor and implements after use	34.	Prepare the given tractor for storage	CO3
		35.	Prepare the implements for storage	CO3
LSO 4.1	Use MB plough as per requirement	36.	Measure angle of mould board plough and do adjustment as per the need.	CO4
LSO 4.2	Use cultivator as per need	37.	Operate cultivator for stirring and pulverizing the given soil.	CO4
LSO 4.3	Use the rotavator at different speed in the field.	38.	Measures the speed of rotavator working in the field.	CO4
LSO 4.4	Use happy seeder for sowing the seed	39.	Operate happy seeder	CO4
LSO 4.5	Use sprayer and duster.	40.	Select sprayer and duster for the given application rate and its capacity	CO4
LSO 4.6	Use self-propelled happy trans planter	41.	Operate self-propelled paddy transplanter	CO4
LSO 4.7	Use thresher according to crop threshed	42.	Operate thresher in the field.	CO4
LSO 4.8	Operate the chaff cutter.	43.	Operate the chaff cutter at different speed.	CO4
LSO 4.9	Calculate the field capacity and field efficiency of the given implements	44.	Determine the field capacity and field efficiency the given implements	CO4
LSO 4.10	Align the mower	45.	Perform the alignment and registration of mower	CO4

L) Suggested Term Work and Self Learning: S2411307 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

i. Prepare periodic service schedule for 10 hours service schedule in a tractor
ii. Prepare periodic service schedule 50 hours service schedule in a tractor
iii. Prepare periodic service schedule 125 hours service schedule in a tractor

b. Micro Projects:

i. Prepare a report on advancement of agricultural equipment's and implements available in the market and how they are useful in rural areas.
ii. Prepare a working model of implements

c. Other Activities:

1. Seminar Topics:
   - Selection, operation safety and maintenance of improved agricultural machinery.
   - Safety in use and operation various agriculture machinery.
   - Troubleshooting procedure of tractor/ power tiller/ implements

2. Visits: Nearby implement manufacturer like rotavator, thresher cultivator manufacture and

3. Self- learning topics:
   - Service and maintenance manual of tractor by escorts ltd Faridabad.
   - Use of advanced technology in agricultural area
   - Research in agricultural area

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	-	-	25%	30%	25%	25%	25%
CO-2	-	-	25%	20%	25%	25%	25%
CO-3	-	-	25%	20%	25%	25%	25%
CO-4			25%	30%	25%	25%	25%
Total Marks	**-**	**-**	**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: (Not Applicable)

O) Suggested Assessment Table for Laboratory (Practical):

S. No	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA * (%)	PDA ** (%)	
1.	Identify different makes, models and specifications of 4-wheeled tractors	CO1	50	40	10
2.	Identify different systems of tractor/power tiller like fuel supply system, lubrication system, ignition system, cooling system, electrical system, hydraulic system, final drive system, inlet and exhaust system, transmission system.	CO1	50	40	10
3.	Check maintenance points and safety in tractor before starting a tractor.	CO1	50	40	10
4.	Practice starting and stopping of the tractor following correct procedure.	CO1	50	40	10
5.	Identify and take correct readings on instruments and gauges like fuel pressure gauge, oil pressure gauge, water temperature gauge, hour meter, hydraulic pressure gauge and temperature gauge fixed on control panel to indicate their operating conditions.	CO1	50	40	10
6.	Operate Starter switch, light switch, horn button, fuel cut off controls fixed on tractors control panel.	CO1	50	40	10
7.	Practice forward and reverse gears tractor driving under the instructor guidance.	CO1	50	40	10
8.	Operate two wheeled tractors (Power Tiller) with and without implement under the instructor guidance as per SOPs.	CO1	50	40	10
9.	Practice hitching and de-hitching of implements	CO1	50	40	10
10.	Perform routine preventive maintenance of tractors as per given schedule	CO1	50	40	10
11.	Identify different servicing and testing tools used for repair and maintenance of tractor/ power tiller and implements	CO2	50	40	10
12.	Operate of disc harrow in field	CO2	50	40	10
13.	Disassemble disc harrow	CO2	50	40	10
14.	Assemble disc harrow.	CO2	50	40	10
15.	Operate of disc plough in field	CO2	50	40	10
16.	Disassemble disc plough	CO2	50	40	10
17.	Assemble Disc plough	CO2	50	40	10
18.	Determine and adjust disc and tilt angle of disc plough	CO2	50	40	10
19.	Execute Hitching system of mounted and semi mounted implements as per requirement.	CO2	50	40	10
20.	Troubleshoot the given tractor for starting problem.	CO2	50	40	10
21.	Identify fault in the given implements/ equipment's	CO2	50	40	10
22.	Measure draft and fuel consumption for different implements under different soil conditions	CO3	50	40	10

