Program Name : **Electrical Engineering Program Group**
Program Code : **EE/EP/EU/IE/IS**
Semester : **Second**
Course Title : **Applied Science (Physics & Chemistry)**
Course Code : **22211**

1. RATIONALE

Diploma engineers (also called technologists) have to deal with various materials and machines. The study of concepts and principles of science like capacitance and current electricity, electromagnetic induction and alternating current, photo-sensors and LASER, water treatment and analysis, electrochemistry and batteries, metals, alloys, insulators and others will help them in understanding the engineering courses where emphasis is laid on the applications. This course is developed in the way by which fundamental information will help the diploma engineers to apply the concepts and principles of advanced science in various engineering applications to solve broad based problems.

2. COMPETENCY

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

- **Apply principles of advanced physics and chemistry to solve broad based engineering problems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Use relevant capacitors in electrical circuits.
b. Use equipment/instruments based on radioactive and ultrasonic principles.
c. Use equipment/instruments based on photoelectric effect, X-Ray and LASER.
d. Select relevant water treatment process for various applications.
e. Use relevant electrolyte in batteries for different applications.
f. Use relevant metals, alloys and insulating materials in various applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
2	-	2	6	90 Min	70*#	28	15*	00	100	40	25@	10	25	10	50	20
2	-						15*	00			25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment (5 marks each for Physics and Chemistry) to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *- Practical;* ***C*** *– Credit,*
ESE *- End Semester Examination;* ***PA*** *- Progressive Assessment*
Note: *Practical of Chemistry and Physics will be conducted in alternate weeks for each batch.*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