S. No	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA * (%)	PDA ** (%)	
23.	Measure nozzle discharge of sprayers & dusters.	CO3	50	40	10
24.	Perform adjustment on M.B. plough, disc plough, disc harrow and cultivator as per the requirement.	CO3	50	40	10
25.	Drive tractor with attaching cultivator as per the given requirement	CO3	50	40	10
26.	Operate mould plough in the field	CO3	50	40	10
27.	Assemble the different part of MB plough.	CO3	50	40	10
28.	Store the farm equipment's in off seasons following the correct procedure of storage.	CO3	50	40	10
29.	Calibrate seed cum fertilizer drill before use in the field.	CO3	50	40	10
30.	Operate seed cum fertilizer drill following the safety precautions.	CO3	50	40	10
31.	Adjust seed cum fertilizer drill as per requirement.	CO3	50	40	10
32.	Operate sprayer following the safety precautions.	CO3	50	40	10
33.	Operate plant protection equipment as per the SOPs.	CO3	50	40	10
34.	Prepare the given tractor for storage	CO3	50	40	10
35.	Prepare the implements for storage	CO3	50	40	10
36.	Measure angle of mould board plough and do adjustment as per the need.	CO4	50	40	10
37.	Operate cultivator for stirring and pulverizing the given soil.	CO4	50	40	10
38.	Measures the speed of rotavator working in the field.	CO4	50	40	10
39.	Operate happy seeder	CO4	50	40	10
40.	Select sprayer and duster for the given application rate and its capacity	CO4	50	40	10
41.	Operate self-propelled paddy transplanter	CO4	50	40	10
42.	Operate thresher in the field.	CO4	50	40	10
43.	Operate the chaff cutter at different speed.	CO4	50	40	10
44.	Determine the field capacity and field efficiency the given implements	CO4	50	40	10
45.	Perform the alignment and registration of mower	CO4	50	40	10

Legend:

PRA*: Process Assessment
PDA**: Product Assessment

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

P) Suggested Instructional/Implementation Strategies: Visit to commercial Nurseries /Agricultural Universities /KVK.

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

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Tractor	HP Category- 50 -55 HP Engine Capacity-3300 cc-3800 cc Engine Rated RPM-2000-2200 RPM No of Cylinder- 3-4 Air Filter-3 Stage wet Air Cleaner, Oil bath type with pre-cleaner Cooling System - Water Cooled	1 to 10
2.	Servicing and testing tools	Set of servicing and testing tools	1-35
3.	Disc harrow	Diesel power – 18 hp Useful for 25-65 hp Tractor width - 7.5	12-14,24,26, 27
4.	M.B Plough	Material high carbon steel blade Depth of soil- 11” No. of bottom =2 hp range upto 45 hp	19-22,24,36,45
5.	Disk Plough	Material cast iron, Disc Diameter = 60 cm Adjustable tilt angle and disc angle	15-22,24,45
6.	Chisel Plough	No. of tines - 9, No. of bottom – 2, Weight - 60 kg	19-22,24,45
7.	Cultivator	Material cast iron, Tyne =30 mm Main Shafting – 85mm, Plough Share- 14×4×10 mm Bar point - 26×1×1.25 inch	24-25,37
8.	Seed cum fertilizer drill	Seed/ Fertilizer Capacity-120/115 kg Soil Opener-Shovel Seed and Fertilizer Metering-Fluted Roller Type Metering Overall Width- approx. 2600 mm Operating Width-approx 2375 mm Depth of Operation 40 to 60	29-31
9.	Power Tiller	Distance between furrow = 10.5’’ Tillage width – 32’’ Overall width- 46’’ Overall length- 45’’ soil type - medium/ Hard	1-10
10.	Chaff cutter	Hand operated chaff cutter machine. cutting capacity-up to 200kg per hr. stand height-35 inch.	24
11.	Sprayer and duster	Product type-manual backpack sprayer capacity - 16 lit weight -3kg. liquid output-50lit/hr.	23,28,32,33
12.	Engine operated Sprayer and duster	2-Stroke 42CC Engine Petrol Backpack Sprayer Cum Duster 14 to 16 L Tank	23,28,32,33

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
13.	Tractor PTO operated Sprayer and duster	Pump-50-55 LPM, Fan-500-550mm, Tank-300 to 500ltrs, Nozzle -10-15, air output- 24m/s, 2 speed , 1 neutral	23,28,32,33
14.	Air plane operated Sprayer and duster	Single-engine agricultural aircraft Capacity 700 to 800 gallons (3,028 liters) of liquid maximum speed -200 to 221 mph maximum operating altitude of 10,000 feet (3,048 meters)	23,28,32,33
15.	Set of Files	Set of files, carbon steel	1-35
16.	Set of Spanners	Pack of 12, wrench type-set.	1-35
17.	Screw Driver Set	Screw driver set	1-35
18.	Pilers Set	Piler set	1-35
19.	Rotavator	Total Width (mm)-2000-2160 Working Width (mm)1900-2050 No of Flanges-7 to11 No of Blades 35-60 Tractor HP required >50 Rotavator Height (mm) 1000-1025 Drive System- Multi-speed heavy-duty transmission gear drive	38
20.	Paddy transplanter	Horse power- 15-19hp Planting speed-1.65-2 m/s Number of planting rows-4-6 rows	41
21.	Sprayer and duster	Product type-manual backpack sprayer capacity -16 lit weight -3kg. liquid output-50lit/hr.	40
22.	Thresher	Capacity (kg/h)-1000-1200	42
23.	Harrow	Diesel power – 18 hp Useful for 25-65 hp Tractor width - 7.5	44
24.	Reaper	Material Mild Steel, weigth- 120kg Flute seed metring mechanism Field capacity - 0.25 ha/hr.	44
25.	Manual Potato Planter	Engine capacity-45-60 hp fertilizer capacity-100kg row distance-61,66cm blade type -furrow	44
26.	Happy Seeder	Power Source – 45hp Hitch type- Category-II Furrow Opener- Inverted T-type Seed & Fertilizer Openers- Separate hopper for Fertilizer and seed with mechanism for feed rate control.	39
27.	Mower	Power-1800-watt, blade size-16-inch grass box capacity-45lit. wheel dia-front-7 rear-8 cutting height-25-75mm.deck=steel	44, 45
28.	chaff cutter	Hand operated chaff cutter machine. cutting capacity-up to 200kg per hr. stand height-35 inch.	43

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Farm machinery operation, care and repair	John Deere	Medtech; 2nd edition, 2017 ISBN-10 9387938808 : ISBN-13 978-9387938809 :
2.	Tractors and their Power Units	John B. Liljedahl, Paul K.Turnquist, David W. Smith Makoto Hoki	CBS Publishers & Distributors; 4th edition, 2004 ISBN-10 8123905017 : ISBN-13 978-8123905013 :
3.	Farm Machinery Design: Principles and Problems	D. N. Sharma	JAIN BROTHERS - NEW DELHI; 2013 th edition ISBN-10 8183601421 : ISBN-13 978-8183601429 :
4.	Farm Machinery Repair and Maintenance - A Collection of Articles on Ploughs, Harrows, Drills and Other Farm Machines	Various (authors)	Read Books, 2011 ISBN-10 1446536106 : ISBN-13 978-1446536100 :
5.	Field operation and maintenance of tractor and farm machinery II	Baldev dogra	e-course online

(b) Online Educational Resources:

1) https://youtu.be/hGJKi-Sz8
2) http://ecoursesonline.iasri.res.in/.
3) vikashpediya agriculture.
4) Agimoon.com
5) Online courses.nptel.ac.in.
6) www.ciae.nic.in
7) www. Nrfmtti.com

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. Visit to KVK
2. Lab Manuals

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A) Course Code **: 2411308(P2411308/S2411308)**

B) Course Title **:** Soil Testing Practices

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

D) Rationale **:**

This course aims to present the various aspects of soil testing and generate soil test report. The student will able to prepare standard solution and chemical reagents for soil testing and practice different soil testing methods to determine various properties and estimate macro and micronutrients present in the soil. The student will be able to identify the elements of environmental concern in soil samples and recommend fertilizer, dosage and their method of application based on soil properties use modern technology (GPS/GIS) for collection of data and input recommendations

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. Test soils and prepare report for the given application.
CO-2. Analyze the effect of irrigation water on soil quality
CO-3. Use modern technology (GPS/GIS) for collection of data
CO-4. Recommend fertilizer, dosage as per the given application

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	1	1	-	1	-	-
CO-2	3	2	2	1	1	-	1	-	-
CO-3	3	1	1	1	1	-	1	-	-

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2411308	Soil Testing Practices	-	-	04	02	06	03

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 Cl 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)	
2411308	Soil Testing Practices	-	-	20	30	20	30	100

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: Minimum basic theory

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Prepare soil profile of the given soil sample *TSO 1b.* Explain different soil survey methods *TSO 1c.* Describe the procedure for soil analysis *TSO 1d.* Analyze the given soil	**Unit-1.0 Importance of soil testing** 1.1 Definition of Soil, Concept of Lithosphere, Soil as a natural body, 1.2 Formation of Soil, Soil Components: Air, Water, inorganic and organic solids, Types of Soils & Basic Concepts, soil survey methods 1.3 Soil Profile & Classification Soil profile 1.4 Soil Testing and soil Analysis, Purpose of Soil	CO1

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	testing and analysis	
TSO.2a Classify the properties of soil *TSO.2b* Explain the given properties of the soil *TSO.2c* Describe the procedure for determining the given properties *TSO.2d* Describe the effects of given properties on the given soil sample *TSO.2e* Analyze the effect of irrigation water on soil quality	**Unit-2.0 Properties of soil and its testing procedures** Introduction to properties of Soil 2.1 Physical Properties: - Soil Separates, Texture, Aggregation and Structure, Temperature, Colour, Properties of Soil Mixture, Pore Space, Bulk Density, Particle Density, Aeration and Drainage, Compaction, Surface area, Soil water relationships. 2.2 Methods of testing physical properties and instruments and equipment required 2.3 Chemical Properties: - Morphology of Colloids, Chemistry of Clays, Ionic Exchange, Acidity, Alkalinity, pH, Salinity, Reactions in Liming and Acidification. 2.4 Methods of testing chemical properties and instruments and equipment required 2.5 Biological Properties: - Soil Organic Matter, C: N Relationships, N-Transformation, Soil Organisms, Sulfur Transformation. 2.6 Methods of testing biological properties and instruments and equipment required	CO1, CO2
TSO.3a Describe the working of the given instrument *TSO.3b* Select instruments and equipment's for the testing the given properties of the soil *TSO.3c* Explain the use of different components of soil testing kit and mobile soil testing van.	**Unit -3.0 Soil testing Instruments and equipment's** 3.1 Construction, working and function of PH Meter, Conductivity meter, spectrometer, UV-Spectrophotometer 3.2 Use of soil testing kit and mobile soil testing van. 3.3 Kjeldahl's Assembly for determination of nitrogen	CO1
TSO.4a Explain the procedure of sample collection using given method. *TSO.4b* Select field as per the requirement *TSO.4c* Describe the procedure of soil processing *TSO.4d* Follow safety precaution during soil collection *TSO.4e* Monitor the condition of crops using given method	**Unit-4.0 Soil Processing** 4.1 Sample Collection and Processing 4.2 selection of field, 4.3 Method of Soil Sample collection using conventional methods, GPS/GIS, drone 4.4 Methods of soil sample processing, 4.5 Precautions during soil collection & processing, Preservation labeling and Storage of soil samples 4.6 Monitoring the condition of crops and field using GPS/GIS and drone.	CO1, CO3
TSO.5a Prepare report on the fertility status of the soil *TSO.5b* Identify macro and micronutrient deficiency in the soil *TSO.5c* Suggest remedial measure to overcome macro and micro nutrient deficiency *TSO.5d* Prepare the soil analysis report *TSO.5e* Prepare soil test report *TSO.5f* Prepare soil survey report *TSO.5g* Recommend fertilizer for the given problems *TSO.5h* Prepare fertility map	**Unit – 5.0 Soil fertility, Soil Test Report & Fertilizer** 5.1 Fertility status of soils 5.2 Soil deficiency with respect to macro and micro nutrient components 5.3 Importance of micronutrient & macronutrient and its sources 5.4 Remedial measures to overcome deficiency. 5.5 Preparation of Soil analysis and test report, 5.6 Soil survey reports, soil distribution Fertilizer recommendation 5.7 Preparation of soil test summaries and fertility maps.	CO1, CO4