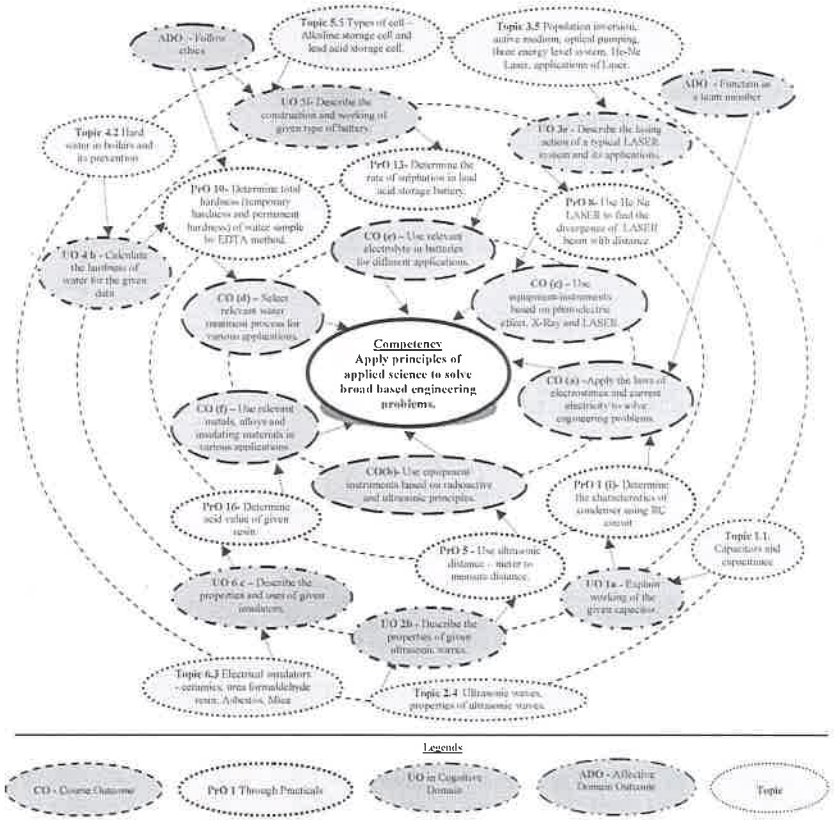

Figure 1 - Course Map

6. SUGGESTED PRACTICALS / EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Physics		
1	i) Use condensers to increase and decrease the equivalent capacity of the circuit. ii) Determine the characteristics of condenser using RC circuit.	I	02
2	i) Use meter bridge to determine the equivalent resistance of the conductors in series and parallel. ii) Use meter bridge to estimate specific resistance of a given wire.	I	02
3	i) Use potentiometer to compare emf of two cells. ii) Use potentiometer to find internal resistance of a cell.	I	02
4	Use resonance tube to determine velocity of sound.	II	02
5	Use ultrasonic distance – meter to measure distance.	II	02
6	i) Use photoelectric cell to see the dependence of photoelectric current on intensity of light. ii) Use photoelectric cell to see the dependence of photoelectric current on plate potential.	III	02
7	Use LDR to see the dependence of resistance of LDR on intensity of light.	III	02
8	Use He Ne LASER to find the divergence of LASER beam with distance.	III	02
	Chemistry		
9	Determine alkalinity of water sample	IV	02
10	Determine total hardness (temporary hardness and permanent hardness) of water sample by EDTA method.	IV	02*
11	Determine specific conductance and equivalence conductance of given salt sample solution.	V	02
12	Determine equivalence point of acetic acid and ammonium hydroxide using conductivity meter.	V	02*
13	Determine chloride contents in a given water sample by Mohr's method	V	02
14	Prepare the Thiokol rubber.	VI	02
15	Separate two miscible liquids like acetone and water using distillation technique.	VI	02
16	Determine acid value of given resin.	VI	02*
		Total	32

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safe practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Demonstrate working as a leader/a team member.
e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Exp. S. No.
1	Digital multimeter : 3½ digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max), A_{dc}, A_{ac} (10 amp max), Hz, Resistance (0 - 100 MΩ), capacitance and Temperature	1,2,3,6,7
2	Micrometer screw gauge : Range : 0-25mm, Resolution: 0.01mm Accuracy: ±0.02mm or better	2
3	Resistance Box: 4 decade ranges from 1 ohm to 1KΩ, accuracy:0.1%-1%	1,2,3,6,7
4	Battery eliminator : 0-12 V, 2A	1,2,3,6,7
5	Meter bridge, Galvanometer and Jockey	2
6	Potentiometer	3
7	Ultrasonic distance meter	5
8	Resonance tube, tuning fork	4
9	Daniel cell and Leclanche cell	2
10	LASER kit	8
11	Conductivity meter; conductivity range – 0.01 uS/cm to 200 mS/cm, Cell constant – digital 0.1 to 2.00; Temp. range – 0 to 100°C	11,12
12	Electronic balance, with the scale range of 0.001gm to 500gm pan size	All

S. No.	Equipment Name with Broad Specifications	Exp. S. No.
	100 mm; response time 3-5 sec.; power requirement 90-250V, 10 watt	
13	Simple distillation unit	15

8. UNDERPINNING THEORY COMPONENTS

9. The following topics/subtopics are to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	Physics	
Unit – I Electricity and Capacitance	1a. Explain working of the given capacitor. 1b. Calculate the equivalent capacity and energy stored in the given combination of capacitors 1c. Calculate the voltage in various components of the given electric circuit. 1d. Calculate the value of the given resistance using the principle of Wheatstone's bridge. 1e. Calculate the emf of the given cell using potentiometer.	1.1 Capacitors and capacitance. 1.2 Parallel plate capacitor, effect of dielectric on capacitance 1.3 Combination of capacitors, energy stored in a capacitor. 1.4 Cells, emf of cell, internal resistance of cell, Kirchhoff's laws, Wheatstone's bridge. 1.5 Potential gradient, potentiometer.
Unit– II Radioactivity and Ultrasonic Waves	2a. Describe the phenomenon of radioactivity for the given system. 2b. Calculate half-life period of given radioactive substance. 2c. Calculate the value of the period, frequency and velocity of the given type of wave. 2d. Describe the properties of given ultrasonic waves. 2e. Describe the properties of the given Piezo-electric material. 2f. Explain the production of ultrasonic waves using the given equipment. 2g. Describe the Doppler effect for the given application.	2.1 Radioactivity, α, β and γ particles/ rays and their properties, 2.2 Radioactive decay law, half-life period. 2.3 Sound waves, amplitude, frequency, time - period wave-length and velocity of wave, relation between velocity, frequency and time - period of wave. 2.4 Ultrasonic waves, properties of ultrasonic waves. 2.5 Piezo-electric effect. Piezo materials; Natural: Quartz, Synthetic: Gallium orthophosphate 2.6 Generation of ultrasonic waves using Piezo electric effect. 2.7 Applications of ultrasonic waves. 2.8 Doppler Effect and its applications.
Unit– III Photo electricity,	3a. Explain concept of photoelectric effect for the given materials. 3b. Explain the working of the given	3.1 Planck's hypothesis, properties of photons, photoelectric effect: threshold frequency, threshold