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2411308

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Prepare sample for soil testing following safety precautions	1.	Select soil sampling apparatus and equipment's for the given application	CO1
	2.	Prepare soil samples for fertility evaluation	CO1
	3.	Collect composite samples using composite sampling procedure	CO1
	4.	Prepare various chemical reagents required for soil testing	CO1
	5.	Prepare standard solutions of hydrochloric acid of different concentrations	CO1
	6.	Prepare buffer solution for soil testing	CO1
	7.	Analyze the given sample using grinding processing method.	CO1
LSO 2.1 Test soil to determine the properties and components present in the soil	8.	Determine soil texture of the given sample using feel, ribbon formation, international pipette, and buoyancy hydrometer method	CO1, CO2
	9.	Determine saturation moisture percentage in the given sample	CO1, CO2
	10.	Determine bulk density of the given sample using Weighing bottle, Clod and Core method	CO1, CO2
	11.	Determine hydraulic conductivity of given soil sample using constant head and falling head method	CO1, CO2
	12.	Determine soil moisture content in the given sample by gravimetric and Infrared moisture meter method.	CO1, CO2
	13.	Determine PH value of given soil sample by electrometric and potentiometric method	CO1, CO2
	14.	Determine electrical conductivity of given soil samples.	CO1, CO2
	15.	Determine organic carbon in given soil sample using modified walkely & Black method, spectrophotometer method, dry combustion and wet combustion method	CO1, CO2
	16.	Determine calcium carbonate (free lime) in given soil sample using acid neutralization method and schrotus apparatus method.	CO1, CO2
	17.	Determine nitrogen in the given soil sample by alkaline potassium permanganate method	CO1, CO2
	18.	Determine phosphorus in the given soil samples by Olsen's method	CO1, CO2
	19.	Determine potassium in the given soil samples by flame photometer	CO1, CO2
	20.	Determine sodium and Sulphur of the given soil sample	CO1, CO2
	21.	Determine cation exchange capacity of the given soil sample by ammonium saturation method and sodium saturation method.	CO1, CO2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
	22.	Determine gypsum requirement of given alkaline soil samples	CO1, CO2
	23.	Determine lime requirement of acidic soil samples.	CO1, CO2
LSO 3.1 Test irrigation water to determine various properties and chemical agents	24.	Collect water samples using standard handling Procedure.	CO1, CO2
	25.	Determine pH value and electrical conductivity of the given irrigation water sample	CO1, CO2
	26.	Determine carbonates and bicarbonates in the given irrigation water sample	CO1, CO2
	27.	Determine Ca, Mg, N and chlorides in water.	CO1, CO2
	28.	Use colorimeter to determine sulphate in the given irrigation water sample	CO1, CO2
	29.	Analyze the following quality of given irrigation water sample i) Salinity, ii) Alkalinity, iii) Sodium adsorption ratio, iv) Residual Sodium carbonates (RSC), v) Specific ion toxicity (Sodium, Cloride and Boron), vi) Miscellaneous (BOD, Colour etc.)	CO1, CO2
LSO 4.1. Calculate macro and micro nutrients from different fertilizer sources	30.	Use atomic absorption spectrophotometer to extract soil micronutrient cations (Fe, Zn, Cu, and Mn) by DTPA Method.	CO1, CO4
	31.	Determine total nitrogen, phosphorus and potassium in the given manures/ composts sample	CO1, CO4
	32.	Perform BOD (Biochemical oxygen demand) and COD (Chemical oxygen demand) in waste water and in organic waste	CO1, CO4
	33.	Generate soil test report and recommend fertilizer	CO1, CO4
	34.	Use software to recommend fertilizer based on soil properties for the given situation	CO1, CO4
	35.	Prepare soil test summaries and fertility maps	CO1, CO4
	36.	Prepare soil health card for the given soil sample	CO1, CO4
LSO 5.1 Use GPS/GIS and drone	37.	Collect data using GPS/GIS	CO1, CO3
	38.	Collect location information by GPS receivers for mapping field boundaries and irrigation systems	CO1, CO3
	39.	Use GPS/GIS to navigate to specific locations in the field, to collect soil sample data or monitor crop conditions	CO1, CO3
	40.	Use GPS/GIS to accurately locate problem areas in crops for input recommendations	CO1, CO3
	41.	Use drone to monitor crop condition	CO1, CO3
	42.	Use drone to accurately locate problem areas in crops for input recommendations	CO1, CO3

L) **Suggested Term Work and Self Learning: S2411308** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

i. Discuss the effect of water content on soil
ii. Analyze the given soil report and give your opinion on the quality of the soil
iii. Assess the fertility level of the given soil
iv. Prepare soil test summaries and fertility maps.

b. Micro Projects:

i. Collect 05 samples from different sites and prepare soil test report, interpret eth result and recommend fertilizer for different soil.
ii. Visit to nearby Soil Testing Laboratory and prepare a report on different types of equipment's and instruments used, their specifications, miniatous method used etc.
iii. Visit to Farmers Fields for Collect 05 samples and prepare a soil test report containing identification of nutrients and micronutrient present in the soils.
iv. Visit nearby agricultural fields having different types of crops, collect the samples and prepare detailed soil test report and containing details of fertility status of soils, soil deficiency with respect to macro and micronutrient components, their sources & Importance. Remedial measures to overcome deficiency
v. Use website for relevant information on soil types, different types of fertilizers and their nutrient composition. Amount, time and methods of fertilizer application.

c. Other Activities:

1. Seminar Topics:
   - Maintenance of soil quality
   - Soil mineralogy
   - Material safety data sheet (MSDS) of chemicals and acid
   - Physical and chemical properties of Soil and their influence on crop and water productivity.

2. Visits: visit nearby agricultural fields having different types of crops, collect the samples and prepare detailed soil test report and containing details of macro and micronutrients analyze the same to identify soil deficiency and give remedial measure

3. Self- learning topics:
   - Soil properties affecting the determination of Texture.
   - Soil biological properties and organisms in soil.
   - Earthworms and their role in soil.
   - Role of bacteria, fungi and actinomycetes in soil.
   - Bio-fertilizers and their use in agriculture

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	-	-	30%	30%	30%	30%	30%
CO-2	-	-	20%	20%	20%	20%	20%
CO-3	-	-	25%	25%	25%	25%	25%
CO4	-	-	25%	25%	25%	25%	25%
Total Marks	-	-	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: (Not Applicable)

O) Suggested Assessment Table for Laboratory (Practical):

S. No	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA * (%)	PDA ** (%)	
1.	Select soil sampling apparatus and equipment's for the given application	CO1	50	40	10
2.	Prepare soil samples for fertility evaluation	CO1	50	40	10
3.	Collect composite samples using composite sampling procedure	CO1	50	40	10
4.	Prepare various chemical reagents required for soil testing	CO1	50	40	10
5.	Prepare standard solutions of hydrochloric acid of different concentrations	CO1	50	40	10
6.	Prepare buffer solution for soil testing	CO1	50	40	10
7.	Analyze the given sample using grinding processing method.	CO1	50	40	10
8.	Determine soil texture of the given sample using feel, ribbon formation, international pipette, and buoyancy hydrometer method	CO1, CO2	50	40	10
9.	Determine saturation moisture percentage in the given sample	CO1, CO2	50	40	10
10.	Determine bulk density of the given sample using Weighing bottle, Clod and Core method	CO1, CO2	50	40	10

S. No	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA * (%)	PDA ** (%)	
11.	Determine hydraulic conductivity of given soil sample using constant head and falling head method	CO1, CO2	50	40	10
12.	Determine soil moisture content in the given sample by gravimetric and Infrared moisture meter method.	CO1, CO2	50	40	10
13.	Determine PH value of given soil sample by electrometric and potentiometric method	CO1, CO2	50	40	10
14.	Determine electrical conductivity of given soil samples.	CO1, CO2	50	40	10
15.	Determine organic carbon in given soil sample using modified walkely & Black method, spectrophotometer method, dry combustion and wet combustion method	CO1, CO2	50	40	10
16.	Determine calcium carbonate (free lime) in given soil sample using acid neutralization method and schrotus apparatus method	CO1, CO2	50	40	10
17.	Determine nitrogen in the given soil sample by alkaline potassium permanganate method	CO1, CO2	50	40	10
18.	Determine phosphorus in the given soil samples by Olsen's method	CO1, CO2	50	40	10
19.	Determine potassium in the given soil samples by flame photometer	CO1, CO2	50	40	10
20.	Determine sodium and sulpher of the given soil sample	CO1, CO2	50	40	10
21.	Determine cation exchange capacity of the given soil sample by ammonium saturation method and sodium saturation method.	CO1, CO2	50	40	10
22.	Determine gypsum requirement of given alkaline soil samples	CO1, CO2	50	40	10
23.	Determine lime requirement of acidic soil samples.	CO1, CO2	50	40	10
24.	Collect water samples using standard handling procedure.	CO1, CO2	50	40	10
25.	Determine pH value and electrical conductivity of the given irrigation water sample	CO1, CO2	50	40	10
26.	Determine carbonates and bicarbonates in the given irrigation water sample	CO1, CO2	50	40	10
27.	Determine Ca, Mg, N and chlorides in water.	CO1, CO2	50	40	10
28.	Use colorimeter to determine sulphate in the given irrigation water sample	CO1, CO2	50	40	10
29.	Analyze the following quality of given irrigation water sample i) Salinity, ii) Alkalinity, iii) Sodium adsorption ratio, iv) Residual Sodium carbonates (RSC), v) Specific ion toxicity (Sodium, Cloride and Boron), vi) Miscellaneous (BOD, Colour etc.)	CO1, CO2	50	40	10
30.	Use atomic absorption spectrophotometer to extract soil micronutrient cations (Fe, Zn, Cu, and Mn) by DTPA Method.	CO1, CO4	50	40	10
31.	Determine total nitrogen, phosphorus and potassium in the given manures/ composts sample	CO1, CO4	50	40	10
32.	Perform BOD (Biochemical oxygen demand) and COD (Chemical oxygen demand) in waste water and in organic waste	CO1, CO4	50	40	10

S. No	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA * (%)	PDA ** (%)	
33.	Generate soil test report and recommend fertilizer	CO1, CO4	50	40	10
34.	Use software to recommend fertilizer based on soil properties for the given situation	CO1, CO4	50	40	10
35.	Prepare soil test summaries and fertility maps	CO1, CO4	50	40	10
36.	Prepare soil health card for the given soil sample	CO1, CO4	50	40	10
37.	Collect data using GPS/GIS	CO1, CO3	50	40	10
38.	Collect location information by GPS receivers for mapping field boundaries and irrigation systems	CO1, CO3	50	40	10
39.	Use GPS/GIS to navigate to specific locations in the field, to collect soil sample data or monitor crop conditions	CO1, CO3	50	40	10
40.	Use GPS/GIS to accurately locate problem areas in crops for input recommendations	CO1, CO3	50	40	10
41.	Use drone to monitor crop condition	CO1, CO3	50	40	10
42.	Use drone to accurately locate problem areas in crops for input recommendations	CO1, CO3	50	40	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

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

P) Suggested Instructional/Implementation Strategies: Visit to commercial Nurseries /Agricultural Universities /KVK.