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
X-Rays and LASERs	photoelectric cell and LDR.	wavelength, stopping potential, Work function, characteristics of photoelectric effect, Einstein's photoelectric equation. 3.2 Photoelectric cell and LDR: principle, working and applications.
	3c. Explain the production of X-Rays from given material with its properties and applications.	3.3 Production of X-rays by Modern Coolidge tube, properties and applications of X-rays.
	3d. Differentiate between LASER and given colour of light. 3e. Describe the lasing action of a typical LASER system and its applications.	3.4 Laser, properties of laser, absorption, spontaneous and stimulated emission. 3.5 Population inversion, active medium, optical pumping, three energy level system, He-Ne Laser, applications of Laser.
	Chemistry	
Unit-IV Water treatment and analysis	4a. Describe the hardness in given water source. 4b. Calculate the hardness of water for the given data. 4c. Describe the effects of hard water in the given boilers. 4d. Explain the given type of water softening process. 4e. Describe the purification of municipal water for the given process. 4f. Describe the reverse osmosis process for the given type of water. 4g. Describe the given process of desalination of water.	4.1 Hardness: Types of hardness, soap solution method, EDTA method. 4.2 Effect of hard water in boilers and prevention: Boiler corrosion, caustic embrittlement, priming and foaming, scales and sludges 4.3 Water softening: Lime soda process (hot lime soda and cold lime soda process), zeolite process, ion exchange process (cation exchange and anion exchange). 4.4 Municipal water treatment: Sedimentation, coagulation, filtration and sterilization. 4.5 Waste water: Characteristics, BOD and COD, Sewage treatment, recycling of waste water. 4.6 De-salination process by reverse osmosis.
Unit –V Electrochemistry and Batteries	5a. Differentiate the electrical conductance in given metals and electrolytes. 5b. Identify factors affecting conductivity of the given solution. 5c. Describe construction of given	5.1 Electrical conductance in metals and electrolytes, specific conductance, equivalent conductance, cell constant. 5.2 Conductance: Nature of solute, nature of solvent, temperature, concentration or dilution.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	electrodes. 5d. Describe the process for calculation of the strength of given acid and base. 5e. Calculate specific and equivalent conductance of given electrolyte. 5f. Describe construction and working of given type of battery.	5.3 Electrodes: Hydrogen electrode, calomel electrode and glass electrode 5.4 Conductometric Titration: 5.5 Batteries- Dry cell, alkaline battery, lead Acid storage cell and Ni-Cd battery, H_2-O_2 fuel cell, Lithium ion battery.
Unit-VI Metals, Alloys and Insulators	6a. Describe the properties of the given metal. 6b. Select relevant thermocouple alloy for given application. 6c. Describe the properties and uses of the given insulators. 6d. Select relevant insulator for given system. 6e. Describe given techniques of unit operation.	6.1 Properties of metals like copper, Aluminium, tungsten, platinum nickel. 6.2 Thermocouple alloy: Composition and characteristics of nickel alloy, platinum/rhodium, tungsten/ rhenium, chromel-gold/iron. 6.3 Electrical insulators: Classification. Solid - ceramics, mica, asbestos, urea formaldehyde resin and glass. Liquid-silicon fluid, Gaseous-inert gases, hydrogen and nitrogen gas. 6.4 Types of rubber : Natural and, synthetic, processing of natural rubber. Synthetic rubber : Properties and applications of Buna-N, Thiokol, Neoprene. 6.5 Process industry unit operations: Evaporation, condensation, Distillation, Energy balance and mass balance for above processes. 6.6 Nanomaterials: Applications of Fullerence, Graphene

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.

10. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
	Physics					
I	Capacitance and current electricity	8	02	03	04	09
II	Radioactivity and ultrasonic waves	12	03	04	07	14
III	Photo-electricity, X-rays and LASER	12	03	04	05	12
	Chemistry					
IV	Water treatment and analysis	12	02	04	06	12
V	Electrochemistry and Batteries.	12	03	05	06	14
VI	Metals, Alloys, Insulators.	08	02	02	05	09
	Total	**64**	**15**	**22**	**33**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note: *This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

11. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course:

a. Seminar on any relevant topic.
b. Library survey regarding Engineering Material used in different industries.
c. Prepare power point presentation or animation for showing applications of lasers.

12. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.

13. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. **Capacitors:** Prepare the models of various types of capacitors.

b. **Current electricity:** Make one circuit with bulbs/ LED/ connected in parallel or series.
c. **Photosensors**: Prepare working model of simple photosensor using LED.
d. **LASER**: Prepare the presentation on the industrial application of LASER.
e. **Water analysis**: Collect water samples from different water sources and determined the acidity, conductivity, dissolved solids, suspended particles in the sample.
f. **Water treatment:** Collect 3 to 5 water samples from borewell and determined the dosage of bleaching powder required for its sterilization.
g. **Water analysis:** Determine the soap foaming capacity of bore water on addition of soda ash.
h. **Energy sources**: Prepare chart showing different types of energy sources with their advantages.
i. **Electrolytic Cells**: Collect fruit and vegetable and prepare working model of cell.
j. **Electric Insulators:** Collect the samples of different insulators and list their industrial applications .
k. **Thermocouple**: Prepare chart showing different types of thermocouples with their characteristics used in electronic and electrical industry .

14. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Physics Textbook Part I - Class XI	Narlikar, J. V.; Joshi, A. W.; Mathur, Anuradha; *et al*	National Council of Education Research and Training, New Delhi, 2010, ISBN : 8174505083
2	Physics Textbook Part II - Class XI	Narlikar, J. V.; Joshi, A. W.; Mathur, Anuradha; *et al*	National Council of Education Research and Training, New Delhi, 2015, ISBN : 8174505660
3	Physics Textbook Part I - Class XII	Narlikar, J.V.; Joshi, A. W.; *et al*	National Council of Education Research and Training, New Delhi, 2013, ISBN : 8174506314
4	Physics Textbook Part II - Class XII	Narlikar, J.V.; Joshi, A. W.; *et al*	National Council of Education Research and Training, New Delhi, 2013, ISBN : 8174506713
5	Engineering Chemistry	Agarwal, Shikha	Cambridge university press ; New Delhi,2015 ISBN :9781107476417
6	Engineering Chemistry	Dara, S. S.	S.Chand. Publication, New Delhi, 2013, ISBN: 8121997658
7	Engineering Chemistry	Jain & Jain	Dhanpat Rai and sons; New Delhi, 2015, ISBN :9352160002
8	Engineering Chemistry	Dr.Vairam, S.	Wiley India Pvt.Ltd. New Delhi, 2013 ISBN: 9788126543342
9	Chemistry for engineers	Agnihotri, Rajesh	Wiley India Pvt.Ltd. New Delhi, 2014 ISBN: 9788126550784

15. SOFTWARE/LEARNING WEBSITES

a. http://nptel.ac.in/course.php?disciplineId=115

b. http://nptel.ac.in/course.php?disciplineId=104
c. http://hperphysics.phy-astr.gsu.edu/hbase/hph.html
d. www.physicsclassroom.com
e. www.physics.org
f. www.fearofphysics.com
g. www.sciencejoywagon.com/physicszone
h. www.chemistryteaching.com
i. www.visionlearning.com
j. www.chem1.com
k. www.onlinelibrary.wiley.com
l. www.rsc.org
m. www.chemcollective.org
n. www.wqa.org
o. www.em-ea.org