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

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Apparatus and materials: Khurpi, Spade, Augers, Plastic bowl, Scale, Rack wooden roller, Mortar-pestle - Sieve, polythene/ paper/cloth bags, Labels, Card board cartons, Aluminum boxes	1 set of each Khurpi, Spade, Augers, Plastic bowl, Scale, Rack wooden roller, Mortar-pestle Sieve, polythene/ paper/cloth bags, Labels, Card board cartons, Aluminum boxes	1,2,3, all
2.	Measuring tape, Zindra, Dori (Nylon rope), Wheel hand hoe, Weighing balance (with accuracy nearest 0.1%), Moisture cans or containers with lid Glass rod, Tongs, Desiccators	1 set of each Measuring tape, Zindra, Dori (Nylon rope), Wheel hand hoe, Weighing balance (with accuracy nearest 0.1%), Moisture cans or containers with lid Glass rod, Tongs, Desiccators	All
3.	Electronic analytical top loading Balance (0.0001 g) precision	• Weighing range: 220g-250g • Calibration: Built in & automatic. • Readability: 0.1 mg • Linearity: ± 0.2 mg	All

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		• Reproducibility: ≤ 0.1 mg • Display: LCD [Liquid Crystal Display] - UNI block/ mono block/ monolithic cell weighing technology - Bi-directional RS-232 data interface port - Overload protection - Levelling feet; level indicator	
4.	Hot air oven (Temperature range 250ºC)	• Forced convection system to ensure good mixing, strong dispersion and maintains higher temperature uniformity inside the chamber. • Synthetic door gasket made of neoprene on the double walled door. • User oriented design of shelves makes you adjust each space of shelves without difficulty. • Adjustable two ventilation slides control inner air / vapour circulation. • Beaded heating elements are placed in ribs, at bottom and sides for uniform heat distribution. • Temperature Range 50°C to 250°C±1°c • Temperature controlled by digital temperature indicator cum controller in conjunction with temperature sensor. • Uniformity maintained by air circulating fan.	9
5.	7 in 1 Soil Integrated Sensor EC PH NPK Moisture Temperature Meter Soil Testing Kit	• Power Supply- 12-24V DC • Output Singal- RS485/4G/NB-IoT/LORA • Protection level- IP68 • Temperature measuring range- 45℃-115℃ • Moisture measuring range- 0-100%RH • PH measuring range - 3-9PH • NPK measuring range- 0-1999mg/kg • EC measuring range- 0-10000us/cm • Temperature precision- ±0.5℃ • Moisture precision- ±3% in 0-53% range; ±5% in 53-100% range • PH precision - ±0.3PH • NPK precision- 2% F.s • EC Resolution- 10us/cm • Response time- ＜1s	12
6.	Infrared moisture meter method.	• Measuring Range-3.5 % to 40 % • Operating Temperature-0-50 Degree Celsius • Accuracy - +/- 0, 2% • Power Source-Electric • Resolution- +/- 0, 1%	12
7.	Microcontroller based pH System with electrode & Temp. probe (Auto Temp. Compensation)	Microcontroller based. • Measures pH, mV-Absolute, mV-Relative and temperature • 3- point calibration for pH • 2 Combination of calibration for pH can be stored and recalled • Automatic & Manual temp compensation for pH 50 or more readings of pH can be stored in battery back-up memory and retrieved through a printer • Alphanumeric display • Facility to measure slope of electrode.	13,25

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		pH Range: 0 to 14 pH, Milli volt Range : 0 to +/- 1999.9 mV., Temperature range : 0 to 99.9 Degree Celsius, Resolution : pH : 0.001 pH, Relative accuracy for pH : : ±0.002 pH ±1 digit, Stability: 0.002 pH per hour. 0/14 pH Special combined Electrode, Temperature probe, Electrodes stand, Printer port 25 pin D type Epson compatible, Instruction Manual	
8.	Microprocessor Based Conductivity Meter with Cells (1.0CC & 0.1CC) and Temp. probe,	• Conductivity- Range: 0.1 /uS to 100 mS. (6 decadic ranges), Accuracy: ±1% of F.S. ±1 digit. • TDS- Range: 0.1 ppm to 100 ppt. (6 decadic ranges), Accuracy: ±1% of F.S. ± 1 digit. • Temperature- Range: 0 Degree Celsius to 100 Degree Celsius, Resolution: 0.1 Degree Celsius, Accuracy: ± 0.2Degree Celsius ± 1 digit • Other features required- Cell Constant: Acceptable from 0.1 to 5.0, Auto temp. Compensation: 0 Degree Celsius to 100 Degree Celsius with PT 100 sensor. • Manual temp. Compensation: 0 Degree Celsius to 60 Degree Celsius users selectable. • Conductivity temp. Co-efficient: 0.0% to 9.9% user selectable. • Display: (3 digits for TEMP/TEMPCO, 4 Digits for Conductivity/TDS). With automatic decimal point selection. • TDS-factor: 0.00 to 9.99 user selectable. • Standard Accessories: Conductivity Cell, Cell constant 0.1, Conductivity Cell, Cell Constant 1.0, Temperature probe (PT-100 sensor), Stand & Clamp, Instruction Manual	14, 25
9.	Smart UV-VIS Spectrophotometer (Double Beam & Graphic LCD)	• Bandwidth 2.00 nm • Optics: Double Beam optics, Modified Czerny-Tuner Monochromator geometry for better aberration correction. • Holographic diffraction grating with 120 lines/mmblazed at 250nm. • Control: Micro Controller Base. • Wavelength Range: 200 to 1100nm. • Accuracy: +/-0.5nm • Repeatability: +/-0.2nm. • Resolution: +/-0.1nm • Bandwidth: 2.0nm • Photometric • Range: +/-2.5Abs. • Accuracy: +/-0.005Abs at 1.0Abs. • Repeatability: +/-0.002Abs at 1.0Abs. • Stray Light: Less than 0.05%T at 220nm and 370nm. • Scan Speed: Slow, Medium, Fast • Data Interval: Depends on wavelength scan range and scan speed; Minimum possible 0.1nm for slow, 0.2nm for medium and 0.4nm for fast scan speeds. • Sample Holder: 5-position automatic positioning, for 10mm sample cuvettes and 1 fixed position for 10mm Ref. Cuvette. • Source: (1) Tungsten-Halogen lamp (Preferred	15, 18, 20, 31

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		usage 320nm to 1100nm) • (2) Deuterium lamp (Preferred usage 200nm to 320nm) • Detector: Photo Diode.	
10.	Double beam Atomic Absorption Spectrophotometer	• Computer controlled true double beam Atomic Absorption Spectrophotometer. • Eight Lamp automatic turret with independent eight power supplies. • Ebert Monochromator with Wavelength range 190-900 nm. holographic • Grating 1800 lines/mm. Focal length 330mm. • Capable of wavelength location by automatic peak searching, auto loading of all parameters and auto bandwidth selection & continuously variable • selection 0.2-2.0 nm with D2 lamp background correction. • Titanium burners for C2 H2 -N2O path length 50 mm & C2H2- AIR path length 100 mm with precise knobs for burner optimization i.e. height, rotational & lateral, Fully inert nebulizer. • System with automatic flame changeover, Full safety interlock including pressure sensors on both lines, power failure protection, burner interlock and flame sensor, flame ignition should be automatic • PTFE spray chamber and adjustable impact bead aerosol. • PC operating AAS software embedded with able to run with MS windows software should be compliance with international quality norms and have upgradeable facility • Suitable Computer system ISO certified and printer should be quoted. The system may also be upgraded with all major accessories. Suitable for 230V:50/60 Hz operation. • Single element Hollow Cathode Lamps Cu/Zn/Mn/Fe/Ni/Cr/Ag/Cd/Sn/Pb/Mg/Na etc. • Software: System should have facilities of repeat of result of same sample & data treatment, Automatic calculation of percentage in base material. • Accessories: Acetylene and Nitrous Oxide cylinder with regulator, air compressor, air filter, voltage stabilizer Spares and consumables for 2 years operations. SS Exhaust Fume Hood with inert centrifugal blower • Instruction manual & Circuit diagram to be provided. • Vapour Generation Accessory -for ppb level of Arsenic, Mercury, Selenium, Antimony and other Hydride forming elements.	30
11.	Automatic Nitrogen Estimation System	Automatic Nitrogen Analyser for determination of Total & Available Nitrogen **Automatic Distillation System** • Auto-sequencing Programmable Microprocessor based Distillation with inbuilt	17,31

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		software, Colour Touch Screen high resolution TFT LCD Display, Large 4.3" screen, Auto Intelligent run of programmable steps, • Addition of Boric Acid, Dilution, KMNO4 Addition for Available Nitrogen, Alkali Addition, Steam Processing, Residue Removal, Process over indication with alarm with inbuilt delay time features, • Automatic Titration Connectivity feature for future upgradation, Aspiration of Receiver Residue. • Flow diagram display to show live auto sequencing steps at each stage of process,Data table export to excel • Facility to program and control distillate volume for determination of available nitrogen • Auto sensing of no water condition in condenser & steam generator with alarm & signal to alert user & Auto deactivation of operation in case of user non-availability • Enables automatic monitoring and measuring of high temperature in distillate with auto warning signal and safety alarm. Continuously measured temperature is displayed digitally. • Auto door open warning indication, Auto tube insert error indication. Auto deactivation of System on error diagnosis, Adjustable steam power, • Auto online water saving mechanism, Auto reagent Level Sensor with Alarm for Reagents, • Stainless steel non-corrosive steam Generator • Inbuilt Automatic Printer for direct print out of results without connecting to PC. • Automatic calculation of results on input of titre value in terms of percentage of Protein/N2. • Automatic water level monitoring & Perilstatic pump for reagents addition.	
12.	Agricultural Soil Testing Kit	• Tests 14 parameters of soil, can recommends crop-specific fertilizer dose for over 100-110 crops • Mobile connectivity, Computer connectivity, In-built thermal printer, Solar charging facility, In-built battery back-up	8-23
13.	Microprocessor based Flame Photometer with Na, K filters and Compressor	Microprocessor based • Up to four elements measured with single aspiration. • Automatic filter selection • Curve fittings for nonlinear ranges (up to 5 standard) • Records kept of Date and Time of Analysis • Saved setup cut operation steps. • 4-Line ,20 Character alphanumeric LCD READOUT • Centronics printer port for Epson compatible dot matrix/Inkjet5 and Laser printers • Oil free Compressor with built in Air filter and Air Regulator	19,31

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number

		• RS-232 Interface (Optional)
		Specifications
		• Range of operation:
		  • Na 10 ppm 100 ppm.
		  • K 10 ppm. 100 ppm.
		  • Li 2 ppm. 50 ppm.
		  • Ca 100 ppm. 300 ppm.
		• Curve fit software is provided for high concentrations mode.
		• Full Scale Sensitivity:
		- Na: 2 ppm K: 1 ppm Li : 1 ppm Ca : 30 ppm.
		• Minimum Detective Limit:
		- Na: 0.2 ppm K: 0.1 ppm Li: 0.1 ppm Ca: 3 ppm.
		• Filters (10 nm Typical) : Na and K supplied
		• Reproducibility: Low Conc.: + 1% f.s.; High Conc.: + 2% f.s.
		• Operating Air pressure: 0.45 kg / cm2 (typical)
		• Oil free Air Compressor: With built-in air regulator and air filter to deliver stable and moisture/oil free air supply.
		• Fuel Gas: LPG
		• Calcium Filter.
		• Lithium Filter	

14.	Automatic Sulfur Analyzer	• Machine Type- Automatic • Frequency- 50Hz • Sample Weight -40 mg to 100 mg • Power- 4kW • Testing Time- 4 to 5 min per sample • Voltage- 230V +10V • Temperature Controlling Precision- +-5 Degree Celsius • Testing Range -> 0.01% • Furnace Temperature Range-1150-1300 Degree Celsius (Coal), 920 Degree Celsius (Oils)	20
15.	Oxygen Bomb Calorimeters	• Oxygen bomb calorimeter with three modes: dynamic, classical adiabatic and isoperibol • Three different starting temperatures: 22°C, 25°C or 30°C • Spherical-top decomposition vessel offers better heat transfer • Touchscreen operation and compatible calorimeter software • Voltage: 115 V • Cooling Method: Water Flow • Chiller, Halogen Resistant • Maximum Working Temperature: 25°C to 40°C	28
16.	Mobile soil testing van.	Mobile soil testing van with facilities to collect soil and water sample and soil and water testing facilities	All
17.	Rotary Flask Shaker (Variable speed Horizontal For shaking solution in glass flasks)	Rotary Flask Shaker (Variable speed Horizontal For shaking solution in glass flasks. • Compact bench model unit with heavy platform to hold Erlen Meyer Flasks from 50 ml. to 1000 ml. capacity. • The platform should be mounted on ball bearing crank shafts to give an orbital circular motion to flasks.	All

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		• The diameter of the orbit should be approx 2". • The assembly should be mounted on casing which houses a motor coupled by means of V Belt with pitch pulley with speed regulator, digital speed meter, digital timer and stainless-steel top. • Platform should hold HP (Motor) and SS Lotus clamps for conical flasks of size. 50ml, 100 ml,150, 250 ml, 500 ml and 1000 ml	
18.	respirometric Control meter	self-check measurement, Suitable for large sample volumes - up to 100 parallel samples	32
19.	Refrigerator	250 litre	All
20.	Glassware's for all analysis burette, pipette, beakers, volumetric flasks, storage bottles, water bottles etc as per requirements	Glassware's for all analysis burette, pipette, beakers, volumetric flasks, storage bottles, water bottles etc as per requirements	All
21.	Chemicals for all reagents as per requirements	Chemicals for all reagents as per requirements	All
22.	Kjeldahl Digestion Distillation Unit	• Units of test- 3 test to 6 tests • Heater • Flask capacities- 30 ML, 50 ML & 100ML 300 ML & 500 ML • Max. temperature-350°C to 400°C • Rating-200 watts - Clamps, Lead fume duct, Condenser rack • Power supply-220 Volts 50Hz	17
23.	Gas cylinders with regulators	a) LPG b) Acetylene c) Nitrous Oxide	
24.	Soil cores	Designed for Bulk density determination	10
25.	Compact Irrigation Water Testing Kit - With EC Meter	Compact Irrigation Water Testing Kit - With EC Meter	26-30
26.	GPS system with mobile phone	GPS system with mobile phone	37-40
27.	Free Softwares like Soil Test Pro 2.1.5, Boring Log & Soil Testing Software 4.0 Or software purchased by institute.	Use free softwar/paid software for generating soil test report and soil analysis for practice	33-36
28.	Agricultural drone		41-42

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Farm machinery operation, care and repair	John Deere	Medtech; 2nd edition, 2017 ISBN-10 9387938808 : ISBN-13 978-9387938809 :
2.	Tractors and their Power Units	John B. Liljedahl Paul K.Turnquist David W. Smith Makoto Hoki	CBS Publishers & Distributors; 4th edition, 2004 ISBN-10 8123905017 : ISBN-13 978-8123905013 :
3.	Farm Machinery Design: Principles and Problems	D. N. Sharma	JAIN BROTHERS - NEW DELHI; 2013 th edition ISBN-10 8183601421 : ISBN-13 :978-8183601429
4.	Farm Machinery Repair and Maintenance - A Collection of Articles on Ploughs, Harrows, Drills and Other Farm Machines	Various (authors)	Read Books, 2011 ISBN-10 1446536106 : ISBN-13 978-1446536100 :
5.	Field operation and maintenance of tractor and farm machinery II	Baldev dogra	e-course online

(b) Online Educational Resources:

1) https://youtu.be/hGJKi-Sz8
2) http://ecoursesonline.iasri.res.in/.
3) vikashpediya agriculture.
4) Agimoon.com
5) Online courses.nptel.ac.in.
6) www.ciae.nic.in
7) www. Nrfmtti.com

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. Visit to KVK
2. Lab Manuals

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